Kincardine Coastal Stewardship Plan



2011

the Coastal Centre

THE LAKE HURON CENTRE FOR COASTAL CONSERVATION

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1. Introduction

Different Shores – Common Concerns

Shores are "Living Systems"

When we think of Lake Huron we often conjure images of sand beaches and the serenity of gentle waves reaching the shore. Lake Huron's coastline is really a complex web of interacting features and processes working in a delicate balance, providing us with a rich diversity for all to enjoy. The Lake Huron coastline is made up of ecosystems unlike any others in the province. It is the result of 10,000 years of evolution, developing coastal features and life forms that have made unique adaptations to the coastal environment.

Kincardine is blessed with three distinct coastal landforms that provide diversity, not only in physical form, but unique plant and animal life forms that make up the natural shore. Sandy beaches and dunes, cobble beaches and coastal wetlands comprise its coastline.

Beach and dune systems not only provide important habitat for some of the rarest plant and animal species in Ontario, but also contribute to maintaining good quality beaches, provide protection from storms, and capture blowing sand. Dune systems only make up about 1.5% of Ontario's Great Lakes coastline, making them a rare landform. They are also one of the most vulnerable ecosystems, and are in decline, mainly because of human activities. These declining ecosystems are leading to a decline in beach quality.

Coastal wetlands are different than interior wetlands. Coastal wetlands are linked to lake levels and they change with the changing water levels. These wetlands are not only important for purifying the water, but they provide habitat for over half of Lake Huron's native fish populations. Ontario has lost over 75% of its coastal wetlands due to development pressures.

Cobble beaches typically occur on high energy coastlines, as they can withstand high wave energy impacts. The cobbles provide a protective

armouring to the shoreline. Limestone cobble shores include many species that are associated with cold, fast-flowing streams, including midges, stoneflies, and mayflies. These beaches can provide valuable feeding grounds for shorebirds and fishes. Because of shoreline development, cobble beaches are becoming so scarce that they are considered globally rare.

Coastal health *is "the science and art of preventing ecological Imbalance, protecting coastal organisms and promoting ecological health through the organized efforts and informed choices of society"*

Many of the special ecosystems along the shoreline (dunes, wetlands, cobble beaches) are at risk because of people's activities that damage fragile plants, or alter the processes that sustain these ecosystems. As a result, the quality of Lake Huron's coastal environments is deteriorating. Most damage is not deliberate, but most is avoidable. Adopting practices that minimize our impacts and respects the needs of these remarkable ecosystems is one of the purposes of this plan.

Kincardine's shores have structure, function and process. They are constantly moving, changing and evolving in response to the influence of natural forces like winds and waves. The form and dynamics of the physical shore create the conditions for the presence and survival of Lake Huron's coastal plant and animal communities. If these biological resources are to be sustained and the integrity of our coastal ecosystems maintained, we must be careful how we use our shores.

Coastal Shore Services

The coast provides important benefits to the Kincardine community in the form of ecosystem "goods and services." Some of these services include improvement to water quality, flood reduction and shoreline protection, recreational use, landscape diversity and carbon storage.

More specifically, ecosystem services can be summarized into four categories:

- ***Provisioning services*** are the products obtained from ecosystems, such as food, genetic resources, and energy (for example, parts of Kincardine's shore are critical for the life cycle of fish).
- ***Regulating services*** are the benefits obtained from the regulation of ecosystem processes, such as regulation of climate, water filtration, and flood control.
- ***Cultural services*** are the non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, environmental education, reflection, recreation, and aesthetic experience.

- ***Supporting services*** are ecosystem services that are necessary for the production of all other ecosystem services. Examples include biomass production, production of atmospheric oxygen, nutrient cycling, water cycling, and the provision of habitat.

Many of these ecosystem services have not typically been identified when valuing Kincardine's coastline, or estimating what is at stake when the coastal ecosystem becomes damaged by human activities and invasive species. However, coastal residents typically describe cultural services as one of the reasons they originally settled along Lake Huron.

Threats to our Coastal Shores

More People: Development along Kincardine's shores has increased steadily over the years. More people mean more demand for access to the coast, more pollution, more stress on fragile wildlife habitat.

Public Health and Safety: Our activities which affect coastal shore processes and resources in turn affect public health and safety. These include beach postings caused by elevated pathogenic pollution, garbage left behind by beachgoers, damage caused by erosion (as experienced in past high lake levels and storms), and poor understanding by the public of risks associated with the lake (e.g. rip currents)..

Community Economics: The prosperity of coastal communities is tied directly to coastal processes and resources. Beach closures, poor water quality, loss of sand and invasive plant species contribute to higher costs and lower productivity for coastal communities.

A cautious approach to development of our coastline recognizes that "when an activity raises threats of harm to the environment or human health, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically."

Urban Shorelines: When natural shores are hardened with bulkheads, riprap, or other means, sediment movement changes along the shores and habitat is damaged or lost. Beaches can disappear, as can wildlife, plants and fish.

Cost: Ignorance of coastal processes can be expensive, both to the environment and to taxpayers. People's alteration of the coast can have long term consequences that are often unintended.

Climate Change: Over the next century, climate change is expected to have a significant impact on Lake Huron's coasts. We are already experiencing more intense precipitation patterns and higher average temperatures. We can expect

lake-effect winter storms to become more intense, with warmer fall-winter-spring seasons that will alter precipitation, ice and wind patterns. All of these changes will impact coastal features and require different management approaches.

Purpose of this Plan

This coastal stewardship plan is prepared for the Municipality of Kincardine and its residents to:

- help provide science-based recommendations for addressing current and emerging issues related to its coastal shorelands;
- Enhance and restore coastal processes, biodiversity, water quality and build resiliency towards climate change;
- Adopt practices that minimize our impacts and respects the needs of the Kincardine's remarkable coastal ecosystems.

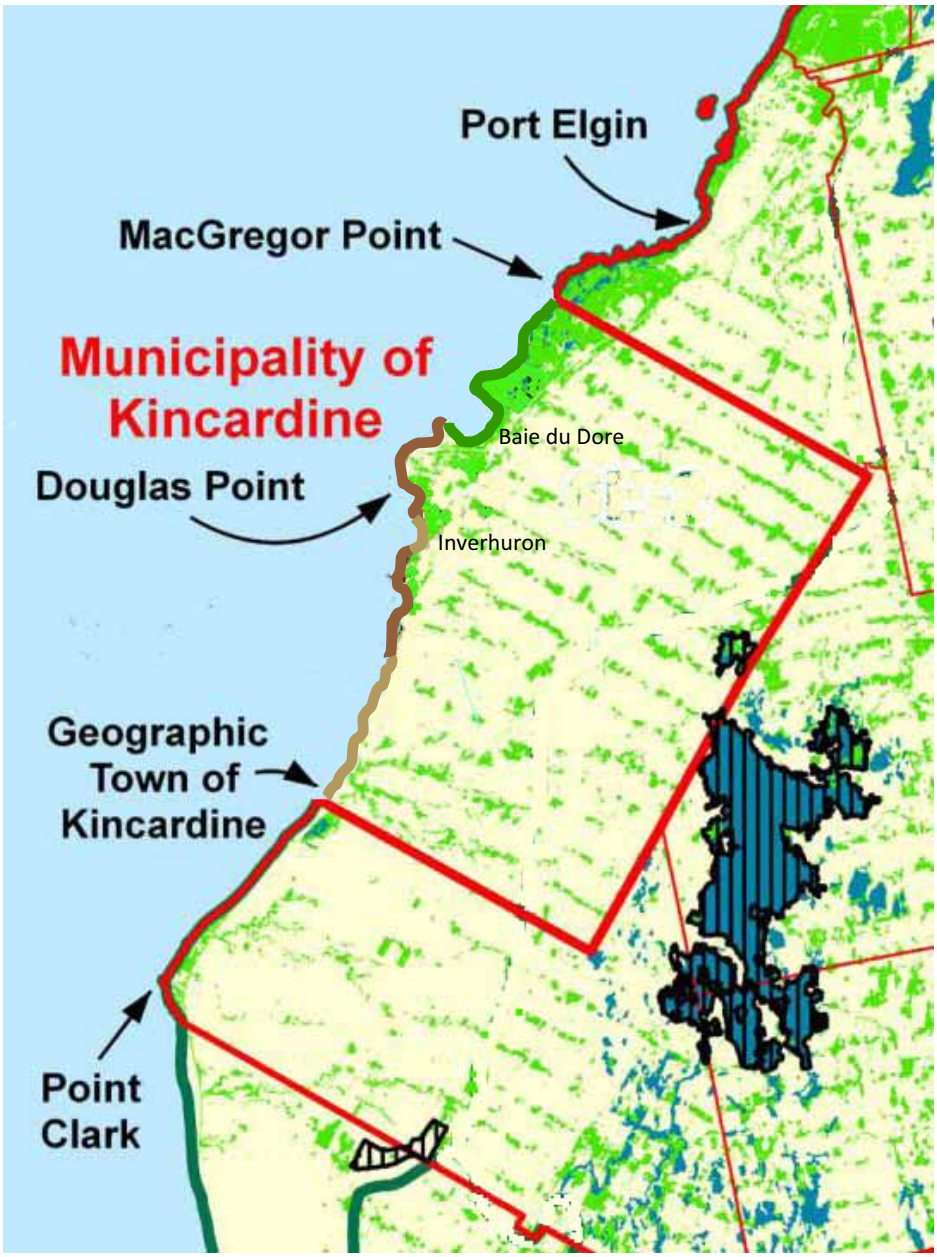
Its geographic scope is generally confined to the coastal area (nearshore, beach and Huron Fringe area). The plan covers the area from Kincardine's south border with Huron-Kinloss north to MacGregor Point Provincial Park. It does not include the Bruce Nuclear Power Development site or Inverhuron Provincial Park to any great extent, as these areas are managed externally to Kincardine.

Our coastal areas are remarkably resilient to nature's forces, yet vulnerable to human activities that alter or damage their integrity. As more people become attracted to the coast, we should expect more stresses on our ecosystems. Anticipating these impacts means that we can plan for and mitigate these stresses by implementing measures outlined in this plan. Climate change poses added uncertainties to the future of Lake Huron, but retaining the natural elements that preserve the health and quality of our coastline will provide the resiliency necessary to cope with that change.

Plan Connections

This plan supports other initiatives on Lake Huron including the work of the Lake Huron Pitcher's Thistle-Dune Grasslands Recovery Team, Lake Huron Biodiversity Strategy, Lake Huron Southeast Shore Working Group, Saugeen Conservation's watershed report cards, Source Water Protection best management practices, Penetangore Watershed Group activities and Kincardine's Natural Heritage Strategy.

Shore Types along Kincardine's Coast



Coastal wetland
Cobble Beach
Dune Grassland

2. Dune Grasslands

2. Dune Grasslands

One of Kincardine's three coastal ecosystem types includes dune grasslands, which are found at the south end of the municipality (Station Beach), and at various locations up to Inverhuron. The Station Beach dunes have regenerated after extensive restoration efforts were undertaken in the 1990s. The Inverhuron dunes are for the most part intact within the Provincial Park, but have become degraded outside of the park as a result of extensive human activities and development pressure. Opportunities for restoration and community stewardship and dune grasslands are available and would aid in restoring the health of Kincardine's coast.

(A) Some 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 rarity, spatial confinement and ecological fragility, are of national and global significance. Lake Huron's dunes are found along a small fraction (about 2 to 3%) of the lake's 6,000 kilometre shoreline. Lake Huron's dune systems, therefore, represent an extremely small land mass. They are narrow linear features restricted to localized areas along major shorelines, and their total area is quite small.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 (Bowles & Maun, 1982). 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.

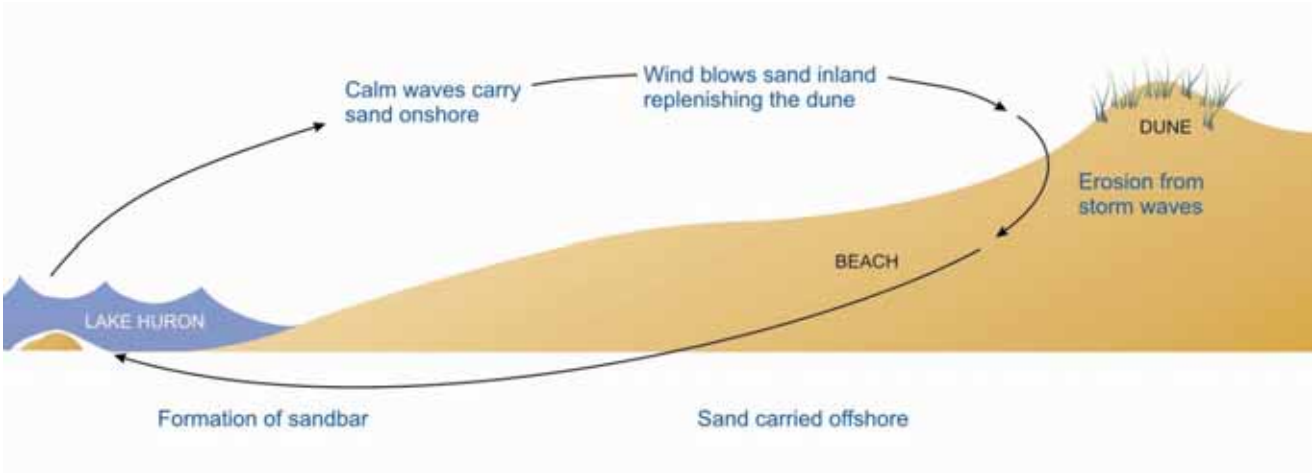
Dunes provide a range of beneficial services that provide enormous value to the community. Some of the services include shore protection, water purification, erosion control, biological diversity, beach quality and aesthetics.

Dunes are enormously rich in biological diversity, and usually contain plant communities and species that are rare. As habitat, dunes are unlike any other ecological feature in Ontario, and so they are special places, to plants, animals and people.

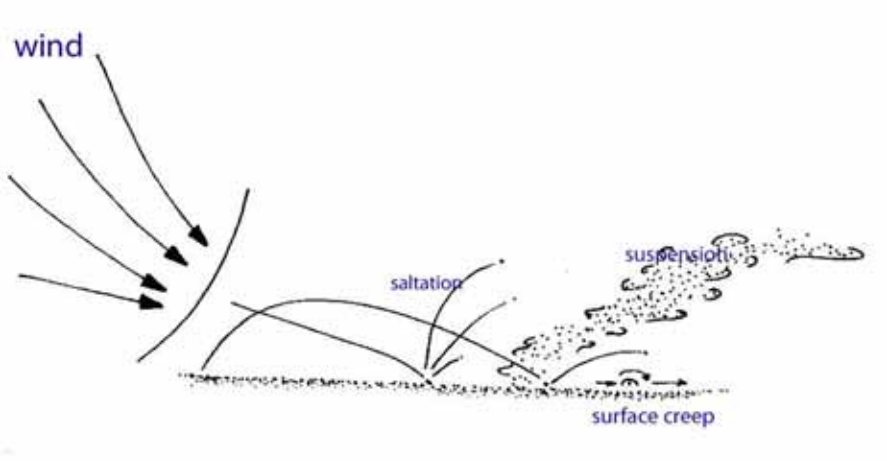
Research on Lake Huron has concluded that degraded dune areas can create the conditions that lead to elevated bacterial pollution in the groundwater below beaches. Erosion of beach sand, dunes caused by the removal or damage of dune vegetation, leads to a shallow depth to the water table, which in turn promotes wet or damp sand on the beach, the invasion and growth of non-native beach plants and a higher exposure risk to *E. coli* (Crowe, FOCA Newsletter, 2005). Conservation of beach and dune systems can help to prevent degraded beaches from occurring.

(i) Beach Processes

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



'Sand Cycle' - wind blown sand collects forming a dune. Waves will erode the dune carrying the sand to form sand bars. Sand bars protect the beach. Gentle waves gradually move sand onshore to be carried by wind back to the dunes.



Methods of sand movement in a beach environment

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. Sand particles begin to move when wind velocity reaches about 20 kph. The smallest particles (0.05-0.15 mms. in diameter) are so tiny that they float in the air: this is known as **suspension**. Slightly larger particles (0.15 -0.25 mms. in diameter) move in a hopping motion known as **saltation**. The energy of the falling grains may not be completely absorbed on impact and may therefore rebound. This may cause another particle to jump or may push a larger grain (0.25 -2 mms. in diameter) forward. These larger grains are continually bombarded by saltation and being pushed forward: this is known as **sand creep**.

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

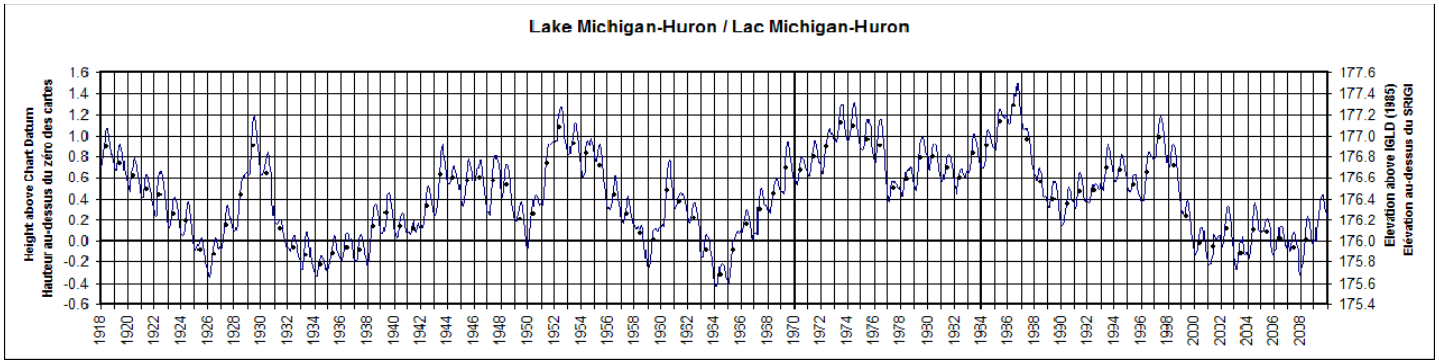
Fine sand deposits in sand dunes have greater water retention capacity than coarse sands and are therefore more suitable for vegetation growth.

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 active dune system.

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 typically finer than those on beaches. This is important because fine sand deposits have greater capacity to retain water 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 causes sand particles to stick together. The wind strength that is needed to initiate sand 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 at certain times of the year can help with determining management strategies for dune conservation and restoration efforts. Winds from the west and southwest are perhaps the most influential in the movement of sand along the shores within the Municipality of Kincardine.

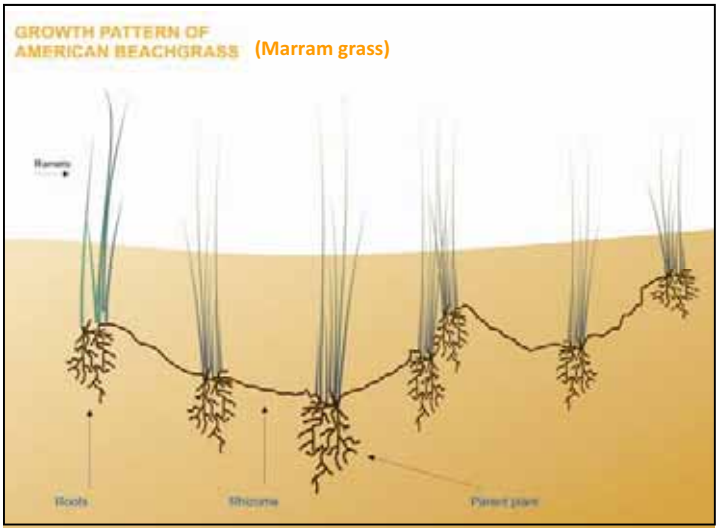
As well as wind speeds and duration, water levels play a significant role in how much sand transportation will take place. During high water levels, more of the beach is submerged and the width of dry beach is less. As a result, less of the beach is exposed to wind erosion. Conversely, during lower water levels, more of the 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.



Hydrograph showing historical water levels on Lake Huron since 1918.

(ii) Role of Dune Vegetation

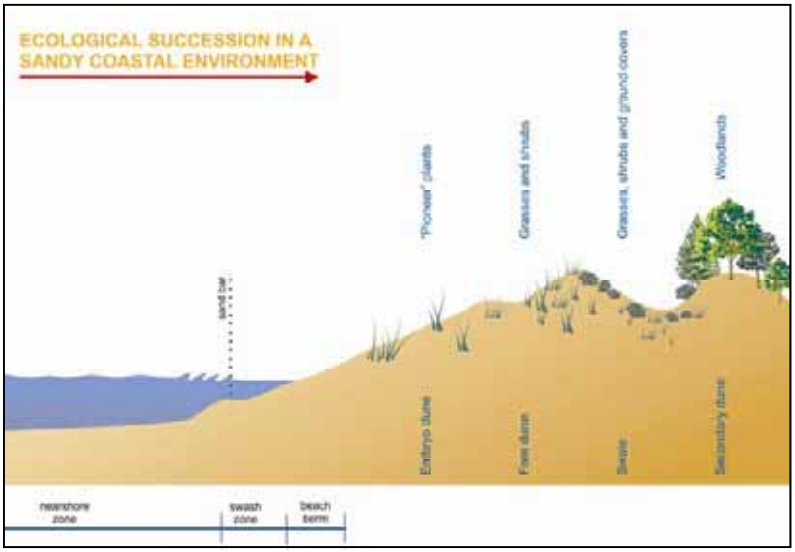
When the wind encounters an obstacle such as a clump of vegetation, the wind speed is reduced and the sand grains fall out under gravity, resulting in sand deposition. As the sand accumulation continues, a dune is formed. Dunes form when there is an adequate sand supply and onshore winds of sufficient 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.

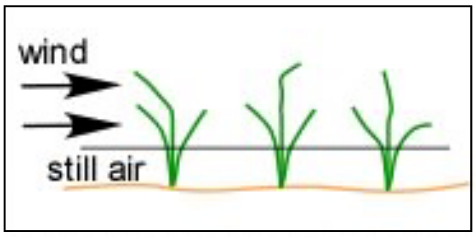
Beach and dune vegetation is typically made up of simpler plant communities that pave the way for a series of future, more complex communities. This process is known as ecological succession and you can observe this when you walk from the beach toward the dunes. You will see differences in plant composition, with grasses and flowering plants in the beach and dune area, changing to more complex plants, like shrubs and trees.



Pioneer plants (like Marram grass) 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, and can create problematic sand drifting in areas inland. Wind erosion of the beach and unvegetated foredunes results in coastline recession. Over the long term, a receding shoreline (gradually moving landward) could impact residences (stationary structures) along the lakefront.

The importance of dune vegetation to dune development is straightforward. The above-ground parts of dune plants act as obstructions, and reduces the speed of the sand-carrying wind. The reduction in wind speed results in the dropping of sand on and around the plant. There is actually a boundary layer where wind speed equals zero and it is in this zone that sand is deposited. Bare sand has a small boundary layer, whereas an area planted with Marram Grass *(Ammophila breviligulata)* has a boundary layer that is 30 times higher than the bare surface.



Marram grass (also known as 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-up. The root structure that develops can be extensive and adds structure to the dune. The roots act as a type of ‘rebar’, holding sand together, even in the face of wave erosion.

After an extensive dune restoration program at Station Beach begun by the author in the early 1990s, the shore was transformed from a gravelly textured beach with no dunes, to a fully functioning fine sand beach and dune system. The Marram grass retained the blowing sand to build sizeable dunes. Without that vegetation, sand was being blown inland and away from the shore – a permanent loss of sand from the beach system.

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 acts as 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 for initial stabilization of dunes.

Sand dune grasses are plants which have specifically adapted to the dune environment. The structure of these grasses resist sand abrasion, wind breakage and water loss. They have adapted to extreme heat (dunes can reach temperatures of 60^{C} in summer!), and to 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.

Long leaved Reedgrass

Marram grass is a common pioneer plant on the sandy beaches of the Municipality of Kincardine but the Lake Huron endemic Long Leaved Reed Grass (*Calamovilfa longifolia*) is another key dune stabilizer. Where Marram grass can tolerate a significant amount of sand burial, Long-leaved Reedgrass is less tolerant and therefore tends to develop in more sheltered 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.

(Note to Reader: Long-leaved Reedgrass, which is an important native dune species, should not be confused with Common Reed, which is an alien, invasive plant species. The names Reedgrass and Reed may sound similar, but the two are very different plants).

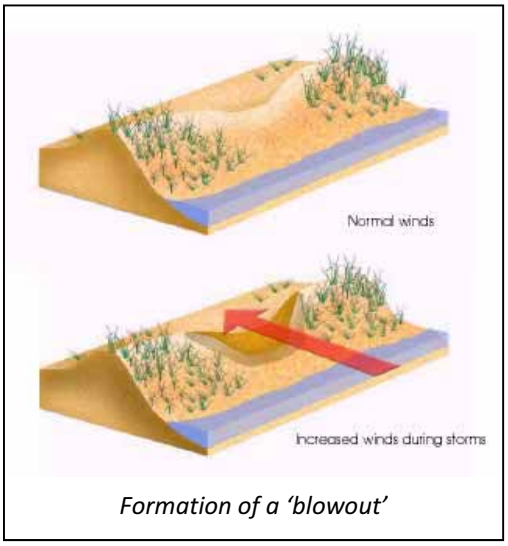
The foredune is the most critical part of the dune system, as far as coastal processes are concerned, and is the area least able to tolerate any human disturbance or development. Vegetation on the foredune builds up the dunes by

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.

Dune vegetation both binds the soil and lowers 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, usually leaving coarse sands behind.

(iii) 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.



Formation of a 'blowout'

Dunes are fragile systems and trampling by beach goers damages or 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 sands along the waterfront are mainly relic materials – ancient sands left behind thousands of years ago. There is no substantive 'new' source of sand, other than from the Penetangore and Pine Rivers, and this has been calculated to be around 410 cubic metres per year. For perspective, the amount of sand generated along the coast between Amberley and Goderich is around 25,000 cubic metres per year.

Sand drifting can also result in substantial maintenance costs to the municipality as it forms drifts along roads 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 might happen otherwise.

As discussed earlier, researchers have identified that damage to dunes and their deterioration can lead to a lowering of the beach profile. In other words, as the beach sand blows away, the beach will become wetter as the sand surface lowers toward the groundwater table. Wet sands can harbour bacteria, and increase exposure to beach goers.

The use of vehicles, including heavy equipment, all-terrain vehicles and snowmobiles, can have a profound negative impact on coastal ecosystems (see Appendix B "Damaging Wheels"). This has been identified as an emerging issue on some Kincardine beaches. Neighbouring municipalities have had to take action to restrict the use of vehicles on the lakeshore. Recreational vehicles, like ATVs and snowmobiles, should not be permitted to operate along the shores of the Municipality of Kincardine. Community education about the sensitive nature of shore ecosystems, and the need to use of ATV equipment only within designated areas of the municipality should be considered. In addition, the municipality may wish to consider posting notices throughout the lakeshore area about the prohibition of ATVs and snowmobiles and work in cooperation with the Ontario Provincial Police to enforce their restricted operation within the municipality.

(B) Beach Management – *the basics*

In recent years we have experienced a period of lower than average water levels on Lake Huron. This has resulted in much wider beaches. This period of low lake levels has given rise to the migration of dune vegetation (particularly Marram grass) toward the lake. This is a natural process which should not be disturbed. This plant migration allows the dune to develop outward and build up its sand reserve. When plants are removed or damaged, the dune tends to build upwards, often obstructing views of the lake.

Beach during high lake levels in 1985, and during low levels in 2005. Dunes need space to build up during low lake conditions, and to erode during high lake levels.

The lakeward expansion of dune vegetation during low lake levels helps the beach to retain sand (reducing wind erosion), and slows the dune building process, effectively allowing certain rare dune species to establish populations. A return of higher lake levels will cause erosion of the dune and return sand to the beach and nearshore. Maintaining this sand cycle preserves high quality beaches.
Beach and dune systems are best managed by not interfering with the natural processes, but instead accepting that wave erosion will occur during periods of high lake levels, and wind erosion and sand deposition will be more prevalent during low lake levels. Working with natural lake processes, rather than at odds with them, provides a wide range of advantages, including ecological, economic and public health benefits. Beaches and dunes are dynamic environments and physical change occurs normally and with regularity.

Mechanical beach grooming is a practice that some municipalities undertake in order to achieve a certain aesthetic. One of the problems with beach raking is that it can interrupt natural processes such that the end result is a compression of the dune (the dune isn't allowed to expand in response to lower lake conditions) and the dune will grow vertically, rather than laterally. This will eventually lead to sightline obstructions, mobility issues for people travelling over the dune to the beach, and sand drifting issues. If raking is done at all, it should be confined to the lower beach area near the water and well away from the leading edge of the dunes.

Climate Change and Beaches

How might climate change affect our beaches? Researchers project a decline in Great Lakes water levels by as much as one to two metres lower than present. This is not to say that we will not experience higher water and erosion of dunes in the future. It means the current range of lake levels (from the record high of 1985 to the record low of 1964), will shift downward. So lake levels will still fluctuate, but within a different range than to what we have been accustomed.

Projected increases in wind strength and duration would increase the likelihood of damage to vegetation, development of blowouts where susceptible, and enhanced migration of sand into the interior.

In general, lower lake levels will expose more sand along beaches, widening their expanse. Wider sand beaches will lead to more wind transported sand. If the necessary dune vegetation is not present to intercept this blown sand, both the quantity and quality of beaches will deteriorate as the fine sands migrate outside of the active beach system.

Changes in total precipitation and seasonal distribution may have a great influence on sand transport rates, since moisture content of near surface sand will influence not only the wind strength needed to begin the process of sand transport by wind, but also the vigour of the beach and dune vegetation. Lower groundwater table could have a major effect on the stability/instability of the dune system, since in active dune systems, the base level of deflation (erosion or lowering of the beach) is controlled by the position of the water table (Houston, et al., 2001). This has important management implications and means that there will be an increasing need to adopt dune conservation strategies in order to maintain the health of Kincardine's beaches and dunes.

Average temperatures in the Great Lakes region are projected to increase by as much as 2 to 4 degrees Celsius. An increase in average temperature may increase the rates of sand transport on bare sand surfaces as the higher temperatures increase the rate at which sand dries out after a rainfall.

Lower lake levels may influence the quality of nearshore waters. Lower levels create a shallower nearshore. Current low lake level conditions and current issues related to nutrient loading to the lake, and pathogenic pollution have led to the accelerated production of algae, and increased incidences of beach postings for unsafe swimming in some areas.

Lower levels and changes in precipitation and temperature regimes may also make it easier for invasive plant species to take advantage of disturbed or unpopulated parts of the beach. More efforts may be necessary to identify invasive plants and establish control programs. Plants like Common Reed, Spotted Knapweed and Sweet White Clover (and others identified in the Coastal Centre's Coastal Plant Guide) are some of the invasive plants currently taking an aggressive hold on some beach and dune areas. Management of these plants has been costly in both time and resources. Invasive plants may be an issue that will require ongoing monitoring, and appropriate control measures, in the future.

(C) Management Recommendations

(i) Station Beach

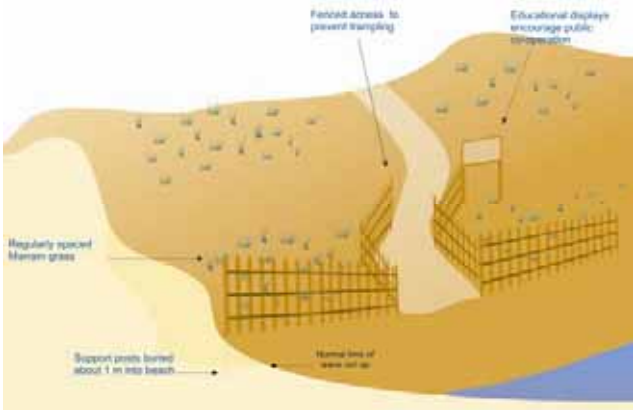
Station Beach is an exemplary example of how a beach has been restored to a level where it is a self-sustaining dune system. It is an example of how other degraded beaches could be restored. Some minor management recommendations are offered to help maintain the health of Station beach.

One of the great successes of Station Beach is that the dunes have been left to respond to changing conditions. Low lake levels since 1999 resulted in wide, exposed beach. Dune building has occurred, and Marram grass has responded by expanding lakeward, and this has helped the dunes build laterally (lakeward), minimizing the amount of growth in height. This has also benefitted the quality of the beach, retaining the fine sands within the dune system and not lost due to wind erosion.

With most dune systems where extensive human activity is experienced, and where stationary structures have been introduced into this dynamic environment, there can be sand management issues. As an example, the gazebo at Station Beach has experienced sand build-up and some burial of the wood structure from blowing sands. Designated beach access points are the pathways that people use to access the beach from the boardwalk. These sand pathways are always vulnerable to sand erosion because they are exposed to wind, and have no anchoring vegetation to prevent the erosion.

Recommendations: First, beach access pathways should take on an 'S' shaped curve which helps to prevent wind scouring that tends to occur on straight pathways where wind funnels unimpeded, and can lead to large movements of sand. An 'S' shaped path prevents a direct, open channel for wind to scour.

Second, during the off-season, sand fencing should be installed at the foot of the pathway to prevent wind scour. Since the beach access pathways are un-vegetated, they require the fencing during the high wind season (fall-winter-spring) to help cut wind velocities and prevent sand erosion.



Beach access designed with 'S' shaped curve helps prevent wind scouring that would occur on a straight pathway.

The famous beach chairs that were installed on the beach are now located within the dunes, due to the expansion of the dunes lakeward. ***Recommendation:*** To lessen impacts to the dunes, and prevent the chairs from being subsumed by sand, it would be prudent to move the chairs to a position lakeward of their current location. Maintenance staff should plan on moving the position of these chairs depending on lake level conditions and corresponding changes to the beach.

At the north end of Station Beach, adjacent to the harbour, the beach is completely without vegetation and is prone to sand erosion. Being adjacent to the harbour means that substantial amounts of sand gets deposited into the harbour, and this requires dredging maintenance from time to time.

Un-vegetated beach at the harbour is prone to wind erosion and sand drifting into the harbour. This leads to an unnecessary dredging expense.

Recommendation: An extension of the dune restoration planting in this area would greatly reduce the amount of sand being lost into the harbour. Engaging local schools to participate in a dune restoration program would support an important educational opportunity for local youth, and have the practical benefit of retaining sand on the beach and reducing maintenance costs

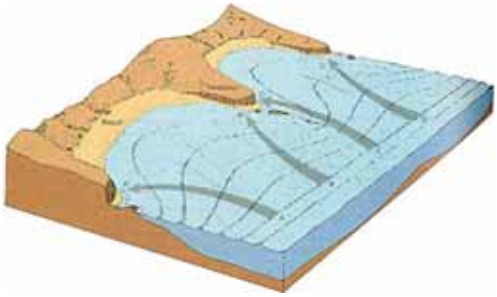
associated with dredging the harbour. The Town of Saugeen Shores was experiencing a similar issue with sand drifting into the harbour at Port Elgin. A dune restoration program there has reportedly been successful in reducing sand deposition into their harbour.

Due to the popularity of Station Beach, some issues have emerged with people creating access pathways through he dunes, causing erosion points leading to sand drifting onto the boardwalk.

Recommendation: Attempts should be made to repair these undesignated pathways during the off-season. Education efforts to promote awareness of the dunes and their vulnerabilities are a continual process, and suggestions are made regarding education later in the plan.

(ii) Inverhuron Beach

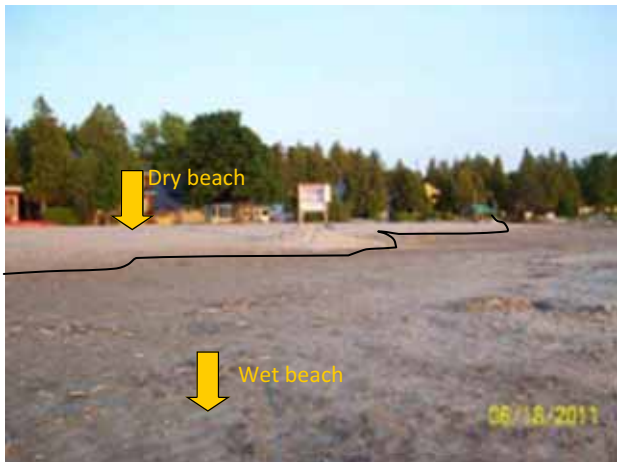
The beach and dune system at Inverhuron is an extension of the system that makes up Inverhuron Provincial Park's coastline. The dune systems is a "pocket beach" which is a term that describes beaches that are contained between two rock headlands. Inverhuron beach is made up of relic sand deposits, meaning that the sand in this area were deposited in ancient times. There is no ongoing source of sand to this beach, other than small amounts from the river, so the beach is a finite resource. It is important to have some care in managing relic beaches to avoid sand loss and resulting degradation of the beach.
It is evident that the beach managed by the Park and the beach managed by area cottagers have resulted in different outcomes. The park allows dune processes to occur naturally, and their beach retains a high quality and is naturally resistant to changing conditions. The beach on the municipal side of



Schematic diagram of a 'pocket beach'

the river lacks dune vegetation, sand erosion is prevalent and the beach is not resilient to changing conditions, and requires aggressive management to manage drifting sand. Residents report that extensive sand drifting occurs inland each year, requiring contractors to dig out sand drifts. Some sand is returned to the beach, while substantial amounts are taken away. This is not a sustainable situation.

Recent research on Lake Huron has concluded that degraded dune areas can actually create the conditions that lead to elevated bacterial pollution in the groundwater below beaches (Crowe, 2005). Removal of dunes and beach grass and the erosion of beach sand by wind leads to a shallow depth to the water table, which in turn promotes wet or damp sand on the beach, the invasion and growth of non-native beach plants including turf grass. As more sand is eroded from the surface of the beach, the distance to the water table beneath the beach decreases. As the water table comes closer to the surface, the sand will become wetter and in some cases springs will form as the water table intersects the beach surface. When combined with input of water and nutrients from beach-front residences, this leads to a wet and nutrient-rich environment favourable for plants such as cattails and sedge grass, but not favourable for natural beach vegetation such as beach grass and shrubs (Crowe, 2005).



Lack of dunes in the cottage area of Inverhuron has meant that there is no building reservoir of sand, rather, the sand continues to blow inland, lost from the active shore system.

It is possible to restore the beach to dry sandy conditions by raising the surface of the beach (i.e., greater depth to the water table). This requires residents to protect and restore the sand dunes and beach grass.

Turf grass is also implicated in the increased occurrences of *E. coli* because turf grass attracts waterfowl, like Canada Geese, which leave large amounts of their waste behind. Studies have shown a positive correlation between these degraded beaches and higher incidences in *E. coli* bacteria. These birds, on the other hand, are not attracted to native dune vegetation. Turfgrass lawns next to beaches should be converted and restored to native dune vegetation.

Recommendation: In the sandy beach area south of the river, the Inverhuron beach would benefit from the establishment of a dune restoration program to prevent further loses of sand from the system, have dunes that are able to perform their role of maintaining good quality beaches, reduce maintenance costs and reduce impacts from heavy vehicles. Beaches with dunes are more resilient to changing lake and wind conditions, and provide valuable shore protection during high lake and storm events. Installation of sand fencing along the entire portion of the beach requiring conservation measures would initially help to lessen the flow of sand inland. Marram grass (*Ammophila breviligulata*) should be planted behind the fencing to provide a sustainable sand collection system. Once the grasses are established, fencing should no longer be required, other than at strategic locations.

Recommendation: Landowners should encourage the development of sand dunes stabilized by native beach grasses, and a "buffer" between the dune and their residences. Stabilized and vegetated sand dunes help to increase the volume of sand available to build sand bars during erosion events, thus protecting the properties behind. The native beach grasses are ecologically adapted to not only survive in a dune environment, but are designed to accumulate sand within the dune and prevent it from migrating to the residences, and blowing outside of the active beach-dune system. Non-native vegetation, including turf or lawn grass can not stabilize the dune or retain sand.

Recommendation: Public education about coastal issues, including beach health, should be promoted in this area. Interpretive signs highlighting beach stewardship should be considered here. The Inverhuron District Resident's Association may be a good partner in a coastal stewardship education program.

(iii) Community Involvement

Coastal conservation work is most effective if there is an involved and engaged local community. Kincardine has a few local cottager associations (e.g. Inverhuron; Bruce Pines), but generally it lacks organized community beach-related organizations, compared with other jurisdictions on Lake Huron. In the

absence of cottage associations, some “Friends of” community groups have developed in other municipalities. For example, Friends of Sauble Beach is a group of community volunteers that took on the role of a voice for beach conservation. The Coastal Centre developed coastal plans for Sauble Beach for the Friends and for the municipality. The Friends have helped the municipality enormously in implementing beach management strategies that have helped to deal with issues of sand management, invasive species control, and protection of beach ecology. The Coastal Centre has assisted Friends of Sauble Beach in the technical aspects of beach management enabling them to focus on implementation.

(iv) Community Awareness

Successful coastal stewardship will require that the community is more informed about the important attributes of the coast where people will need to be active participants in conservation. **Recommendation:** The municipality of Kincardine and its partners (including the Coastal Centre) will need to invest some effort in a community awareness program to help people understand how to minimize their impacts along the coast, and that their participation will benefit the long term health of Kincardine’s coastline. Better water quality, excellent beaches and preserved natural heritage will be the anticipated outcomes from a well informed community performing best stewardship practices.

(v) Beach Cleaning

Environmental issues related to beach cleaning are presented in Appendix C. Mechanical beach grading, clearing and raking is done to provide an aesthetic appearance for recreation purposes. However, such activities can interfere with natural beach and dune processes. When lake levels are low and the beach very wide, there is enormous potential for sand movement during wind storms. In a natural, undisturbed beach environment vegetation would quickly establish above the strand line. Such vegetation would help trap the moving sand and lead to the formation of a new dune ridge. If the dune vegetation is not permitted to expand Lakeward due to mechanical intervention, the blowing sand will either be captured in the existing

The strand line is the line of debris usually found on the upper part of the beach after a storm. Strand lines often contain organic material and insects that shorebirds feed on.

dunes causing the dunes to grow vertically or it will be carried out of the dunes and onto adjacent roads and properties.

Small amounts of organic material usually form a “strand line” on the beach, particularly after a storm. The material in the strand line is important to the ecology of the beach, providing habitat for various invertebrates, and nutrients for shorebirds and beach and dune plants. The strand line should not be disturbed. Mechanical beach cleaning can impact the physical and biological character of beaches and dunes and, if done at all, should be done with great care. Work should be restricted to the lower beach, and limited in frequency (e.g. seasonally or after wash-ups of large algae mats or other noxious material) and extent (e.g. only areas where garbage is observed).

Recommendations: Some of the alternatives to regular grooming that would help to protect beach ecology include:

- no grooming,
- hand grooming (personnel or volunteers with rakes). There may be opportunities to engage local groups to develop an “Adopt-a-beach” program where volunteers look after a section of the waterfront.
- seasonal grooming (spring clean-up), zonal or rotational grooming, and
- threshold grooming (leaving the beach alone until debris reaches a certain threshold), or strand line removal beyond a certain density or height.

Some shorebirds nest on beaches (historical records indicate Station Beach was a nesting site for Sandpipers). Nesting shorebirds require minimal beach disturbance during the nesting period.

(vi) Motorized Vehicles

The use of motorized vehicles (ATVs, contractor vehicles) are damaging to coastal ecosystems. **Recommendation:** Kincardine should consider strong By-Laws restricting the use of vehicles on beaches. Neighbouring Huron-Kinloss has sample By-Laws that it has passed to restrict vehicle use on shorelands and prevent damage to the environment.

(vii) Garbage/recycling

Beach garbage is an important management issue from the standpoint of debris that is not only aesthetically offensive, but could choke, poison or entangle wildlife. Local volunteers participating in the national Great Canadian Shoreline Cleanup program recorded the second overall highest garbage collected in

2008 compared with other communities along the Lake Huron shoreline. **Recommendation:** The municipality is encouraged to work with the Coastal Centre and Blue Flag program to motivate greater community support for the cleanup program. The Great Canadian Shoreline Cleanup organizes community beach cleanups that have volunteers collect and record garbage, including weight, quantity and categorization. This data helps beach managers understand the extent of the issue and to develop strategies aimed to minimize beach garbage. Past cleanup results have been documented by the Coastal Centre in a report released in 2010.

(vii) Sustainable Beach Access

Beyond Station Beach, there are other public accesses to beaches for cottagers and local residents within the Municipality of Kincardine. **Recommendations:** Access to beaches in dune areas should be designed to protect the values and functions of beaches. Sustainable beach access refers to locations where the public has access to the beach, and to the appropriate ways for people to access the beach that causes the least harm to sensitive environments. Generally, a more passive approach to access control is preferred over extensive, high maintenance methods, like boardwalk structures.

Sand fence can serve to help direct people to the beach and to control sand erosion where vegetation is absent and needs to be restored.

On the beach side, it is **recommended** that in areas where sand drifting is an issue, sand fencing be established. Sand fencing would have the dual effect of directing people to the designated access trail from the beach, and help with sand management and dune restoration. Signs that identify where the public beach accesses are provide a useful reference to beach users. Such signs should be located both at the point of entry from public parking, as well as on the beach to help guide people back onto the correct path.

In areas where beach access is limited mainly to local residents, beach access trails are best if they are confined to a single path with an 'S' shape configuration to minimize sand erosion.

Beach access trails should remain as sand pathways where possible. They are well defined and provide a distinguishable path to the beach. Structural treatments (e.g. boardwalks) are usually not necessary, and create more impact to the dune than pedestrian foot trails. The exception is where the construction of a boardwalk structure was considered to be important to provide a hard surface access for wheelchairs and other special needs purposes.

(D) Dune Stabilization or Restoration Measures

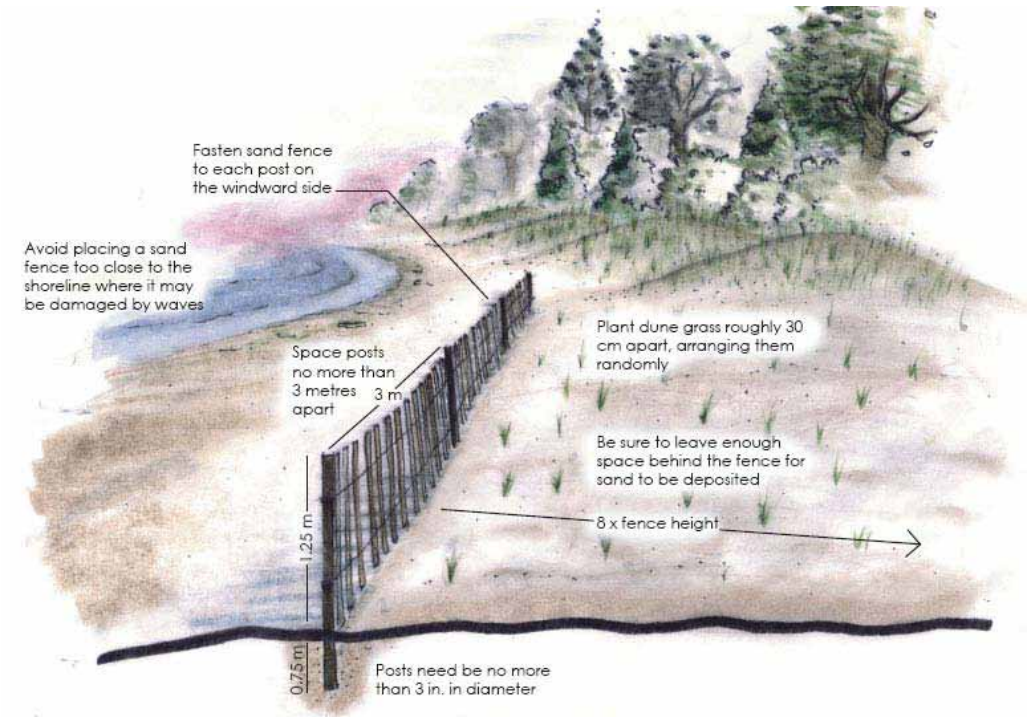
(i) Use of Sand Fencing

Sand fences are used worldwide in beach and dune erosion control efforts. The fencing ideally requires 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, wind and wave damage.

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). 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.

Seasonal Sand Fencing

For seasonal use, the wood slat fence should be installed with 7 foot long "T" rails, or similar post, driven approximately one metre into the sand. The posts should stand about the same height as the fencing. The fence is fastened to the windward side of the posts with galvanized wire. Posts are spaced in 3 metre spacings.



Sand fencing is used for controlling sand drifting on beaches. It is best if sand fencing is coupled with beachgrass planting. Once the vegetation becomes established, fencing is usually no longer required.

If sand fencing is used, it should be installed no later than the Thanksgiving Day weekend in mid-October, prior to the fall storm season. It should not be removed prior to the Victoria weekend as lake winds in April and early May can be quite strong and move a lot of sand.

Recommendation: On Station Beach, sand fencing should be installed at the north end (by the marina) in an effort to reduce the amount of sand drifting in to the harbour. Currently, substantial amounts of sand drifts in to the marina requiring regular dredging to maintain adequate draft. Multiple lines of fencing (2 to 3) are recommended in the area where no dune vegetation exists.

In other areas of Station Beach where dunes are present but sand drifting is an issue, single-line fencing should be considered to help minimize sand drifting and to help reduce maintenance. Currently, municipal staff is responsible for fencing installation. As with other municipalities managing their beaches, there is a staffing shortage when it comes to installing and removing sand fencing. This can lead to fencing installation occurring too late in the season when significant drifting may have already occurred, or not getting the required fencing up at all. It is recommended that temporary staff be retained to undertake this work. Alternatively, the municipality could engage volunteer support to assist with fence installation.

In Inverhuron, the lack of dunes and dune vegetation on the public beach has led to a situation where sand erosion from wind is causing a lowering of the beach profile (loss of sand from the active shore). Over the long term the prospect is a degraded beach system. The best solution to restore the beach is with a combination of fencing and dune grass planting. Restoring dunes to the shore is the most efficient and cost effective method of maintaining the beach sand cycle, and helps to restore the full range of values and functions of the dune system. Once the vegetation is established, the fencing is no longer required. Once dunes are in place, little maintenance is necessary.

However, some local residents have expressed concerns about dunes being restored on the beach, claiming that they would interfere with people's use of the beach for recreation. If dune restoration is not undertaken here, an important but less effective alternative would be to use sand fencing alone to help minimize sand erosion and help keep the sand on the beach. The result will be the formation of unstable, open sand mounds developing behind (landward) of the fence. The sand would then have to be managed to prevent remobilization. Past practice by residents was to obtain local contractors to push

drifted sand down towards the water's edge. This kind of activity is now regulated by Saugeen Conservation and would likely require a permit.

Year Round Sand Fencing

Seasonal fencing requires a substantial investment in time and energy to install and remove each year. Some jurisdictions have taken the approach of installing 'Year Round" fencing, where the fence is installed onto 'permanent' posts and left up throughout the year.

The year round fencing approach uses the same wood slat fencing, but fastens them to wood 4x4 posts. The wood posts remain in place over several seasons, while the wood slat fencing can be re-positioned on the posts depending on the amount of sand burial occurring. The wood posts can be re-positioned lakeward as sand accumulations develop.

This type of fencing has a two-fold purpose: (1) act to help control pedestrian access into the dunes, and (2) help build sand deposits and promote dune growth on the leading edge of the dune.

Sand fencing can be quite effective at controlling sand accumulations and keeping sand on the beach. 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.

(ii) Beachgrass Planting

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, and reduces 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, also known as Marram grass (*Ammophila breviligulata*), 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. sandy beach and dune). 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.

Restoration planting is recommended where year round fencing is proposed. Planting should occur landward to the fencing where the area might lack natural dune vegetation. Plants used for dune restoration should be harvested locally from existing dunes and transplanted to the area being restored. Instructions on how to harvest and transplant are in Appendix D. Harvesting and planting should be done during fall. Harvesting along the foredune of adjacent dunes should be targeted to obtain source material needed for site restoration. Plant harvesting should be done with care. Plants should be harvested randomly and sporadically through the source population, so that the issue of over-harvesting leading to a wind erosion situation is avoided.

Plants should be dug up, separated and placed in garbage bags. The plants should be kept in a cool, dark location until they are required for transplanting. Dug plants should be stored no longer than 5 days. When planting, spacing should be 30 centimetres apart.

Dune restoration planting is typically recommended for late autumn, once the 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 Marram grass about three to four years to become fully established and begin to fill in the planted area.

(iii) Structures and facilities

Beaches and dunes are dynamic and always changing. Fixed structures, like boardwalks, ornamental stones, etc., do not change with the dunes, so problems can sometimes arise when the structure either gets buried with migrating sand, or the sand around the structure gets scoured away by winds leaving hollowed out depressions. On Station Beach, the dune restoration efforts have kept the boardwalk from getting completely buried. There is, and will always be some degree of sand management issues with the boardwalk, but minimizing sand erosion and drifting through the use of dune vegetation and fencing will help to preserve the boardwalk, and the gardens adjacent to it.

Some ornamental stone has been placed at locations along the west side of the boardwalk (in the active dune). Structures like these are prone to wind scouring creating a drift zone.

(iv) Gardens in the Coastal Zone

Gardens are a great way for people to connect with our environment. In coastal areas, we recommend using native plants. In particular, native *coastal* plants. These are plants that have adapted to the special climate and regime of living in the dynamic coastal zone. In dune grassland areas especially, blowing sand can bury plants. Native dune plants can tolerate sand burial (some even thrive on it!).

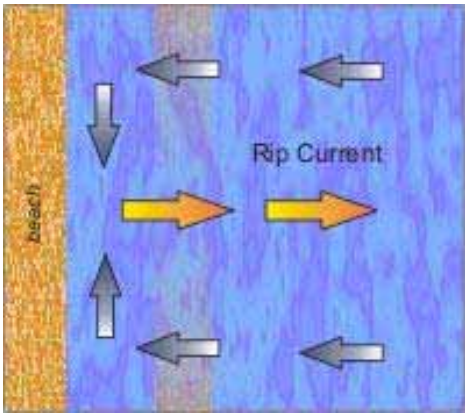
Non-native ornamental plants are easy to access from nurseries, but are not beneficial for planting in coastal areas. Some can ‘escape’ from gardens and invade native plant populations. Cotoneaster was one ornamental that had been planted along the Station Beach boardwalk. Uncontained, it soon began degraded beaches

and higher incidences in *E. coli* bacteria. Cottagers with private lands bordering natural dune areas should consider using native plants on their properties, or at least planting native plant gardens as a buffer between a lawn and the natural dune. Native plant gardens can help prevent non-native invasive plants from escaping into beach and dune areas.

The Coastal Centre has prepared a guide that helps explain the concepts of native plant use in dune areas, and provides suggestions for types of plants to use. The “Dune Planting Guide” is intended as a user friendly resource to help people interested in coastal stewardship.

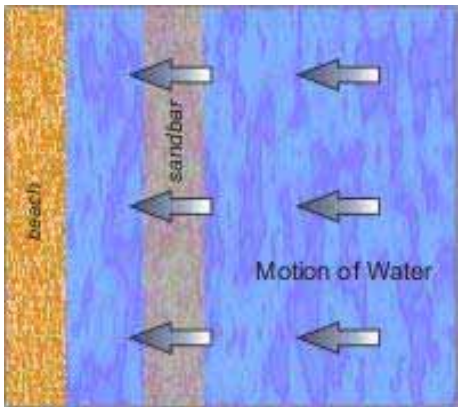
(E) Rip Currents

Rip currents are formed when waves break near the shoreline, piling up water between the breaking waves and the beach. One of the ways that this water returns to the lake is to form a rip current, a narrow jet of water moving swiftly offshore, roughly perpendicular to the shoreline. Rip currents can be found on many surf beaches every day. Rip currents most typically form at low spots or breaks in sandbars, and also near structures such as jetties and piers. Rip currents can occur at any Great Lakes beach with breaking waves.

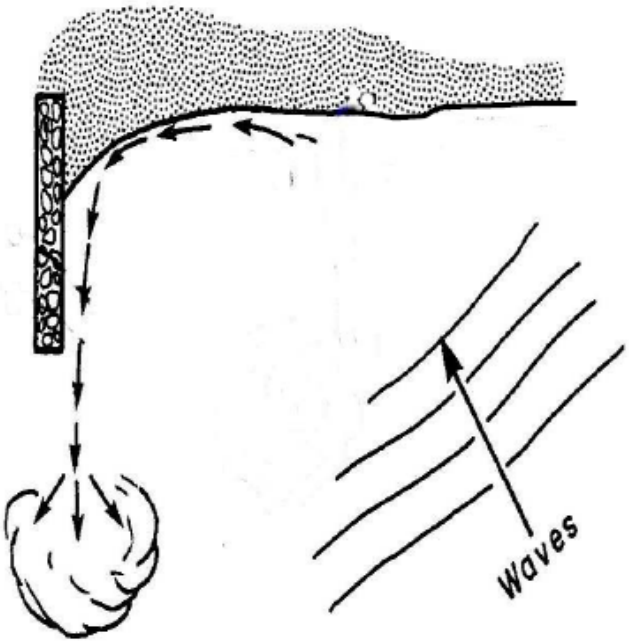


Rip currents most typically form at low spots or breaks in sandbars, and also near structures such as groins, jetties and piers.

(Diagrams: US National Ocean and Atmospheric Administration)



Rip currents can be found on many sandy beaches every day. Under most lake conditions the speeds are relatively slow. However, under certain wave, and beach profile conditions the speeds can quickly increase to become dangerous to anyone entering the surf. The strength and speed of a rip current will likely increase during stormy wave conditions.



Waves from the southwest can generate currents that can be channeled along the pier, forming a rip current out into the lake. The pier has been implicated in several drownings at Station Beach.

At Station Beach, the harbour pier presents a structure where rip currents can become generated. The sand bars off the beach can also present the circumstances necessary to develop rip currents during wavy conditions. Inverhuron beach also generate rip currents with some regularity.

Recommendation: At Station Beach there is an opportunity to undertake some dune restoration work adjacent to the pier that might help to dissuade people from venturing onto the pier. Filling in this area, initially with Marram grass, may help to provide a visual and physical barrier to the pier. This work should be done in combination with a public awareness campaign. This would present media with an opportunity to have a visual that could be used in articles and video clips.

Recommendation: The Municipality of Kincardine should consider hosting annual "rip current awareness" events at Station Beach and Inverhuron Beach. This could be done in partnership with the Lifesaving Society of Canada, Blue Flag and the Coastal Centre. Such an event could include information demonstrations, media events, literature distribution, swim lessons and other relevant activities targeted to beach safety and rip current awareness.

Recommendation: Additional rip current awareness signs would be helpful in communicating about the risks associated with some beaches. A sample interpretive sign is presented in Appendix E.

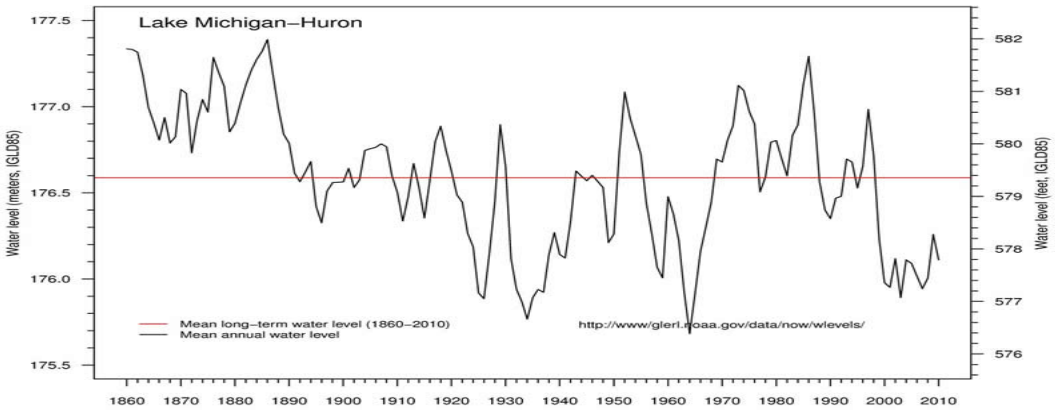
3. Coastal Wetlands

3. Coastal Wetlands

Coastal wetlands are located in dynamic environments along the Great Lakes shoreline, and are directly influenced by fluctuating water levels both seasonally and over cycles of several years. Although they share many of the same functions and values as inland wetlands, it is the influences from lake processes that differentiate coastal wetland hydrology and vegetation structure from inland wetlands. Fluctuations in Great Lakes water levels influence coastal wetland extent and distribution, vegetation composition, and wetland-dependent birds, fishes, and other wildlife as well as determine ecological diversity and functioning.

The predominant coastal wetland community in the study area is the Great Lakes Coastal Meadow Marsh, which is not only provincially but also globally rare. An ecological review of Kincardine's north shore, between Baie du Dore and MacGregor Point Provincial Park, was undertaken by an ecological consultant for the Coastal Centre in the spring and summer of 2011. Four provincially rare vegetation community types predominate along the Lake Huron shoreline in the study area. These include: Great Lakes Coastal Meadow Marsh Type, Shrubby Cinquefoil Coastal Meadow Marsh Type , Juniper Dune Shrubland Type, and Little Bluestem-Long-leaved Reed Grass-Great Lakes Wheat Grass Dune Grassland Type. Details of these ecosystems are presented in Appendix H (Jalava, 2011).

Natural variation in Great Lakes water levels creates a dynamic shoreline characterized most noticeably by changes in plant life. As low water levels expose seed-rich bottom sediments, emergent and non-woody wetland plants



Lake Huron Hydrograph 1860 to 2010 showing variations in lake levels over time. (NOAA)

Type	Cause	Magnitude	Duration	Impact on Coastal Wetlands
Short-term	Storms, and wind and atmospheric pressure-driven "tides" known as seiches	0.5 metres	Usually less than one day	Damage to vegetation due to high winds and waves. vegetation
Seasonal	Reflection of the yearly hydrologic (water) cycle in the Great Lakes basin. Lowest levels often occur in late summer, after evaporation has peaked.	30 to 50 centimetres	A few months	Unpredictable and variable water levels result in the highest level of plant diversity. Many plants and animals are adapted to and depend on a highly changeable wetland environment. Low water levels in the autumn expose wetland bottom sediments which allow the seeds contained there (in the seed bank) to germinate.
Multi-year	Basin-wide, continental or global climate changes that result in different patterns of precipitation and evaporation over a number of years. Also caused by human-induced water level regulation to facilitate shipping.	Up to 2 metres during the 20th century.	More than one year.	High water levels can eliminate large areas of wetland by flooding. Low water levels that expose mud flats with an extensive seed bank will allow wetlands to expand toward the new lakeshore.

reclaim many coastal regions particularly in areas with gradually sloping shorelines. This periodic regeneration of shoreline vegetation is an essential component of healthy coastal wetland ecosystems.

Coastal wetlands provide important habitat for many species of plant, fish and wildlife and perform valuable ecological functions. Over the past two centuries, coastal wetlands have been increasingly degraded as a result of human activities. Coastal wetlands occur along the shorelines of the Great Lakes where erosive forces of ice and wave action are low, allowing the growth of wetland plants. Open shoreline wetlands are fringes of aquatic plants along the shore that can withstand wave energy. Coastal wetlands are also heavily influenced

by *water level fluctuations*, both the short term fluctuations associated with seiches and the longer term seasonal and between-year fluctuations (Maynard and Wilcox, 1997).

Water Levels

Coastal meadow marshes are extremely sensitive to water level fluctuations, meaning that a modest change in water level can have a significant change in the position of the water's edge. The water table varies with seasonal fluctuations in Lake Huron's water levels including short-term changes due to seiches and storm surges, seasonal and long-term lake level fluctuations. Coastal meadow marshes expand and contract depending on lake levels and location (Mortsch *et al.* 2008).

Looking back over the last century, lake levels have fluctuated as a result of the changing balance between evaporation and precipitation over the lake. Lake Huron water levels were very high in 1973-75, 1985-86 (highest on record), and 1997 and very low in 1934-35 and 1964-65 (lowest on record). Water levels dropped again from highs in 1997, in part because 1998 was the hottest year (+2.3 Celsius degrees (ºC)) and fifth driest year (-8.9%) in the Great Lakes region for the 51-year record at that time. The drought that began in 1998 and lasted until 2002 (excluding 2000) affected the water balance of the Great Lakes significantly; summer temperatures ranged from 0.9 to 1.3ºC above average while exceedingly below normal summer precipitation occurred in 2001 (-26.8%) and 2002 (-15.4%), and ranged from -1.0 to -4.3% in the other years. Lake Huron water levels were affected the most (Mortsch *et al.* 2006).

The coastal area in northern Kincardine presents an opportunity to preserve a highly significant element of the region's natural heritage, with many globally and provincially significant ecological features

(Jalava, 2011)

The northern coast of the Municipality of Kincardine has a high number native plant and animal species, and so is considered to be biologically diverse. Those species connect, and interact. Those interactions create communities and systems, and those systems provide goods and services, like oxygen production, pollination, water filtration and storage, pest control, food production, climate moderation through shade and moisture release, carbon storage and, flood and erosion control.

Other values and functions of Lake Huron's coastal wetlands include:

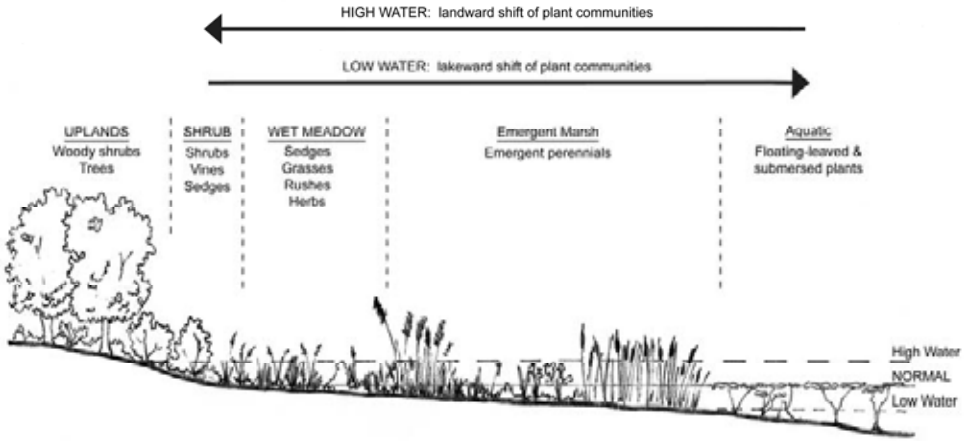
- flood storage, by storing flood water and releasing it slowly;
- sediment control, by reducing water velocity and allowing sediment deposition;
- protection from storms, by acting as wave barriers to the erosion of shorelines;
- water quality improvement, by removing excess nutrients and many

chemical contaminants;

- habitat for flora and fauna, by providing suitable habitats for many plants, spawning, nursery and feeding areas for many fish and shellfish and breeding, nesting, feeding, and protected areas for many species of waterfowl and other fauna;
- biodiversity reservoirs, by providing habitat for nearly 35% of all rare, threatened and endangered animal species;
- commercial products, such as timber from forested wetlands, fur resources and baitfish;
- recreation, by serving as sites for fishing, hunting, and observing wildlife;
- historic and archaeological values, by serving to understand historical events and native cultures;
- education and research, by providing opportunities for nature observation and scientific study; and
- open space and aesthetic values, by providing areas of diversity and beauty for recreational and visual enjoyment.

(Maynard and Wilcox, 1997)

Great Lakes coastal wetlands are more widely recognized as ecologically diverse and highly productive ecosystems that perform important functions by providing habitat, improving water quality, protecting against flooding and erosion, and allowing for recreation opportunities. A crucial benefit is that numerous regionally endangered and threatened birds, reptiles, fish, and amphibians use coastal wetlands for all or part of their life cycles. In the Great Lakes, more than two-thirds of all lake fish species spawn in coastal wetlands while many bird species rely solely on wetland habitat for nesting and rearing young.



Profile showing typical vegetation types. Plant communities shift in response to changes in lake levels.

Lake Level Influence on Biodiversity

Wetland vegetation communities expand and contract along a moisture gradient with fluctuating lake levels. Variations in water levels maintain diversity of vegetation and habitat interspersion. Also, the relative abundance of vegetation communities changes as certain plant species die back and vegetation is displaced landward or lakeward in response to water level changes. For example, during low water years, landward margins of wetlands dry and mudflats are exposed as water retreats lakeward. Emergent vegetation is displaced by sedges, grasses, and shrubs that expand into areas where the water was once too deep. Submerged aquatic vegetation is replaced by emergent vegetation as germination occurs on exposed mudflats. With the return of high water levels, vegetation communities slowly retreat landward.

The plant species along Kincardine's coast depend on fluctuating water levels to maintain periodic open sandy shorelines, and during low water years, sprout abundantly from newly exposed seedbanks. They flower, and set seed again, waiting until the next low water year before they can sprout again (Keddy and Reznicek 1986).

High water years kill woody plants which become established in low water years, which is a factor in maintaining the open conditions. In addition to fluctuating water

Coastal Wetlands and Fish Habitat

Although water levels do fluctuate, the boundaries of fish habitat, as defined in the *Fisheries Act* within a body of water, do not change. Fisheries and Oceans Canada, Ontario -Great Lakes Area (DFO-OGLA) determines the boundary of fish habitat using historical long-term water levels, linking the habitat to the requirements of fish populations throughout their life cycles. This means that the extent of fish habitat is not determined by short-period water level fluctuations. For example, in low gradient shoreline areas (e.g. sand beaches and wetlands) small decreases in water level sustained over a long period of time may result in large distances created between the current water level and the levels that are more indicative of an average year. In low-water years, beaches grow significantly larger and wetland areas flourish with vegetation. The nearshore areas once covered with water may be mistakenly considered "dry" land. Although these areas appear to be dry and may have been for a year or more, historical data shows that water levels will rise again and nearshore areas will be re-submerged, providing important spawning, nursery and adult fish habitat. DFO-OGLA considers these areas to be fish habitat, and they therefore fall under the requirements of the *Fisheries Act*. (Source: Fisheries and Oceans Canada).

levels, meadow marshes are also subjected to wave energy. This washes away organic accumulations, and deposits new layers of sand. Although impacted by this deposition, these coastal meadow marshes contain extremely dense seedbanks. These seedbanks allow the vegetation to replace itself during low water periods. Studies of coastal meadow marshes have identified that more than 80% of buried seeds occurred within the top 2 cm of the soil (Keddy and Reznicek 1986).

Fish Habitat

Eighty percent of the Great Lakes fish species are found in nearshore areas for some part of the year and depend directly on coastal wetlands for some part of their life cycle (eg. feeding, shelter, spawning, nursery, and dispersal of young). The western shoreline of the Bruce Peninsula may represent the most productive lake whitefish spawning shoals and associated larval nursery grounds in Lake Huron (Lake Huron Biodiversity Strategy reference document on coastal wetlands, March 23, 2009). Fifty-nine fish species utilize the coastal wetlands of Lake Huron. Over half are permanent residents while the remainder uses them on a temporary basis for feeding, shelter, spawning, nursery, dispersal of young and migratory wandering. Lake Huron wetlands also provide important habitat for amphibians and reptiles. The amphibians use them for spawning, nursery and feeding. Reptiles nest on uplands, but many species spend the remainder of their life cycle in these wetlands (Maynard and Wilcox, 1997).

The coastal wetlands of Kincardine are located north of the Bruce Nuclear Power Development to MacGregor Point Provincial Park. These wetlands expand and contract with the lake levels. Currently, the wetlands have expanded due to an extended period of below average lake levels. As they expand, new habitat emerges that benefits plant and animal populations (particularly fish, birds and amphibians). The expansion of these wetlands is critical to the broader lake ecosystem because when low lake levels expand wetlands on Lake Huron, they shrink on Georgian Bay. Georgian Bay's steep nearshore doesn't allow for wetland plants to expand bayward. On a net basis, the two situations appear to balance out.

Creating boat channels for mooring small craft damages the coastal wetland and causes fragmentation of habitat.

It is important to ensure activities that impact wetlands be restricted since the contributions of these wetlands have a lake-wide significance.

Significant Species

Several significant species were observed (Jalava, 2011) in the coastal wetlands of Kincardine. The following Species at Risk were observed in the north Kincardine coastal meadow marsh area:

Turtles (e.g. Spotted Turtle—endangered)

American While Pelican (threatened)

Eastern Ribbonsnake (special concern)

Bald Eagle (special concern)

Chimney Swift (threatened)

Barn Swallow (threatened)

Bobolink (threatened)

Provincially rare species included the Great Egret, Caspian Tern, Blue Leaf Willow, Stiff Yellow Flax, Cylindric Blazing Star, Low Nut Rush, Beaked Spike-Rush, Long Leaved Reedgrass. Other species observed are noted in Jalava, 2011 (Appendix H)

Threats

Since coastal meadow marsh (sometimes referred to as coastal 'fens') occur in prime areas along shorelines, they are under intense pressure, primarily as cottage and condominium development, but also municipal road and drainage 'improvements'. Much of this vegetation has already been lost in Ontario to these human factors. (Natural Heritage Information Centre, 1995).

Protecting the hydrology of Kincardine's coastal wetlands is critical to their long-term health. We can prevent increased surface flow and reduction in groundwater recharge by establishing no-cut buffers around coastal fens and avoiding road construction and complete canopy removal in stands immediately adjacent to fens. In addition, All-Terrain-Vehicles can create deep ruts in the loose soils of

Common Reed in Lorne Beach area

coastal fen, altering surface flows and species composition, and creating opportunities for invasive plants to establish.

Of great concern is the spread of **Common Reed** (*Phragmites australis*), which, if left uncontrolled, could very well invade most of coastal habitat, as it has done in areas further south. Not only is it an extremely serious invasive from an ecological perspective, Common Reed also affects shoreline access for recreation and is an aesthetic bane in that because of its great height it obscures views of the lake. Common Reed is highly aggressive and very difficult to eradicate once established. Many of the control measures, such as herbicides, may have negative impacts on native species, so an informed approach using the most effective but nevertheless environmentally appropriate techniques should be used. (Jalava, 2011)

European Black Alder is another potentially serious invasive along the coast, but it is currently localized in the study area. It can be more easily controlled because it is slower-growing and reproduces less rapidly than Common Reed. Manual removal (cutting) from impacted areas over several years may produce satisfactory results.

Knapweeds (*Centaurea* spp.), **White Sweet Clover** and **Crown Vetch** are also quite localized in the area and have not impacted large areas of natural habitat, but each could potentially become a serious problem on the sand beach ridge (sand dune) habitats. Manual removal and/or other control methods should be considered for these species. The spread of **Basket Willow** and **Purple Loosestrife** should be monitored, and control measures undertaken if populations show significant increases from their current (relatively low) levels.(Jalava, 2011)

After invasive species, the unrestricted use of motorized off-road vehicles is probably the most serious ongoing impact on sensitive habitats (fens, coastal meadow marshes and sand beach ridges) in the study area. Off-road vehicles are damaging substrate, vegetation, altering hydrology, causing erosion, rutting and almost certainly introducing invasive species to otherwise high-quality, diverse and often globally and provincially significant ecosystem types

Recommendation: Activities that could negatively impact coastal wetlands be restricted. No dredging, channelization or alterations should be made to shorelands. Motorized vehicles should be restricted from driving on shorelands. Appropriate bylaws, their enforcement, signage and construction of barriers (such as boulder piles) at access points, and public education are all methods that may be used to alleviate these problems.

Recommendation: Common Reed in coastal wetlands may pose one of the greatest emerging threats to these ecosystems. Kincardine should embark on a control program aimed at minimizing the spread of this invasive species. We encourage the Province of Ontario to assist in this work, as these wetlands play a significant role in the quality of the coastline generally.

Recommendation: Residents of the area should be educated regarding invasive plant species, and strongly encouraged not to plant garden cultivars in the coastal areas. Residents should especially be encouraged to plant native species specifically suited to the local habitats in their gardens.

4. Cobble Beaches

4. Cobble Beaches

Cobble beaches form in a dynamic, high energy environment of storm wind and waves. Storm waves regularly disturb the beaches, reconfiguring the substrate and removing fine sediments. The cobbles provide substantial armoring to the shoreline, protecting it from erosion.

During the winter, shoreline ice freezes to the bottom sediments and cobbles are plucked loose during storms, further eroding and modifying the lake bottom. Wave action results in the removal of finer clay, silt, and sand particles from fine textured tills, resulting in the formation of a cobble layer (lag) underlain by finer till. Angular cobbles also form when weathering releases rock fragments from the underlying bedrock; on some bedrock beaches, as you would find at Inverhuron, the observer can see the entire sequence of recently eroded, angular rocks to rocks rounded by years of wave action.

Intense winter storms can result in the formation of storm beaches, in which cobble-sized rocks are piled upon each other (e.g. Lorne Beach). In addition, long-term, cyclic fluctuations of Great Lakes water levels significantly influence vegetation patterns of limestone cobble shore, with vegetation becoming well established during low-water periods and the loss of most species during high-water periods.

The uprush or swash of water carries a highly corrosive load of sand, gravel, and cobbles. During moderate weather, the waves disturb only the upper layer of the debris that covers the beach, but in storms the entire mass may be moved back and forth, grinding the beach profile lower.

Large breaking waves throw cobbles up above the limits of the swash, building ridges at the back of the beach that are considerably higher than the high water level. Storm ridges often develop across the mouths of small streams, diverting the flow of water to the lake.

A cobble beach offers a precarious, unstable anchor for plant life. Beach plants are typically distributed in zones parallel to the shoreline because of the varying ability of different plants to withstand the conditions that occur when they're exposed during low water levels. The width of each zone is determined by the slope of the beach-the steeper the slope, the more narrow the band. The

movement of lighter rocks dislodges or kills any plant or animal that tries to attach to them. This movement is often seasonal. Many cobble beaches have productive ephemeral (short-lived) animal and plant communities that are adapted to take advantage of seasons with calm weather.

Limestone cobble shores share many species with cold, fast-flowing streams, including midges, stoneflies, and mayflies. Spring migrations of warblers feed heavily on the midges that settle in the cedar that ring the shoreline.

The number and area of these beaches is decreasing due to shoreline development. In fact, cobble shorelines are becoming so scarce that they are considered globally rare (SOGL, 2009).

Not only do cobble beaches provide habitat for numerous plants and animals, but they provide important armouring of the shoreline that helps protect cottages during high lake levels and storms. Removal of the armouring can create erosion conditions.

Threats to Conservation

A principal threat to the cobble beach is motorized vehicles (like all-terrain vehicle use—ATVs), which can result destruction of habitat, and the introduction or spread of invasive, non-native plant species (see Appendix B). Motorized vehicles should be restricted from use on Kincardine's beaches.

The number and area of cobble beaches are generally decreasing due to shoreline development. A wide variety of vegetation surrounds cobble beaches and the cobble beaches themselves also serve as a home to plants and animals that are unique to the Great Lakes shoreline.

Another key threat is people moving stones both in the water and on shore to

clear paths for walking and swimming, and construction of boat slips. Often, people will pile the cobbles to form a groyne-like structure, and this will reduce the flow of water along the shore, leading to accumulation of algae and debris. There is a lack of awareness or confusion over the value of these beaches. Beside the high ecological value of these beaches, cobble beaches provide valuable shore protection from lake erosion and wave damage.

Recommendation: Better awareness of the value and function of cobble beach ecosystems might generate more appreciation for these special beaches.

Recommendation: Use of motorized vehicles on shorelands can damage ecology and alter hydrology. They should not be permitted on beaches or nearshore areas.

Recommendation: Removal or alteration of cobbles on the beach or nearshore can be damaging to shore ecology and reduce the shore protection capacity of the beach. This practice should be strongly curtailed to preserve all of their benefits.

5. Species at Risk

Photo—R. Otfinowski

5. Species at Risk

Species can become 'at risk' for a number of reasons including habitat loss, pollution, development and the spread of invasive species. More than 190 of Ontario's wild species are at risk (MNR, 2011). Species at risk are like the 'canary in the coal mine,' alerting us to serious declines in our biodiversity. Along Kincardine's coast, a number of species fall under the provincial and federal lists for species at risk. Many other coastal species are provincially, nationally and globally rare.

As discussed earlier, dune grasslands are remarkably diverse ecosystems. Inverhuron Provincial Park contains considerable dune grassland biodiversity. The Inverhuron beach community south of the park may present some habitat potential if dune restoration and stewardship become implemented there. The park contains a small population of the endangered **Pitcher's Thistle**. While no plants are known to exist outside of the park boundaries at present, the dune grasslands surrounding the park could one day provide suitable habitat for this species, which would aid in its recovery. Again, this could only happen if dune stewardship measures were implemented by the cottage community.

Other Species at Risk that have occurred historically within the Inverhuron area include **Dwarf Lake Iris** (Threatened), **Butternut** (Endangered), and **Monarch Butterfly** (Special Concern). The endangered Spotted Turtle is also known to occur along Kincardine's coast.

Aside from Species at Risk, there are a number of rare species present along Kincardine's coast, including American Beachgrass, Long-Leaved Reedgrass, Great Lakes Wheatgrass and Blue Leafed Willow.

Plant communities (special assemblages of plants) occur along the coast as well. Coastal wetland communities located north of Baie du Dore, and south of Inverhuron are part of a Graminoid Coastal Meadow Marsh Type, which is ranked S2 or Imperiled (OMNR 2010), and as such should be considered significant wildlife habitat. Species at Risk identified in the coastal meadow marshes of Kincardine include Turtles (endangered), **American White Pelican** (threatened), **Eastern Ribbonsnake** (special concern), **Bald Eagle** (special concern), **Chimney Swift** (threatened), **Barn Swallow** (threatened), and **Bobolink** (threatened). (Jalava, 2011).

Definitions of Species at Risk

Extinct species: a wildlife species that no longer exists.

Extirpated species: a wildlife species that no longer exists in the wild in Canada, but exists elsewhere in the wild.

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

Threatened species: a wildlife species that is likely to become endangered if nothing is done to reverse the factors leading to its extirpation or extinction.

Special concern species: a wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.

In the dunes at Inverhuron (south of the park) Cottonwood Dune Savannah Type community has been identified (NRSI, 2011) and is ranked as S1 or Critically Imperiled by the MNR (OMNR 2010).

Active stewardship of Kincardine's coastal environment will be necessary if these species, and other rare plants and animals, have any chance of long term survival.

Threats to Biodiversity

In Kincardine, the primary threats to species at risk, as well as other rare species and their habitats, include:

1. Development related impacts (e.g. road and other construction), cottage use, encroachment onto the shore, and vehicle damage to the shore. Vehicle impacts to beaches are explained in the information sheet "Damaging Wheels" included as Appendix B.
2. Genetic and reproductive isolation occurs when habitats are destroyed or become degraded, and a species' range becomes fragmented. As parcels of suitable habitat become smaller and barriers between these pockets of suitable habitat become greater, remnant populations become increasingly isolated. The more limited a population's genetic variability, the less able the population can deal with change, disease or other factors and the less likely it is to survive over the long term.

Impacts related to climate change may accentuate the dangers to plant populations in Kincardine, particularly those already stressed by other human related impacts.

3. Altered moisture regime caused by drainage ditches and other shore alterations, can make habitat no longer suitable for some species.
4. Invasive plant species can aggressively overtake native plants and their habitat, creating monocultures of the invader species. An invasive species of great concern along Kincardine's coast is Common Reed (*Phragmites australis*) - Appendix G.

Species at Risk Legislation

Species at Risk are protected under the federal *Species at Risk Act*. The goal of the *Act* is to prevent endangered or threatened wildlife from becoming extinct or lost from the wild, and to help in the recovery of these species. The Act is also intended to manage species of special concern and to prevent them from becoming endangered or threatened. Environment Canada is the lead ministry for federal protection of Species at Risk.

Species at Risk are also protected under the Provincial *Endangered Species Act*. As soon as a species is listed as extirpated, endangered or threatened, it is automatically protected under this legislation. The Ontario Ministry of Natural Resources is the lead ministry for Species at Risk protection.

The Lake Huron Biodiversity Strategy (2010) aims to encourage the stewardship of biodiversity, including Species at Risk, and other rare species in the Lake Huron region.

Land use planning, policies and by-laws at the municipal level can assist in the protection of Species at Risk.

Recommendation: Greater awareness of Species at Risk in Kincardine is necessary in order to help protect these species and their habitat. Simply avoiding areas containing these plant species will help in their survival. Information sheets on the known species at risk along Kincardine's coast are provided in Appendix F.

Recommendation: A invasive species prevention program targeting key invasive species (like *Phragmites australis*) will benefit species at risk and their habitat.

Recommendation: Coastal Stewardship refers to the wide range of voluntary actions that can be taken to care for the environment. Activities range from monitoring and conserving wildlife species and the places where they live (their habitat), to protecting and improving the quality of soil, water, and natural environments. These types of conservation activities, particularly those that protect habitat, are essential to the recovery of species at risk. They are also instrumental in preventing other species from becoming at risk in the first place.

Recommendation: Whenever possible, Kincardine should communicate with developers to encourage awareness and action with respect to the early consideration of species at risk and habitats. The case can be made to developers for the importance of the proactive consideration of wildlife and their habitats in land use planning and development. There are a number of reasons to consider wildlife and their habitats early in the development process, including the business advantages, legal requirements, and improved community support. If a wildlife concern is identified after a development is underway it can result in more costs and effort than if a proactive approach were taken.

Recommendation: **Prevent Collecting of Species At Risk and Native Plants**

Public education campaigns should be undertaken to raise awareness of the biological needs and human-caused threats to SAR and other significant species found in the study area. Reporting of violators and enforcement of the Endangered Species Act should be encouraged, particularly with respect to collecting of reptile SAR and provincially rare wildflowers.

6. Water Quality

6. Water Quality along Kincardine's Shores

Beach impairments from high bacteria or algae fouling has been a concern to people living in the south end of the lake, but increasingly these issues are having a presence in Kincardine. Posted beaches due to high *E. coli*, or decaying algae along the beach or in the nearshore, are becoming a greater concern to the lakeshore community. Station Beach is currently the only beach in the municipality that the Grey Bruce Health Unit regularly tests during the summer season for *E. coli*. In the absence of data to inform swimmers of water quality risks, the conventional practice has been to post signs identifying conditions that poor water quality is likely to occur (e.g. after rains, wavy conditions, turbid waters).

The irregular shoreline of Bruce County, and the current period of below average lake levels combine to make beaches vulnerable to localized water quality impairments. Small embayments and shallows are particularly susceptible to bacteria or algae fouling. Shallow nearshore waters are likely to warm more quickly during the summer. Warm temperatures are more favourable for bacterial survival and algae growth. The sequence of headlands and bays along the coast can be a shelter to alongshore currents that help to flush pollutants from beaches. Nutrients from runoff and stormwater can become entrapped in these coastal niches, and localized algae blooms can result. Flushing of polluted embayments is dependent on the degree of wave activity. During summer months, wavy conditions tend to be less intense and less frequent. There may be several days or weeks where little flushing occurs and a stagnant situation persists.

Irregular coastline in north Kincardine.

Water quality impacts on Lake Huron's coast are very complex, and may be the result of a combination of impacts from local watershed runoff, stormwater, faulty septic systems, wildlife, and changes in water chemistry due to non-native invasive organisms, like Zebra and Quagga Mussels.

In 2008, Saugeen Conservation released its report card on the state of the Penetangore River watershed. Forest and surface water quality conditions were ranked 'D' and 'C' respectively. In 2010, water sampling at Station Beach at the mouth of the Penetangore River led to the beach being posted unsafe for swimming on several occasions. Several severe summer storms contributed to high river discharges and likely contributed to the high bacterial numbers that summer. As a consequence, Station Beach was given provisional Blue Flag status in 2011.

Efforts to improve the quality of the Penetangore watershed through restoration measures would help to prevent future issues at the beach. Similar to the work being done in the Pine River watershed in Huron-Kinloss Township to the south, a local volunteer group has emerged to promote similar measures for the Penetangore. The municipality and the broader Kincardine community should encourage this initiative to help improve local water quality in its rivers and streams and, ultimately, the beaches of Lake Huron.

Local Contributors of Nutrients and Bacteria

(i) Cottage and Residential Development

The large expanses of sand deposits have given rise to an extensive cottage community along the shores of Kincardine. These relatively flat, well drained sandy soils with a shallow water table provide ideal conditions for the transport of nitrate and bacteria to groundwater, and in turn, enhance the preservation of nitrate once it reaches the groundwater (McLellan, 2000). Development in the rural lakeshore area handles human waste primarily through the use of private sewage disposal systems. While such systems can be very effective at treating sewage, they are sometimes under-managed by their owners, and this can contribute to system failure. Some owners wait for signs of failure before they react to a system failure. However, systems in sandy soil

environments do not typically produce the clues to failure that systems in other soils may provide.

Since sewage disposal systems are underground, there is a tendency for them to be overlooked. Systems typically have a life span of about 25 years, depending on the amount of use. Regular maintenance is necessary to reach the full life expectancy. Many systems along the lakeshore of Kincardine are older than 25 years.

Another sources of nutrients associated with lakeshore development can come from the application of lawn and garden fertilizers, which in a sand environment, has ready access to the shallow groundwater table. Reducing or eliminating the use of fertilizers, and encouraging the establishment of native species would be beneficial to the health of the lake.

Keeping buffers of native vegetation along the waterfront helps to filter surface runoff, removing some of the pollutants that flow toward the lake. Dunes and wetlands provide buffers and should be maintained or enhanced.

(ii) Agriculture

The landscape of Kincardine is dominated by agriculture. The amount of forest cleared for agricultural production is up to 90%. While the surrounding Saugeen River watershed has a forest cover of around 30%, the Penetangore River watershed has a forest cover of about 10%. The relative lack of forest cover

Agriculture dominated landscape, particularly in the Penetangore River watershed.

corresponds with a relative lack of buffering capacity, or ability to filter pollutants from surface water runoff.

Similar in function to wetlands as water purifiers, woodlands play a significant role in keeping our waters clean. These woodlands are essential in filtering out nutrients from farmland and development runoff, pesticides, pathogens and excessive sedimentation. At the landscape level, Kincardine is particularly vulnerable to surface water impairments due to this lack of filtering capacity. The only remaining forested lands of significant size are those along the lakeshore.

In addition to landscape change, agriculture has become more industrialized, with Intensive Livestock Operations (ILOs) forming within the municipality. Some initial efforts are being undertaken by the Penetangore Watershed Group to encourage conservation farm practices and the development of vegetated buffers around watercourses. Greater adoption of such measures will help to attenuate the contributions of water impairments by the agricultural sector.

(iii) Waterfowl

Gulls are a common sight along our beaches, and on occasion they arrive in such numbers where they might contribute to water impairments. However, they probably play a more important role in cleaning our beaches of rotting fish and other animals that wash ashore from time to time. Where they become a nuisance is when people feed these birds food that is not typically in their diet. In some areas of Lake Huron, the birds have become dependent on feeding on human food. Aside from the health issues affecting the birds themselves, large numbers of these birds attracted by human activity can also pose a public health risk to humans through excessive amounts of excrement within the beach area.

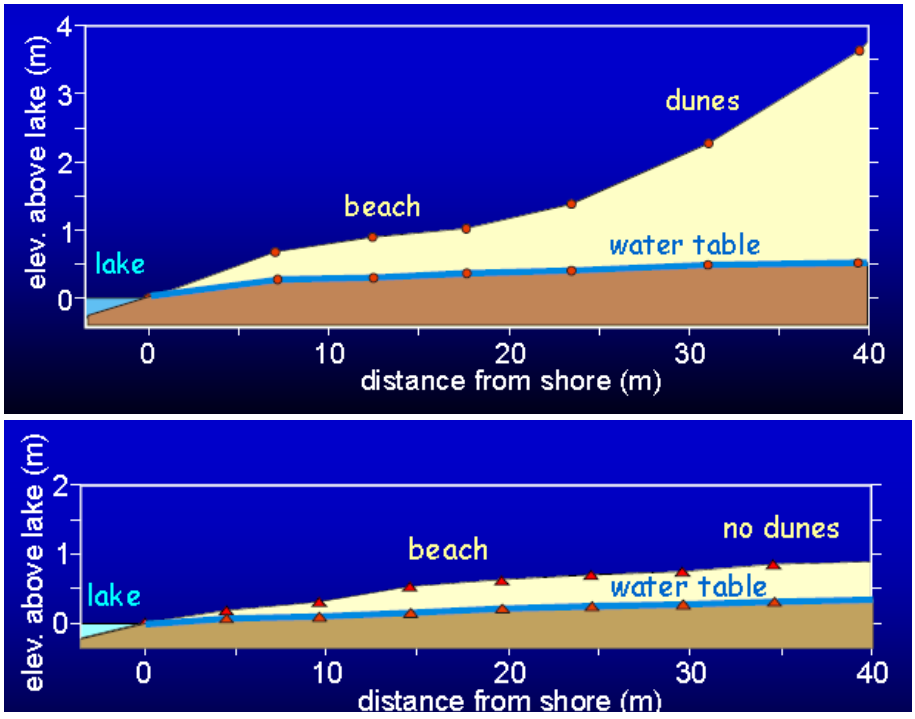
More problematic in recent years has been large numbers of Canada Geese congregating along beaches. The temperate-breeding Canada goose population in Ontario has been growing by about 12% annually since the early 1970s. Starting from a few small centers of population in southwestern and southeastern Ontario, these geese have expanded their breeding range and can now be found virtually throughout southern Ontario. The total population size this spring is probably around 550,000 geese. This is on top of the northern migrant Canada geese that pass through in spring and fall.

It appears that the Lake Huron region is an area in which local breeding populations have recently become established and are increasing rapidly. If the local populations are growing at around 12% per year, the number of geese can be expected to double every 6-7 years. The Canadian Wildlife Service encourages all municipalities to begin taking action to control population growth. They can: modify habitats (in parks etc.) to make them less attractive to geese; discourage feeding of geese among other things (Hughes, J., CWS, personal communication, 2007).

Canada Geese are grazers and are particularly attracted to turfgrass lawns. Landowners can prevent this grazing by replacing turf grass with native shoreline vegetation. In sandy shore areas like Kincardine, replacing turf lawns with dune vegetation is ideal, as geese are not attracted to dune grasses, shrubs and other dune plants. In other coastal areas, planting native trees and shrubs can help act as a deterrent by disrupting take-off and landing opportunities. Appropriate plant species selection is available from the Coastal Centre's 'Dune Planting Guide' and from Centre staff.

(iv) Beach Conditions

Researchers with Environment Canada have found that the type of beach you have can impact how much E. coli may be present. Beaches that are typically wet tend to have high amounts of E. coli whereas dry beaches do not. Beaches can become wet beaches if the conditions that maintain a healthy beach environment are compromised. Beaches where dunes have been damaged or



Comparison of a dry beach with wet beach. Wet beaches can be formed dunes have been removed, where the beach sand blows off the active shore zone and the beach deflates over time.

Beaches with dunes retain the sand cycling characteristics and sand is not lost from the active shore system.

(From Crowe, 2011)

removed tend to degrade into wet beaches. Where dunes are present, or have been restored, the beach tends to be dry (Crowe, 2011). The dune restoration work done at Station Beach has resulted in a healthy beach system. The lack of dunes and current beach maintenance regime at Inverhuron is leading to the development of a wet beach.

(v) Stormwater and Beaches

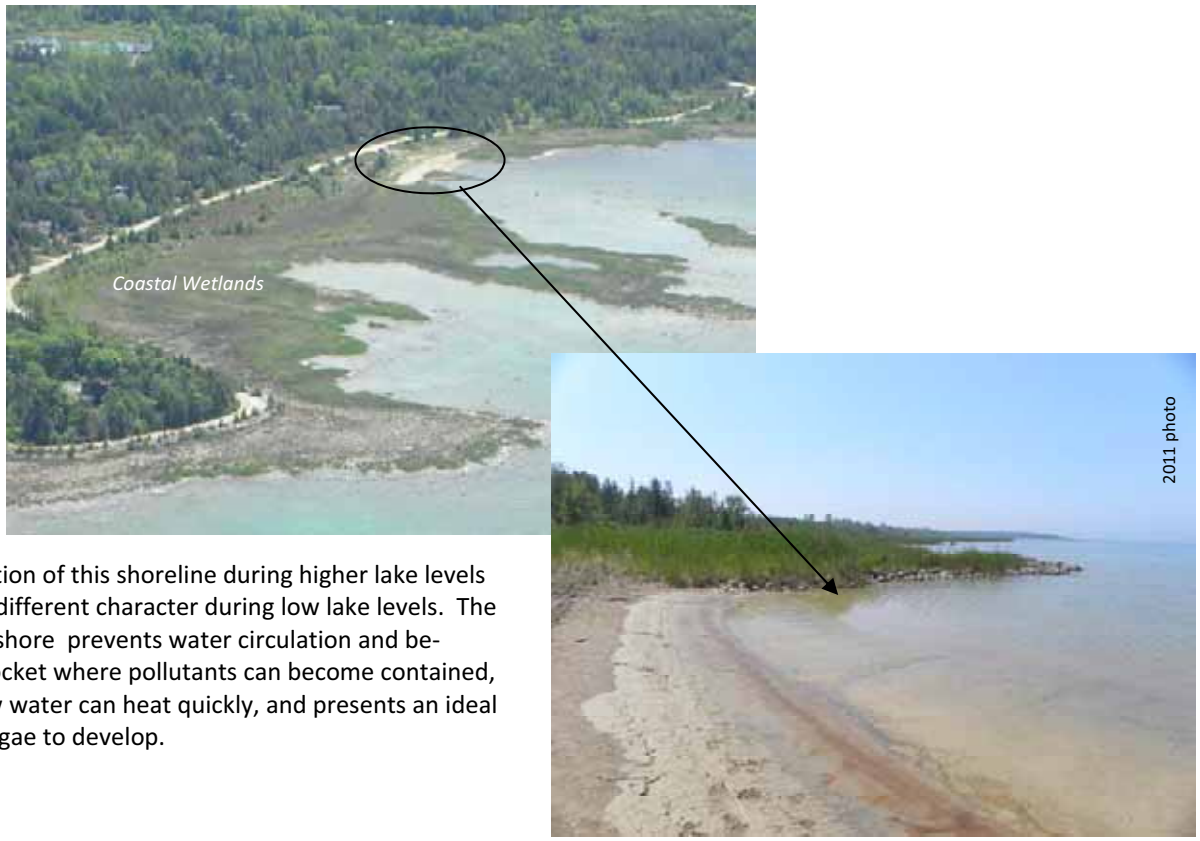
Dealing with stormwater (precipitation runoff) is a challenging issue for municipalities and can be particularly challenging when the drain outlet flows onto a beach. Stormwater from storm drains has the effect of creating channels on the beach, which can occupy large expanses of beach depending on how the channel mouth is moved by alongshore currents. Stormwater can also transport pollutants to the beach elevating bacteria and nutrient levels. Past practices have encouraged the fast removal of stormwater from the land and convey water to the lake through culvert systems. At the beach, stormwater has been typically left to empty onto the beach where it creates a channel to the lake. During low flows, the beach sand may have some capacity to filter nutrients and pathogens from the water, but high flows will result in direct inputs to the nearshore waters. Local impairments of beaches can result, including elevated bacteria and algae occurrences.

The municipality should consider using ‘green’ infrastructure to minimize stormwater impacts to beaches. Rain gardens, bio-retention cells, infiltration swales, green parking lot design, rain barrels, are examples of technologies that are intended to address stormwater quality and quantity issues.

(vi) Effects of Local Shoreline Modifications

Modifications made to the lakeshore that alter shore processes can affect the health of beaches and the nearshore. Alterations can include the removal or reshaping of rocky lake bottom, dredging of channels, beach/dune alterations, harbour structures and shore protection structures.

Between Concession 6 and the Bruce-Saugeen Townline, there are instances where rocky lakeshore bottoms were cleared in the past in order to benefit swimming or boating activities. In some cases, rocks were piled in linear 'groynes' extending from the beach outward into the water. During higher lake levels there were no obvious impairments to the shore (other than to the ecology dependent on rocky lake bottoms). During low lake levels, however, these groynes have impeded the circulation of water and the artificially created beaches become areas where water can stagnate. The shallow waters can heat up quickly in the summer sun, and ambient nutrients can contribute to algae growth. Rotting algae contained between the groynes can present an unpleasant situation for beach goers with smell and water quality problems.



Past alteration of this shoreline during higher lake levels takes on a different character during low lake levels. The excavated shore prevents water circulation and becomes a pocket where pollutants can become contained, the shallow water can heat quickly, and presents an ideal place for algae to develop.

(vii) External Influences

The movement of pollutants does not stop at the municipal borders. Water impairments from areas outside of the municipality can influence our local beaches. Nearshore currents can carry pollutants originating north or south of the township's borders.

The predominant wave direction on Lake Huron is from the northwest (Reinders, 1989). This sets up an alongshore current that moves nearshore sands, on a net basis, from north to south. During summer months, when winds and waves tend to come from the southwest, the alongshore current can move sand northward. Alongshore currents and the resulting sand movement will have an influence on the movement of pollutants entering the nearshore waters of the lake, particularly those pollutants that become attached to sand particles and move along the shoreline with the longshore drift. These alongshore currents can also form barrier beaches across the mouths of creeks and small watercourses causing a temporary damming and stagnation of the creek or river mouth (estuary). Researchers from the United States Geological Survey report that barrier beaches can act as a retainment structure that can hold back pollutants from entering nearshore lake waters (Richard Whitman, USGS, personal communication, 2010).

Nutrients may also be contributed through what scientists call the nearshore phosphorous "shunt". The invasive Zebra and Quagga Mussels filter the water column creating clear water conditions that allow sunlight to penetrate deeper into the water. The waste created by the mussel's form a concentrated layer on the lake floor that is high in phosphorous. Waves can re-suspend the phosphorous.

The mussels also increase the surface area available for benthic algal attachment by increasing the amount of surface area for the algae to attach to, including the accumulations of empty shells. Water clarity and a ready source of nutrients can combine to aid the growth of algae.

Nearshore pollution issues extend beyond the direct control of Kincardine. The municipality and its residents have an important role in safeguarding our nearshore waters. However, due to the nature of the lakeshore, and external sources of pollutants that can contribute to beach impairment, it is important that higher levels of government participate in funding clean up and stewardship efforts that help to improve the quality of our beaches.

Recommendation: Watershed restoration of Kincardine's river's and streams would benefit local water quality and help to improve conditions at the beach. Stormwater retention and riparian buffers would help to reduce flow rates and aid in filtration of surface runoff. Local volunteer groups and the municipality, with guidance from Saugeen Conservation, should coordinate to implement watershed based restoration work to improve water quality conditions.

Recommendation: Station Beach is the only beach in Kincardine that is monitored during the summer for *E. coli*. There appears to be some confusion amongst the public about the state of unmonitored beaches, and under what lake conditions caution should be taken. The Grey Bruce Health Unit is encouraged to better promote precautionary information about lake conditions through more extensive use of signs on unmonitored beaches, promotional materials and through the media. Establishing communication partnerships with the Municipality and the Coastal Centre could provide some advantage in message dissemination.

Recommendation: Algae fouling of beaches during summer may become more prevalent under below average lake levels. The municipality should establish protocols for the appropriate removal of excessive algae on high use beaches. If beach grooming is required, clear guidelines should be established for how work is carried out, and under what conditions.

Recommendation: Appropriate inspections and monitoring should be undertaken to ensure that septic systems are functioning properly and that untreated wastewater from roads and urban areas does not enter Lake Huron and end up transported by water currents to the north Kincardine coastal area.

Recommendation: Landowner stewardship can provide substantial benefits to beach quality. Septic system maintenance, reduction or elimination of fertilizer use, native plant gardens and buffers and water conservation measures can all play a role in lessening water impairment sources from cottage communities. Communicating best management practices is encouraged . Kincardine should lead in this effort, with the technical support of the Coastal Centre, Saugeen Conservation and the local Health Unit.

Recommendation: Kincardine is encouraged to continue to support the Blue Flag program at Station Beach. This program helps to bring greater awareness to environmental and public safety concerns at beaches, and encourages better stewardship.

Recommendation: Proper coastal stewardship should be encouraged as a contributor to the goals of Source Water protection and the future of Kincardine's drinking water supply.

Recommendation: Kincardine consider becoming involved in the Blue Flag marina program at Station Beach to include the boating industry in water protection.

Recommendation: Monitor and Reduce the Impacts of Hyperabundant Native Species. Canada Geese were observed in the study area during the 2011 surveys. Numbers were relatively low, and it is suspected that current impacts are minor. If populations exceed the ecosystem's natural carrying capacity, Canada Geese can cause severe damage to wetland vegetation, and their droppings can pollute beaches and coastal waters. The introduced Mute Swan, which also occurs in the study area, may have similar impacts, and populations should be monitored. If these species start to become a nuisance, as they are on the southern coast of Lake Huron, appropriate and approved deterrents might become necessary.

7. Invasive Species

7. Invasive Species

Invasive, non-native species are plants, animals and microorganisms that have been accidentally or deliberately introduced into areas beyond their normal range. Invasive species are defined as harmful alien species whose introduction or spread threatens the environment, the economy, or society, including human health. The ecological effects of invasive species are often irreversible and, once established, they are extremely difficult and costly to control and eradicate (OISSP, 2011).

Our coastlines are being affected by alien invasive plant species that can pose a real problem for local ecosystems and overall beach health. Invasive species tend to intrude into natural areas and overtake native plant populations. Invasive species are opportunistic and usually move in when an opening has been made available. Often a human disturbance, like the removal of large amounts of native vegetation or landscape alteration, can provide the opening necessary for an invasive plant to take hold. One of the characteristics that make these species such a problem is their high capacity to reproduce. This helps the plant to overtake native populations and eventually form a monoculture of the invasive plant.

While many of the non-native species occurring in the Municipality of Kincardine's coastal areas may not be a current cause for management concern, several are considered highly invasive. If they become established they can out-compete the native species, alter ecosystems and become major management concerns that become costly to address. Careful monitoring of the status of invasive species and early action can minimize the need for extensive and costly management measures should these plants overtake natural ecosystems.

The biggest current threat by invasive species in Kincardine's coastal areas is from Common Reed (*Phragmites australis*), and this section will focus mainly on this plant. This species has been spreading aggressively in southern Ontario over the last few years. As it becomes well established in beach habitats and wetlands it can form dense, impenetrable stands. Common Reed, which can grow upwards of 3 to 4 metres in height, can impact lake vistas, alter beach ecology, and impair access (Appendix G). There are several places where *Phragmites* is present

on the shores of the Municipality of Kincardine – particularly in areas like Boiler Beach and in the coastal wetlands in the Bruce Pines area. The Coastal Centre conducted a field analysis of Phragmites infestation from Point Clark to Sauble Beach in 2007. The state of the infestation was mapped and priority sites for targeting control measures was determined, to aid municipalities and community groups. Priority areas for Kincardine have been identified and serve as a starting point for Phragmites control in the municipality.

Root system (rhizomes) of the Common Reed

The recent invasion of Common Reed on beaches along Lake Huron has posed concerns. The reed, which can grow up to three metres or more in height,

Negative Effects of Non-native Invasive Species

The negative effects of invasive species on natural ecosystems may be felt through one or more of the following:

- Reducing biodiversity
- Altering hydrologic conditions
- Altering soil characteristics
- Interfering with natural succession
- Competing for pollinators
- Poisoning or repelling native insects
- Displacing rare plant species
- Increasing predation on nesting birds
- Serving as reservoirs of plant pathogens
- Replacing complex communities with single species monocultures
- Diluting the genetic composition of native species through hybridization
- Being difficult and/or costly to control

first appeared on beaches in the Municipality of Kincardine between 2003-2005. It began growing in wet beach swales between the foredune and the lake, and on low gradient beaches. Below average lake levels helped produce the conditions that made this environment open and attractive for this plant to invade.

The decaying plant material from previous year's growth, as well as roots, will reduce the pore structure of the sand and reduce the ability of beach sand to transmit groundwater. As a result the flow of shallow groundwater below the beach will be impeded and the water table will rise. As the water table moves closer to the ground surface, the beach becomes wetter, and enables other invasive species to take root.

Contaminants from septic systems will flow towards the shoreline. The reduced permeability of the sand and corresponding rising water table will increase the risk of contaminants discharging onto the beach. The wet beaches can be affected by pollution from geese, gulls or nearby septic systems. So, expansive invasions by alien plants like Common Reed are not only a concern to local ecology, but also their potential to contribute to beach impairment by pathogens. In controlling invasive plants, it is important to be able to distinguish the invasive nonnative plant from the native plants that are important to the health of our coastal ecosystem.

In any invasive plant control program, consideration must be taken with regard to site specific conditions such as native plant diversity, wildlife usage, and water table fluctuations.

As discussed earlier, vehicle use along beaches (ATVs, contractor equipment, public works vehicles, etc.) can spread Common Reed. Consequently, vehicles should be restricted from use on Kincardine beaches.

A disturbed soil surface where native vegetation cover has been disturbed provides an excellent seedbed for the Common Reed. Attention needs to be focused not only on dispersal vectors likely to spread the plant from one area to another, but also on preventing the creation of disturbed soils. Management practices leading to a dense native plant cover that can compete for space and light with Common Reed seedlings may represent an effective strategy for preventing the establishment of a Common Reed stand (Belzile, *et al*, 2009).

In attempting to control large stands of an invasive non-native plant like Phragmites, the first instinct might be to use machines to dig up the plants and remove them. Experience has demonstrated that this is not very effective. Even

small sections of rhizome will re-sprout if left in place. The Ontario Ministry of Natural Resources has developed a “Best Management Practices” guide for invasive Phragmites which explains an preferred approach for a control program. Once a control program is initiated, annual monitoring and removal is needed to ensure that the species does not take hold in other coastal areas of the Municipality of Kincardine.

In neighboring jurisdictions (Saugeen Shores, Huron-Kinloss), the use of herbicide appears to have had the best results in controlling this invasive, although there are some concerns with this approach in environmentally sensitive areas. From a practical standpoint, herbicide use is one of the few effective options for large patches of *Phragmites*. In smaller patches, or for isolated plants, mechanical removal may be the best option.

Large patches of *Phragmites* may require herbicide treatment initially. This option should be undertaken in fall once native plants have gone into dormancy, and the *Phragmites* can be more easily targeted. Direct application of herbicide (i.e. hand wicking method) is recommended over spraying . Use of herbicide should only be undertaken by provincially licensed applicators and requires a letter of opinion through the Regional Director of the Ministry of Natural Resources as to whether the application of herbicide is in support of natural resource management including control of an invasive species that may be detrimental to the health of persons or the environment or economy of Ontario.

During summer, a management approach would be to harvest the seed heads from the plants, bag and dispose or burn the seed heads in the landfill. Removing seed heads will help to prevent seed dispersal and the establishment of a seed bed in the surrounding soils. Local community groups should be consulted to see if volunteers could be obtained to assist, as this will be a significant undertaking. This work should commence in mid-summer once the seed heads have fully formed on the plants. This would need to be a recurring activity, but the effort needed should decline as the chemical and mechanical control efforts take effect.

There may be small isolated occurrences of *Phragmites* where hand removal may be possible. It is important that the entire plant, including all root fragments, be removed and disposed or burned in the landfill. Any lingering fragment can produce another

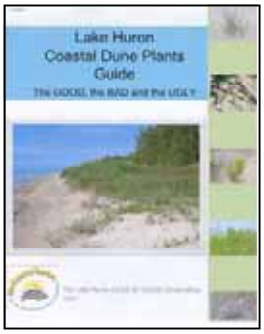
plant. Coordinating efforts with other municipalities and groups may help to slow its mobility alongshore.

Control of invasive plants can be difficult, but the effort usually pays off. Taking no action could jeopardize the very environment we enjoy. Since coastal plant communities are often high in diversity, and contain a number of rare plant species, keeping vigilance over invasive species is important. Control measures are often different for different invasive plants. It is important to use tested and proven techniques to ensure that control efforts are successful and not made worse by poor information, or a lack of understanding of the plant's ecology.

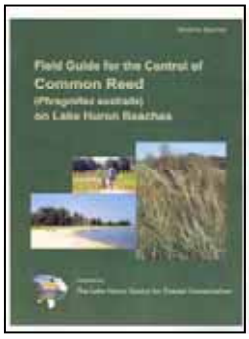
A plant species identification catalogue has been developed by the Coastal

Available Resources

"Occurrence of Common Reed on Lake Huron Shorelines". Field survey report on the occurrence of Phragmites, with recommended priority target areas for control programs. Available from the Coastal Centre.



"Coastal Dunes Plant Guide" - User friendly catalogue of native coastal plants and typical non-native invasive plants. Available from the Coastal Centre.



"Field Guide for the Control of Common Reed on Lake Huron Beaches" available from the Coastal Centre.

"Dune Planting Guide" - tips on using native plants to restore degraded areas, or for native plant gardening. Available from the Coastal Centre.

"Invasive Phragmites—best management practices" available from the Ontario Ministry of Natural Resources.

Centre to assist people identify the invasive plants from the beneficial ones. This plant identification guide lists both native and non-native plant species that one might encounter along the lakeshore. If you are unsure if a plant is native or an invasive non-native, it is best to leave it alone until it can be accurately identified. Some of the key invasive plants along the Kincardine coast include Common Reed, Spotted Knapweed, White Sweet Clover and Giant Hogweed.

Ecosystem resilience describes the ability of an ecosystem to cope with change. A strong and resilient ecosystem is more able to withstand stresses such as invasive species. Resilient ecosystems, when stressed, have a better chance of recovering. Rapid response is important and the knowledge of how to deal with invasive species is crucial. Each plant has its own ecological characteristics which need to be understood before a control program is undertaken.

Phragmites Control *Recommendations* for Kincardine

Some very small patches in good quality habitat are **extremely high priority** for control. Although these may patches seem minor at the moment, the ability of this plant to spread rapidly means that "early containment," especially in areas with good natural vegetation or a high social value, is critical in order to ensure wise use of limited resources.

Best results in invasive species management are obtained when, rather than beginning in the weediest area, weeds are removed from the best quality (and least weedy) areas, and native plants are permitted to reestablish. Typically, invasive species (including *Phragmites*) thrive and spread most easily in open mineral soil that is produced by disturbances, or in this case, low water levels. Then, once the best natural areas are protected and the seed bank of native species is maintained, the core of the established areas can be undertaken (Bickerton, 2007). Where resources are limited, it is better to completely eliminate *Phragmites* from one area than to partially eliminate it from many.

Boiler Beach, Saugeen St. north to Lorne Beach, and the coastal wetlands north of BNPD are noted as high Phragmites occurrence areas.

Given the extent of the infestation of Phragmites, it may be necessary to consider the use of herbicide in combination with other control methods. Use of herbicide should only be done by licensed professional applicators, with a Letter

of Opinion from the Ministry of Natural Resources. Application timing is typically autumn once native plants have gone dormant.

Private landowners are not encouraged to undertake herbicide control. The hardware store variety of herbicide to which they would have access, is not concentrated enough to use on Phragmites. Using under-strength herbicide could lead to the plant developing resistance to stronger varieties.

Other Invasive Plant Species of Concern

While Phragmites is the current priority species of concern because of its aggressive and ecologically destructive capacity, other species can cause problems. Within Huron Fringe forest lands,

Garlic Mustard (*Alliaria petiolata*) can threaten the long term health of coastal woodlands. Garlic Mustard can form a carpet on the forest floor, and emit a toxin that stunts the growth of emerging seedlings and saplings optimizing conditions for its own expansion.

Giant Hogweed (*Heracleum mantegazzianum*) looks like overgrown Queen Anne's Lace. It is an invasive plant that exudes a clear watery sap, which if exposed to the skin sensitizes the skin to ultraviolet radiation. This can result in severe burns to the affected areas resulting in severe blistering and painful dermatitis. It can cause blindness if it enters the eyes. Giant Hogweed can grow to a height of 4 metres.

Spotted Knapweed poses a serious threat to the fragile dune systems of the Great Lakes Region. Once established, knapweed tends to dominate the site thus reducing the abundance and diversity of native communities. The most effective control is early detection and removal of pioneering plants. Removal of

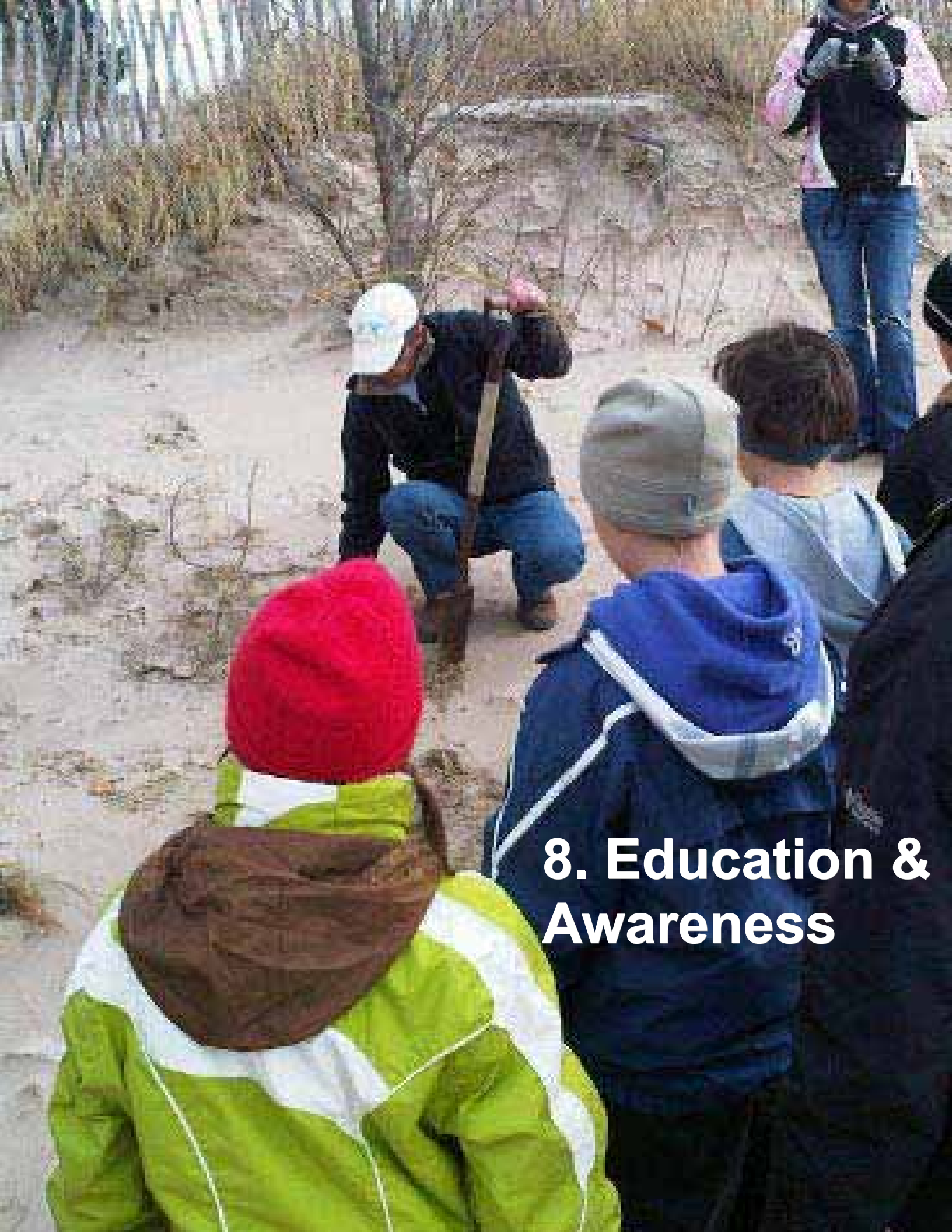
Garlic Mustard

Giant Hogweed

Spotted Knapweed

this plant can be done by simply pulling and bagging. Knapweed plant juices contain carcinogens, so it is best to wear gloves and use extreme caution when handling these plants (OSU, 2008).

Other invasive plants are noted in the Coastal Centre's "Coastal Dunes Plant Guide" available online (www.lakehuron.ca). Some invasive plants are 'escapees' from gardens. The Centre encourages coastal landowners to use native plants in gardens, or ensure gardens are fully contained if non-native ornamental are used. The Centre's "Dune Planting Guide" is another resource that can assist landowners with appropriate native plant selections for use in gardens.



8. Education & Awareness

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Education and awareness is one of the most fundamental investments in a successful coastal conservation program. There are various approaches to providing education and awareness services, and no one approach should be considered sufficient to reach the targeted audiences. Rather, a broad, multi-faceted approach that includes both formal and informal education tools is necessary.

Education and awareness should be regarded as an ongoing effort that has no expiry date. Community-based implementation is important, and the Municipality, community groups, cottage associations and agencies should participate in the education and awareness process, in partnership with the Coastal Centre.

A) Formal Education

In this context, formal education refers to the process of developing people's environmental literacy in a structured program. This includes elementary, secondary and post-secondary school opportunities to learn about Kincardine's coastal environment. Kincardine offers a unique advantage of providing a "living laboratory" for teaching about coastal processes, geomorphology, biodiversity, water quality and climate change, and all of the topics derived from them. This area could be marketed within the educational community as a special learning environment for multi-disciplinary education. The Coastal Centre has developed education resources for schools interested in teaching about Lake Huron's coast. These resources are available to schools, and encourage field trips to the coast to learn about these ecosystems first-hand.

Part of the learning is to experience the environment and participate in active learning. The Coastal Centre promotes the involvement of students in dune restoration projects as part of a coastal science program.

Community workshops provide another means of education in a formal setting. The Coastal Centre hosts a biennial "Is the Coast Clear?" conference, held in even years and is open to the public. It

typically covers many of the current and emerging issues facing Lake Huron's coast. The Centre also hosts special topic workshops from time to time. Contact the Coastal Centre for information or assistance in hosting local coastal stewardship workshops.

The Coastal Centre has also helped organize and participate in continuing education courses on Great Lakes issues. There may be an opportunity to offer a similar education series in partnership with the Lake Huron Lifelong Learning Centre.

B) Informal Education

There are a variety of methods of informal coastal education that should be considered at Kincardine. Many of these involve orienting beach users about the municipality's unique and sensitive nature through the use of signs, literature and other media.

i) Signs

The use of informational signs is important as an educational tool, particularly since this may be the only opportunity that visitors have to learn about the coastal wetlands and dune grasslands at Kincardine and why their conservation is so important. Signs used for this purpose must not only be attractive and appealing to the reader, but they should also be stylized so that all signs used along the waterfront have a consistent look. Colour, lettering style and size are all considerations in an attractive and functional sign system.

ii) Interpretive Signs

Interpretive signs are large signs placed at major entrances to the beach. They provide information to the reader about the sensitive natural environment, threats to the coastline and information on how people can help protect Kincardine's environment. Some excellent examples are present at Station Beach through the Blue Flag program.

Interpretive signs provide beach users and other interested people with some more detailed information about the coastal environment. These types of signs signify to the reader that coastal conservation is an important part of the local community, and ask visitors to participate in stewardship. They also list the

partnering organizations involved in the conservation efforts here. A sample interpretive sign is provided in Appendix _. Interpretive signs would be effective at all major beach access locations in the municipality, including Inverhuron, Lorne Beach

iii) "Sensitive Area" Signs

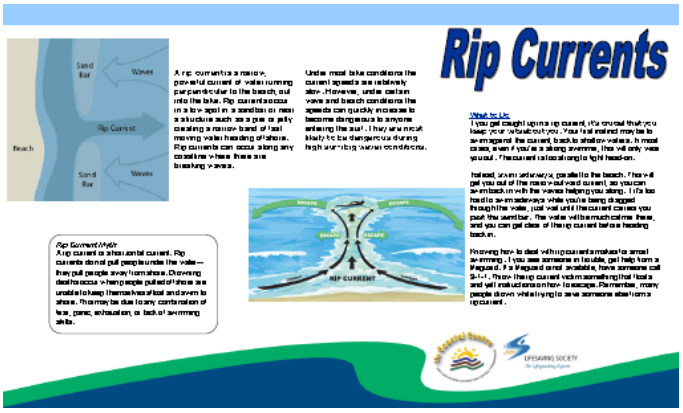
Sensitive area signs are smaller aluminum signs that can be placed at strategic locations (perhaps at trails where people have been accessing the beach by vehicle) to advise visitors of the vulnerability of the shoreline to human impacts. The objective of these signs is to 'remind' beach users that their participation in coastal stewardship is expected. They are designed to provide a concise conservation message. These are different from By-Law signs which are intended to advise people of regulations in force by the municipality. A sample "sensitive area" sign is provided in Appendix _. These signs have been used effectively at Station Beach, but could also be considered at other beaches in the municipality.

iv) Beach Access Signs

Beach Access signs identify the designated access routes that people are permitted to take to access the beach. Having designated routes helps reduce the myriad of pathways produced when there is no organized beach access routes planned. Wording on the signs can be as simple as *"Beach Access – Please follow the designated trail"*. It is useful to have signs at both ends of the trail so that people can return home by the same trail.

v) Rip Current Awareness Signs

Rip currents are a natural coastal process that presents a public safety hazard to people who are unaware of the risks, and unfamiliar with how to deal with a rip current situation. Kincardine has some signs in place warning about rip currents (using the outmoded term 'undertow'). Additional information about their cause, and what to do if one experiences a rip current would be



helpful. A sample design is included as Appendix E.

B) Information Literature

Literature describing the ecological and social values of the Municipality of Kincardine will be an important method of providing conservation messages to the community. The Coastal Centre has produced a number of publications on dune grassland, coastal wetland and cobble beach conservation. In addition, the Centre has produced an information brochure on the invasive plant *Phragmites australis* and its threat to Lake Huron's beaches. These are examples of the information that the Municipality of Kincardine could share with the community to help build awareness of some of the issues.

C) Media

The Municipality, in partnership with the Coastal Centre, should consider regular submissions to local newspapers and other media during the summer season highlighting various aspects of the Kincardine coastline. The objective should be the education and awareness of readers concerning the waterfront. This could include articles on dune and wetland conservation, Species at Risk, water quality, water levels, biodiversity and climate change. It could also include historical accounts, archeological information, First Nations history and other topics of interest. Short, regular weekly features would help promote the dunes, wetlands and their conservation, a better understanding of the waterfront and its inter-connectedness, and how the community can participate in its stewardship.

D) Municipal Council

Municipal Council should be kept informed about conservation issues along the shores of Kincardine. As the local government, they play a key role in stewardship efforts. Council members change for time to time, so it is important that they are provided with up-to-date information on the coastal environment, particularly the issues that threaten the health of this environment. The Coastal Centre endeavors to assist its partner municipalities with updates on current and emerging issues along the coast. We encourage Council to endorse this plan as a guideline document for the municipality.

E) Messaging

Consistent messaging is important to prevent confusion about Kincardine's coastal ecosystems and how people can help to protect ecosystem health. Keep the messages simple, and use them consistently in all varieties of media used.

Some of the general messages recommended include:

- *Kincardine's rare coastal ecosystems are part of our common natural heritage.*
- *The coastal ecosystems are vulnerable to human disturbances.*
- *Our shorelands are habitat for rare species including Species at Risk.*
- *Dune grasslands provide a repository of sand that preserves beaches during high lake and storm events.*
- *The coastal meadow marsh filters water providing a cleaning function and therefore improving water quality.*

Some specific messages include:

- *Stay on designated trails and beach pathways.*
- *Don't drive vehicles off the municipal roadways.*
- *Tread lightly, don't pick flowers, or damage the vegetation.*
- *Your help to protect Kincardine's rare and vulnerable coastal ecosystem is appreciated.*

F) Rules and Regulations

Lake Huron is an international waterbody, the lakebed is owned by the province, Kincardine's beaches are mainly Crown land a number of features and species are protected to varying degrees. This makes for a wide range of legislation, policies and bylaws from all levels of government that relate to the coast. Greater public awareness of the rules would help prevent damaging activities and practices. Appendix I provides a list of some of the common legislation and the agency responsible for its implementation.

9. Conclusion

9. Conclusion

The way we live on and manage our coast can shape its future - positively and negatively. Through stewardship practices, education and monitoring, individuals, governments and organizations can maintain the natural shore systems. But stewardship involves more than education, enhancement and restoration. It demands a change of attitude, the understanding that we all can make a difference.

One of the greatest social values associated with the shore is recreation. Beaches are treasured for swimming, playing and socializing. But shores aren't just for fun. They are vital for sustaining our quality of life.

In the introduction, we discussed the 'coastal shore services' that we enjoy (food, flood control, fresh water, social benefits, etc.). Paying for these "free" services would cost us billions of dollars. We often ignore these unaudited benefits while making short-term economic gains at the expense of long-term preservation of our environment. When we ignore the value of nature's services, we are "cooking the books." Sustaining the shore and its intrinsic features is essential to our social, economic and environmental well being. On the other hand, taking care of the natural values of our coast adds value to our properties, and the community as a whole.

This plan was developed to provide guidance to the Municipality of Kincardine and the Kincardine community in managing its beaches and shorelands with the intent of protecting the natural integrity, and special attributes of this coast. As Kincardine is becoming a highly popular beach destination, there is risk to vulnerable environments like dune grasslands, cobble beaches and coastal wetlands to cottage/residential development and intensive use by beach goers. There is also an opportunity to proactively manage people's access to the beach in a way that minimizes impacts and informs the user that this is a sensitive and highly valued coastal environment.

The recommendations set out in this plan are intended to accomplish the goal of accommodating people's need to access the beach, with the need to conserve the beach and dune ecosystem for future generations. The Kincardine community will be key to this plan's success as local champions to the cause of coastal conservation. Coastal conservation aims to preserve the integrity and quality of the coast for future generations to enjoy.

The future health of Kincardine's coast will depend on its care and stewardship. Several challenges are ahead:

Increased Use: As Ontario's population increases, demand for quality beaches is anticipated to increase as well. Greater use of Kincardine's coast will place greater stress on the vulnerable ecosystems present. Work implemented through this plan should help to provide the necessary measures antecedent to greater increases in beach use.

Climate Change: Projected lowering of lake levels, higher mean temperatures and changes in precipitation patterns are anticipated to combine to increase sand migration. Unaltered dune systems should be able to assimilate this sand. However, degraded dune, and large breeches in the dunes will be pathways for sand to erode inland, out of the beach-dune system. Recommendations identified in this plan are intended to promote the natural integrity of the dune system, which, if effectively adopted, should enable the dunes to adapt to changing conditions. Under current circumstances, the dunes at Station Beach will be better able to adapt to changes than Inverhuron Beach.

With lower levels, coastal wetlands are anticipated to expand in size. Kincardine's coastal wetlands will play a significant role in the broader regional context since wetlands on Georgian Bay will decline with lower levels. Kincardine's growing wetlands will help Lake Huron to compensate for the loss of wetlands on Georgian Bay. Protection of these wetlands will be an important undertaking, for the health of the whole lake.

Invasive Species: Invasive non-native plant species could pose a threat to native dune and wetland species in Kincardine. Careful monitoring, and rapid response control measures will help to minimize impacts from invasive species. Removal should be done with care, keeping in mind that removal of large infestations may require the temporary use of sand fencing, as well as restoration planting with native vegetation, to prevent wind erosion.

Informed Community: The success of implementing stewardship measures is going to largely rely on how well the community and visitors are educated about the coastal environment, its vulnerabilities and what is needed to protect its values and functions. Environmental education and awareness will be an ongoing action item for the municipality, agencies like Saugeen Conservation and government ministries, and organizations like the Coastal Centre and Blue Flag.

The foregoing challenges can be met through the implementation of this plan, careful monitoring, and adapting to changes as they arise.

Glossary

Adventive: in botany terminology, describes a plant which has been introduced to an area recently, in particular since colonisation by humans.

Aeolian: pertaining to wind.

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

Beach Health: term used to describe the ecological condition of a beach and dune system. A 'healthy beach' is one that retains its bio-physical form and function, allowing the beach to respond to changing wind and wave conditions.

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 wetland: Lacustrine wetlands are predominantly influenced by lake forces, in protected bays or on a stretch of open shoreline.

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 held together by specially adapted vegetation.

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 where there is no sufficient source of sand to replace what is lost.

Dynamic beach: that portion of a shoreline where accumulated unconsolidated sediment (eg. sand, gravel, cobbles) continuously moves as a result of naturally occurring processes associated with wind and waves and changes in the rate of sediment supply. Dynamic beaches are associated with dune systems which, if left unaltered, provide habitat for unique and rare species, provide a protective function from storm waves, and are linked to improving local water quality. Dunes are considered to be one of the Great Lakes most vulnerable ecosystems.

Ecosystem services are benefits that people obtain from the lake and coast, such as fish, recreational opportunities, climate regulation, renewable energy, and spiritual fulfillment. Ecosystem services are also called nature's services.

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.

Endemism: Endemism may be considered on at least three levels (Riley pers. comm. 2002): 1. Site endemism, where a taxon occurs at only one site (e.g., at a single mountain range or island) in the world; 2. Geographic endemism, where a taxon is restricted to a relatively small geographic area (such as the Great Lakes basin, or a specific country); and, 3. Occurrences limited to a narrowly-defined geographically-restricted habitat type, such as Great Lakes

dune or meadow marsh systems.

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.

Graminoid: grasses (family *Gramineae* or *Poaceae*) and grass-like plants such as sedges (family *Cyperaceae*) and rushes (family *Juncaceae*).

Headland: an erosion resistant point of land, either man-made or natural, extending into the lake; Sand deposits often form on the updrift side of the headland (e.g. Point Clark, Kettle Point).

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

Lake Algonquin: post glacial lake which existed about 11,000 years ago. 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 ago. The remnant beach ridges left by Lake Nipissing are still evident landward of the Algonquin bluff. A large portion of the cottage development in Huron-Kinloss has been built on the Nipissing sand deposits.

Littoral zone: of or pertaining to the bio-geographic region between the nearshore zone (generally to 4 metre depth on the Great Lakes) and the high-water line and sometimes including the supralittoral zone above the high-water line.

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.

Pioneer species: Pioneer species are species which colonize previously un-colonized land, and make them easier for succeeding plants species to grow in.

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 or Algoma).

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.

Seiche: an occasional and sudden oscillation of the water of Lake Huron producing fluctuations in the water level and caused by wind or changes in barometric pressure. During a seiche, the waterline can either rise or fall, but the water level change at the shore is temporary.

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 over 500 plant and animal species at risk in Canada. Species at Risk are wild species that are in some danger of disappearing from Canada. The dune species Pitcher's Thistle is a Species at Risk in Canada.

Stewardship: care 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

Kincardine Coastal Stewardship Factsheet

Protecting Kincardine's Coast

Coastal Stewardship

In this Issue:

Shore Facts

- Lake Huron's dunes are nationally rare and threatened ecosystems.
- Coastal wetlands that help to purify water by filtering pollutants.
- Kincardine's coastal features are vulnerable to human impacts.
- Lake Huron's coast is habitat for several Species at Risk.

Lake Huron's coastline represents a concentration of rare habitats like dune grasslands, coastal wetlands and cobble beaches. Within these habitats are numerous rare plants and animals that have adapted to these shores over thousands of years.

Kincardine's diverse coastline includes a combination of all these habitats, from sandy beaches and dunes to the south, to cobble beaches in central Kincardine to coastal wetlands to the north.

Each of these habitats have vulnerabilities to human disturbance. As large numbers of people continue to be drawn to the beaches these sensitive coastal ecosystems, and the plants and animals they support, will need our help to ensure they are not degraded or destroyed.

What would degradation look like?

- Impacts to coastal vegetation could lead to beach erosion,
- Poorer sand quality,
- Poorer water quality (as the filtering vegetation is removed),
- More invasive species (like Phragmites, Giant Hogweed, Garlic Mustard, etc.),
- Loss of rare species and Species at Risk.

Coastal Stewardship restores the balance between peoples use of our beaches, and the protection of our ecosystem assets.

Beach & Dune Processes

The changing physical processes responsible for the ecological character of Kincardine's coast needs to be recognized in stewardship planning efforts.

Great Lakes dunes are among the most vulnerable ecosystems in Canada. They have undergone significant declines during the past century, largely as a result of shoreline development and recreational activities.

Our diminishing dunes and their adjacent beaches are home to a number of rare species and plant communities, including dune plants like American Beachgrass, Great Lakes Wheatgrass and Long Leaved Reed Grass. Endangered plants like the Pitcher's Thistle is present at Inverhuron.

These are examples of key plants that grow on Lake Huron's dunes, and are responsible for their creation and stability. Without them, the sand would continue to blow inland, and those reserves of relic sand would not be present for protection during future high levels and storms.

The consequence would be landward migration of the shoreline, threatening buildings and resulting in the loss of the recreation potential of the beach.

Proper care and conservation can ensure that our dunes are not lost due to complacency or neglect. Using designated beach access pathways, and avoiding trampling beach vegetation helps protect these important coastal ecosystems.

Coastal Wetlands

Coastal wetlands are different than the wetlands found inland because they are influenced by a continual process of adapting to the long-term fluctuations in water levels. Water level change is necessary for these wetlands to maintain optimum productivity and diversity of vegetation.

Coastal wetlands act as a natural buffer zone, cleansing surface and groundwater before it enters the shore waters. Not only do the wetlands slow down the movement of sediments and trap pollutants, but the vegetation can absorb many persistent pollutants, such as heavy metals. Chemicals like nitrogen, phosphorous and pesticides, are taken up by the wetland plant's root system. These wetland buffers help make our shoreline swimmable.

Dredging, development, use of motorized vehicles, clearing and invasive plants are all threats to Kincardine's coastal wetlands.

Cobble Beaches

Due to shoreline development, cobble beaches are becoming so scarce that they are considered globally rare (9% of total Lake Huron shoreline). These shores provide rich feeding grounds for shorebirds. Limestone cobble shores share many species with cold, fast-flowing streams, including midges, stoneflies and mayflies. Spring migrations of warblers feed heavily on the midges that settle in the cedar that ring the shoreline.

A principal threat to the cobble beach is all-terrain vehicle use (ATVs), which can result in the destruction of habitat, and in the introduction or spread of invasive, non-native plant species. Moving stones both in the water and on shore can alter habitat, and remove shore protection.

Threats to Kincardine's Coast

Kincardine's beaches are a prime attraction for visitors and resident alike. As a result, they are under increasing pressure primarily from additional cottage development and increased recreational users.

In addition, unwise decisions regarding beach management and drainage can also contribute to beach degradation, both by municipal workers and landowners. More awareness is needed of the vulnerabilities of Kincardine's coast.

A changing, warmer climate, expected for our area, will increase the beach season, imposing greater demands on the coastal environment in the future.

In addition, invasive plants, like *Phragmites australis* (Common Reed) have appeared in and around Kincardine's coast. Vehicle use in natural areas can spread Phragmites seeds and root fragments which get caught in treads and transported to other areas. Other invasive plants, like the Spotted Knapweed, Sweet White Cover, Garlic Mustard, Giant Hogweed, and others, can pose great risks to ecosystems.

You can help to protect native coastal vegetation by limiting access to only designated beach access routes designed to minimize disturbance.

Remember that this shore provides natural shore protection, filters pollutants from runoff and is habitat for unique flora and fauna.

Disturbance to native plants and soil provides an opportunity for invasive species like *Phragmites australis* to take over.

The invasive plant *Phragmites australis* grows in thick monocultures, overtaking native species. Its rapid grow rate can become hard to control once it becomes established.

Damage to dune vegetation can lead to mass erosion of sand, creating drifting and burial problems. The mainly relic sand, once eroded, is lost from the beach system.

All-terrain vehicles can be very destructive to beaches, dunes and wetlands, and to Species at Risk. These vehicles are also responsible for the spread of *Phragmites*.

Beaches can be unsafe due to elevated bacteria. Excessive nutrients from land sources can lead to algae fouling.

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Community Stewardship

Development of a stewardship plan will:

- Evaluate the Kincardine coast;
- Seek community involvement;
- Develop recommendations for future stewardship efforts in the Municipality of Kincardine.

Updates on this plan will be posted on the Coastal Centre website (see below). The Kincardine Coastal Stewardship Plan is a project supported by the Kincardine Recreation Committee, a committee of Council.

What Can You Do?

People who enjoy Kincardine's coast play an important role in beach conservation:

- Make sure you use the established pathways so that your impact is kept to a minimum.
- Take special care not to damage any beach vegetation.
- Learn to recognize species at risk. Don't disturb the plants, and don't pick their flowers.
- Recreational activity should be focused on the open, un-vegetated sandy parts of the beach, away from the beach vegetation.
- Keep your waterfront in a natural state. Nature has created a balanced equilibrium. Do not remove beach vegetation or alter the beach.
- Avoid driving vehicles onto beaches. Vehicles can destroy vegetation and the habitat of numerous plants and animals that call the beach their home.
- You are in a dynamic coastal system where natural shoreline change is normal. Interfering with this beach ecosystem can have damaging consequences.
- Make sure any garbage you create you take home with you. Animals can ingest, or become entangled in, plastics and other materials.

For more information on Kincardine Coastal Stewardship, visit:

Lake Huron Centre for Coastal Conservation
website—www.lakehuron.ca

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Appendix B

Damaging Wheels Factsheet

(Restricting Motorized Vehicles on Beaches)

Protecting Our Beaches

LAKE HURON CENTRE FOR COASTAL CONSERVATION

Beach Conservation

Damaging Wheels

Driving vehicles on beaches is a subject that has become controversial in recent years. Cottagers who have spent many years enjoying our lake will often have stories, or even photographs, of driving up and down the beach back in the 1940s and 50s.

Today, cars are not acceptable, but all-terrain vehicles and snow mobiles sometimes find their way to our beaches. Some local contractors also find the beach a convenient way access job sites with their heavy equipment. At some locations, municipalities have chosen to use beach cleaners to manage a certain aesthetic.

Is there really a problem with driving a vehicle on a beach?

The use of vehicles in beach areas is a practice that is being challenged throughout the world as a better understanding develops of beach ecology and the environmental consequences of allowing vehicles on beaches.

At first glance, a beach may look barren and lifeless. However, a closer look reveals there is life both within and on our beaches. “Strand lines”, which are the lines of debris that collect where the waves wash up on the beach , often contain considerable amounts of organic matter, which the bodies of decaying insects, bacteria and fungi break down, releasing nutrients into the sand which are used by plants in the nutrient poor dunes.

Motorized vehicles can cause compaction of the sand, damage native beach plants and disturb the nesting, feeding and resting functions of shorebirds, like the sandpiper, dunlin and piping plover.

Dune plants are key to the health and stability of beaches. They gather sand, shelter birds, and withstand wind and waves. But they are very sensitive to a vehicle driving over them. All motor vehicles can kill native beach plants with a single pass, and even the wide flotation tires of quad bikes crush and destroy plants.

Impacts to Beaches

Research has identified that vehicle traffic on beaches compacts beach sand at depth, but loosens the surface of the beach, making it more susceptible to wind and wave activity. The effects of vehicle passage extends to a depth of approximately 20 cm. The sheer stresses of turning wheels loosens the sand and breaks plant roots as well as crushes seedlings of annuals and young plants of perennials like American Beachgrass.

Vehicles compact the sand, squashing small creatures that live on or under the sand and compressing their habitat. These animals are important food for shorebirds. Vehicles can also frighten away shorebirds and other species sheltering in the dunes, and crush their nests and eggs.

Driving vehicles in beach areas has important ecological implications. It is a practice that has long lasting effects on dunes and other coastal ecosystems, and this has contributed to the need for extensive conservation efforts by local communities to turn things around. The benefits of protecting our lakeshore extend well beyond environmental. Our beaches are important to our local coastal communities, both economically and socially. Beach stewardship is about restoring the balance between how people use beaches and what our natural ecosystems need to provide the benefits they provide us.

Vehicle access across a dune can have extensive impacts on the dune. The bare tracks provide an opening for wind erosion.

SUVs and boat trailers, ATVs, and snow mobiles are all vehicles that can damage or destroy dune systems. Dunes are simply too sensitive to withstand the effects of vehicles.

Threats to a Rare Ecosystem

On beaches, nesting shorebirds, such as the endangered piping plover are particularly at risk from vehicles. Piping plovers feed along beaches and sand flats. They feed primarily on exposed beach substrates by pecking for invertebrates one centimeter (0.4 in) or less below the surface. Primary prey for piping plovers includes worms, crustaceans, insects, and occasionally bivalve molluscs.

Fledgling Plovers feeding on the beach at Sauble Beach.

Their nests accidentally get crushed by passing vehicles. The presence of motorized vehicles may also cause the birds to desert the nest, exposing eggs or chicks to the hot sun and predators. Interruption of feeding may stress juvenile birds during critical periods in their life cycle.

Vehicles can damage feeding grounds for shorebirds, like the endangered Piping Plover, and tire ruts can impair juvenile birds mobility to feed and escape danger.

Lake Huron's beaches are narrow ribbons of unique plant and animal life that have evolved over thousands of years. This great diversity of life is becoming more imperiled because of increases in human activities that go beyond the ability of the ecosystem to repair itself. Plants, like the endangered Pitcher's Thistle, and other at-risk species like Indian Plantain, Dwarf Lake Iris and Hill's Thistle are examples of species whose habitat is being affected by people. It is important that we regain the delicate balance between people's use of our beaches, and the needs of our beach environments.

Indian Plantain

(flowers in summer)

Pitcher's Thistle (endangered)

(flowers once in its 10 year life cycle)

Dwarf Lake Iris

(flowers in spring)

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Spread of Invasive Plants

The invasive Common Reed (*Phragmites australis*) originates in Europe and is a very aggressive, robust, densely growing member of the grass family. Weeds, like the invasive Common Reed can be spread as vehicles pick up seeds and root fragments in their tires and chassis and carry the unwanted plant to other parts of the coastline. The spread of these invasive plants have become a costly problem for many municipalities to control.

The height and density of Common Reed allow it to form single-species stands that outcompete most non-woody native plants. The buildup of litter from previous years of growth prevents other species from germinating or establishing. It is capable of occupying and degrading vast areas of important lake habitats, like dunes, marshlands and fens. Common reed vegetation communities have low plant diversity and offer poor quality habitats for wildlife. Common Reed on beaches threaten the habitat of endangered species like the Piping Plover and Pitcher's Thistle, as well as many other rare coastal species.

Common Reed is an invasive plant that can overtake beach ecosystems. This has been declared one of Canada's most invasive non-native plants.

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Appendix C

Beach Grooming Factsheet

LAKE HURON CENTRE FOR COASTAL CONSERVATION

Beach Conservation

The Trouble with Beach Grooming

Introduction

Some conventional beach management practices that include mechanized raking or grooming the beach can be destructive and have long-range implications for the sustainability of the beach-dune system.

Some beaches which have a fine-grained, low gradient beach are often high in moisture content (particularly during periods of high lake levels). Raking has the effect of aerating the sand and drying it out, thus making the fine sands vulnerable to wind erosion. Raking and grading also tend to obliterate sand binding beach vegetation which tends to populate the mid and upper beach. This undermines the critical relationship between lake levels and dune development.

During low lake levels, dune vegetation (Marram grass in particular) will migrate lakeward through its underground rhizome systems and colonizing areas of the upper beach. The extent of this colonization is confined by high lake levels and storm events.

The practice of beach grooming can have profound long-term negative effects on beach erosion and shore ecology. Along many parts of the Lake Huron coastline, particularly north of Point Clark (including southern Georgian Bay and the south shore of Manitoulin Is.), beach and dunes are considered geologic relics—sand deposits which were deposited centuries ago when the coastal geologic conditions were much different than today. The beach

and dunes should be regarded as a non-renewable resource that must be conserved in order to maintain this natural resource. That means understanding the natural coastal processes at work, and ensuring that our interactions with the beach-dune system do not compromise beach quality or quantity.

The process of beach grooming, which has been done at a number of beaches for aesthetic purposes, can make the erosion problem worse such that sand is lost from the dune system, interrupting the dune cycle. Sand blown beyond the foredune (or 'first dune') represents a permanent loss to the system.

Raking has three key negative consequences:

First, the typically wet sand is drawn up and aerated, contributing to drying out of the sand and making the fine sands more vulnerable to wind erosion. High winds can transport fine sands a considerable distance inland.

Second, raking can destroy new seedlings establishing at the leading edge of the dune. Although seedlings in this 'embryo' dune, or pioneer zone, often become buried by wind-blown sand or storm-deposited sand, they will usually grow through the new sand layer and continue to stabilize the area. In addition, these upper beach and foredune vegetation colonies expand lakeward during lower lake levels. Conversely, these colonies contract during high lake levels and storm events as wave erosion removes and redistributes the foredune plants.

Third, the beach ecosystem is a habitat and feeding grounds for a mosaic of wildlife, including shore-birds, invertebrates, terrestrial insects and vegetation. Raking with heavy machinery can have a detrimental impact on species and habitat. More subtly, beach raking removes organic debris that washes up on the beach forming a strand line (sometimes referred to as wrack line). This organic detritus typically releases valuable nutrients into the beach substrate. These nutrients, in turn, are used by beach plants like Marram grass, Silverweed, and germinating seedlings of Sea Rocket and Pitchers Thistle. Preventing the nutrients from recycling can affect the integrity of the dune system over the long-term.

LHCCC Photo

Grooming can aerate the sand, drying it out. Dry sand is more prone to wind erosion

Grooming can damage dune vegetation that would ordinarily collect sand and prevent erosion. Preventing dune grass from growing lakeward during low lake levels means the dune will build vertically rather than horizontally.

LHCCC Photo

Excessive debris can be removed from the beach, however, it is the tendency to conduct regular scheduled raking that produces a sterile beach environment.

Aside from the ecological effects of raking, there are compelling economic reasons for reconsidering the practice of beach raking. Losses of sand from the beach-dune system represent a loss to the protective capacity of the beach-dune system during high lake levels and storm events. While losses may not appear significant on a *per annum* basis, over the long-term it can amount to substantial quantities of permanent sand loss. The value of a beach-dune system simply as shore protection has been estimated at about $3000 per linear metre. Beyond this, dunes provide a buffer for water filtering, and reduces maintenance costs by preventing sand drifting.

While grooming may "beautify" the beach, aggressive mechanized grooming removes significant amounts of wrack and sand and disturbs or destroys countless beach organisms as well as beach nesting habitat.

Other local jurisdictions with significant public use and similar beach characteristics, either have not embarked on a raking program (Pinery Park), or have strict guidelines around the practice (Huron-Kinloss; Sauble Beach). A number of American jurisdictions (e.g. Palm Beach County, Florida) have reevaluated their raking programs, based on their environmental impacts, and have radically scaled back their programs.

It is recommended that the beach managers consider implementing a beach cleaning program that is more environmentally appropriate. Large raking machines in current use could be replaced by beach clean-up staff walking the beaches and picking up litter manually. In some municipalities, staff is already assigned to clean up waterfront litter, particularly on busy summer days or weekends, and so this could be a logical extension. Other alternatives could include working with

LHCCC Photo

Strand line on beach.

Nutt photo

Nutt photo

Endangered Piping Plovers foraging in beach strand material.

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local groups to develop an "Adopt-a-beach" program where volunteers look after a section of the waterfront.

Regularly scheduled beach grooming is indiscriminate, allowing for unnecessary raking to occur. There may be occasions when mechanical raking is considered unavoidable (e.g. excessive debris washing up on the beach, garbage accumulated after a holiday weekend), but generally it is unnecessary and can be harmful to the beach ecosystem. Municipalities should review what conditions constitute a need for raking and develop guidelines so that all field employees have a clear understanding of the limitations necessary on beach grooming.

What are some Options?

It's important to manage people's expectations. Do you really need to groom the beach? Some of the alternatives to regular grooming that would help to protect beach ecology include:

- no grooming,
- hand grooming,
- seasonal grooming, zonal or rotational grooming, and
- threshold grooming, or strand line removal beyond a certain density or height.

The old notion of the "pristine" beach, clear of nothing but sand, is one that fails to recognize the life that forms, or relies on, the beach ecosystem. Beaches are far from lifeless. Managing them as an ecosystem will restore some balance, where people's needs and the needs of the coastal environment occur in harmony.

Plants, like the endangered Pitcher's Thistle (left) and Sea Rocket (right) can occur on the upper or mid beach. The habitat and survival of these plants can be impacted by beach grooming.

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Funding for this publication was made possible by funding from the federal Habitat Stewardship Program for Species at Risk.

Appendix D

Harvesting and Planting Beachgrass Factsheet

LAKE HURON CENTRE FOR COASTAL CONSERVATION

Dune Conservation

Harvesting Beachgrass

American Beachgrass (*Ammophila breviligulata*) is the plant typically used in dune stabilization projects. The grass should be obtained from local sources. Importing from other areas can introduce genetically different plants, or introduce disease that local plants may be unable to cope with. Restoration planting using American Beachgrass is best done in the fall, once the plants are dormant. Harvested plants can be placed in a garbage bag and kept in a cool dark place u to five days. Make sure the grasses will be planted into cool, moist sand. To transplant, follow the steps below.

Undercut the plant with a spade. You will have to cut the rhizome in order to get the plant out.

Grab the leaves of the plant and pull, shaking off sand.

The plant is made up of several plant culms, each of which will form an individual unit for transplanting.

Separate the plant into one culm. The culm will not typically have much of a root system.

Planting Beachgrass

Place blade of spade 20 to 30 centimeters into the sand.

Move handle of spade forward creating a wedge in the sand.

Place culm into wedge. The culm should be planted 15 to 20 centimeters into the sand.

Take the heal of your foot and pack the sand around the plant to eliminate any air pockets around the root.

Beachgrass should be planted with about 30 centimeter spacing between plants. The planting pattern should be irregular (not in rows).

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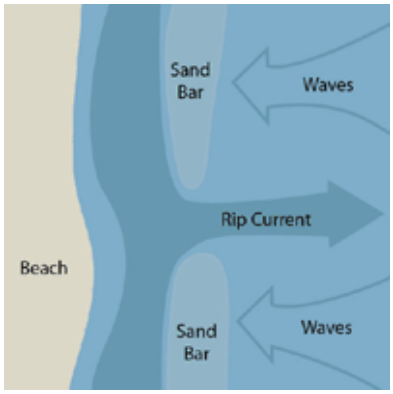
2005

Appendix E

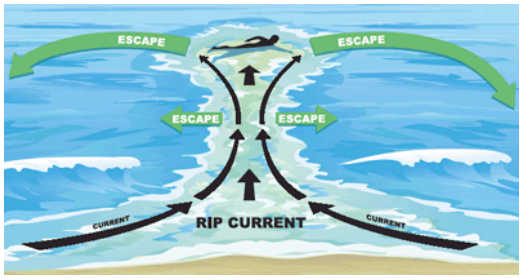
Rip Current Awareness Interpretive Sign

Rip Currents



A **rip current** is a narrow, powerful current of water running **perpendicular** to the beach, out into the lake. Rip currents occur in a low spot in a sandbar or near a structure such as a pier or jetty creating a narrow band of fast moving water heading offshore. Rip currents can occur along any coastline where there are breaking waves.

Under most lake conditions the current speeds are relatively slow. However, under certain wave and beach conditions the speeds can quickly increase to become dangerous to anyone entering the surf. **They are most likely to be dangerous during high surf (big wave) conditions.**



Rip Current Myth
A rip current is a horizontal current. Rip currents do not pull people under the water–- they pull people away from shore. Drowning deaths occur when people pulled offshore are unable to keep themselves afloat and swim to shore. This may be due to any combination of fear, panic, exhaustion, or lack of swimming skills.

What to Do

If you get caught up in a rip current, **it's crucial that you keep your wits about you**. Your first instinct may be to swim against the current, back to shallow waters. In most cases, even if you're a strong swimmer, this will only wear you out. The current is too strong to fight head-on.

Instead, **swim sideways**, parallel to the beach. This will get you out of the narrow outward current, so you can swim back in with the waves helping you along. If it's too hard to swim sideways while you're being dragged through the water, just wait until the current carries you **past the sandbar**. The water will be much calmer there, and you can get clear of the rip current before heading back in.

Knowing how to deal with rip currents makes for smart swimming. If you see someone in trouble, get help from a lifeguard. If a lifeguard is not available, have someone call 9-1-1. Throw the rip current victim something that floats and yell instructions on how to escape. Remember, many people drown while trying to save someone else from a rip current.

LIFESAVING SOCIETY
The Lifeguarding Experts

Appendix F

Species at Risk Factsheets

LAKE HURON CENTRE FOR COASTAL CONSERVATION

Beach Conservation

Pitcher's Thistle

A Species at Risk

By Geoff Peach, LHCCC

The Pitcher's Thistle *(Cirsium pitcheri)* is a native flower that grows on the open sand dunes and low beach ridges of the Great Lakes' shores.

For thousands of years, this thistle has coped with blowing sand, low soil nutrients, and herbivorous mammals and insects. Today however, the Pitcher's Thistle's greatest threat is human activity.

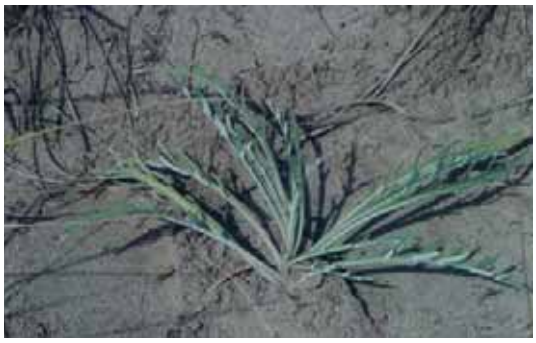
In unprotected areas, shoreline development, all terrain vehicle use and trampling have led to the destruction of dunes and the loss of critical Pitcher's Thistle habitat and populations.

In response, the Pitcher's Thistle has been declared an endangered species in Canada.

Although it is related to other thistles found in fields or roadsides, Pitcher's Thistle is a separate species that is found only on the open sand dunes and low beach ridges of Great Lakes shores.

Less prickly than other thistles, Pitcher's Thistle has distinctive blue-green leaves covered with fine white hairs that give the plant a downy appearance.

Its range is restricted to the Great Lakes, primarily along the shores of Lakes Huron and Michigan. The plant's life cycle includes a long 5 to 8 year



Pitcher's Thistle rosette

(Coastal Centre photo).

Pitcher's Thistle in full flower.
(R. Otfinowski photo).

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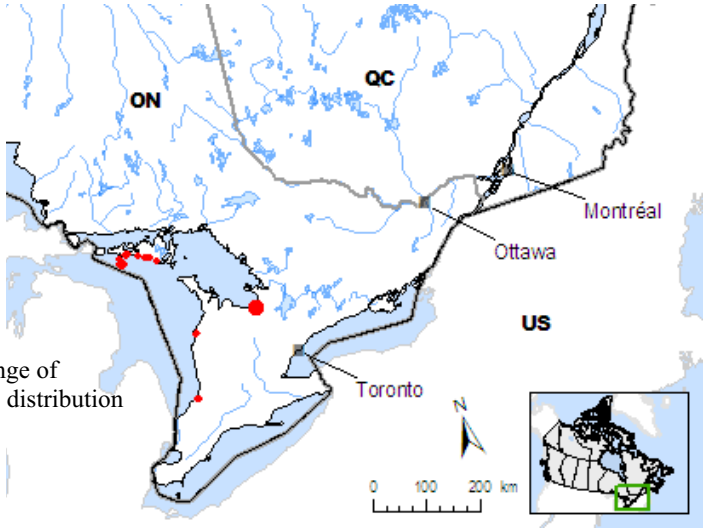

Approximate range of Pitcher's Thistle distribution in Canada.

growth period, and once its seeds form and disperse, the entire plant dies. This unassuming plant is an important to the ecology of the dunes they inhabit, and are effective sand stabilizers, helping prevent erosion.

How Can You Help?

- Keep vehicles out of beach and dune areas.
- When hiking, stay on established or authorized pathways to avoid harming rare plants like Pitcher's thistle and damaging fragile natural dune areas.
- Use native plants in landscaping and gardening and avoid the use of invasive plants that have been imported from other countries, such as purple loosestrife, dames rocket, black locust and Lombardy poplar. Invasive plants destroy the habitat of native coastal plants.
- Residential, condominium, and marina development along with associated landscaping directly eliminates Pitcher's thistle and its habitat within the footprint of the development. Development can also fragment remaining populations and dune habitats, reducing the diversity of the dune. Development should be planned with dune grasslands conservation as a priority.
- Learn more about beach and dune conservation and preserving the value of our coast. Explore the Coastal Centre's website (www.lakehuron.ca), as well as the Pitcher's Thistle website (www.pitchersthistle.ca).

Funding for this project provided by:

Environment Canada Environnement Canada

The Municipality of Kincardine — great energy, balanced life.

nwmo — Nuclear Waste Management Organization / Société de gestion des déchets nucléaires

LAKE HURON CENTRE FOR COASTAL CONSERVATION

Beach Conservation

Dwarf Lake Iris

A Threatened Species

By Geoff Peach, LHCCC

This miniature iris grows nowhere else in the world but in the Great Lakes Region. Dwarf Lake Iris (*Iris lacustris*) usually occurs close to the Great Lakes shores on sand or in thin soil over limestone rich gravel or bedrock.

It tolerates full sun to near complete shade, but flowers mostly in semi open habitats. These areas can be very long and narrow strips bordering the high water line, or large flat expanses located behind the open dunes of the Great Lakes shoreline. Many iris locations are on old beach ridges of former shores of the Great Lakes.

Flowers bloom from mid-May to early June with flowers being open for about three days. Seed capsules ripen from mid-June to mid-August. Plants die back in autumn leaving the rhizome to over-winter. Dwarf Lake Iris is small and seldom grows taller than 10 cm, although its strap-like leaves can be up to 18 cm long.

Fluctuating water levels of the Great Lakes play a vital role in opening up new habitat for Dwarf Lake Iris. During high water years, trees and shrubs along the shoreline may be flooded out. This flooding may open up patches within the forest where the Dwarf Lake Iris may spread.

Threats

Since Dwarf Lake Iris is largely restricted to the Great Lakes

Photo of Dwarf Lake Iris

Photo—OMNR

the Coastal Centre
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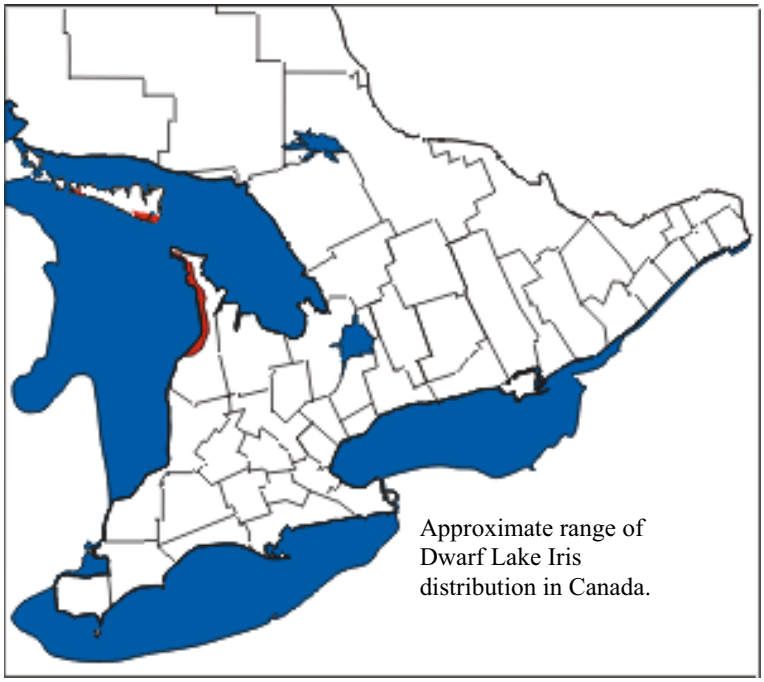

Approximate range of Dwarf Lake Iris distribution in Canada.

shores, it is highly vulnerable to ongoing shoreline development and intensive recreation.

It is very sensitive to mechanical disturbance, or removal of its soil, but can often re-colonize small disturbed areas if it flourishes nearby. All Terrain Vehicles (ATVs) are particularly destructive to its habitat.

The species is also genetically impoverished, which makes it less able to adapt as a population, and could make it especially vulnerable to disease or climate change.

You Can Help Protect this Threatened Species

- Learn more about dwarf lake iris and other Species at Risk. Understand how the destruction of habitat leads to loss of endangered and threatened species and Canada's plant and animal diversity. Tell others about what you have learned.
- Grow native plants in your lawn and garden but obtain the plants from local nurseries, do not dig up native plants from natural areas.
- Keep vehicles away from these plants and their habitat. When accessing the beach, stick to designated pedestrian pathways to help minimize disturbance.

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Royal Ontario Museum, www.rom.on.ca, 2009.

Ontario

Assistance for this project was provided by the Ministry of Natural Resources

LAKE HURON CENTRE FOR COASTAL CONSERVATION

Beach Conservation

Ontario Turtles

Declining Species

Ontario's turtles are living in a perilous time. All eight turtle species found in Ontario are in decline, with six species listed as a ***species at risk***. Ontario turtle species include: common snapping turtle, wood turtle, spotted turtle, musk turtle, northern map turtle, painted turtle, spiny softshell turtle and the Blanding's turtle.

Facts about turtles

- All turtles lay eggs on land.
- Turtles do not give parental care to their eggs or young.
- Although turtles have lungs, some species are able to stay under water for prolonged periods of time due to pharyngeal respiration (where oxygen is exchanged through the mouth cavity and the cloaca or posterior opening).
- Turtles are unique among reptile species because of their shells. The shape of the shell will vary according to the species and their habitat (e.g., aquatic species have a rather flat shell; terrestrial species have a dome-shaped shell).
- Turtles lack teeth, but their horny shaped bill will tear plant and animal matter.
- The temperature of the surrounding environment determines the sex of most turtle offspring. In most species, cooler temperatures produce male offspring and warmer temperatures result in female offspring.

Photo of Spotted Turtle—endangered
Photo credit— John Mitchell /© ROM

Photo of Common Snapping turtle—Special Concern

Photo credit—Natural Resources Canada

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Species that have been identified as extirpated, endangered or threatened are provided legal protection under Ontario's *Endangered Species Act, 2007* (EAS). Under the Act, a species is protected from any actions that may cause further harm to the species or its habitat. Turtles are also provided protection in Ontario under the *Fish and Wildlife Conservation Act*, which makes it illegal without a permit to hunt, trap, keep, sell or purchase live specimens.

How You Can Help

1 Leave wild turtles in the wild. Don't collect turtles for pets. Observe and enjoy them in their natural habitat.
2 Ban balloon releases. Turtles sometimes eat plastic bags and balloons. Instead of having balloon releases to celebrate special events, organize a bubble release.
3. Don't pollute. Pick up garbage and plastic from beaches and decrease your use of plastic by using reusable bags and paper plates instead of Styrofoam. Recycle as much as you can.
4. Chemicals from fertilizers, oil and paint run off into our waterways and can be a major hazard to turtles as well.
5. **Help a turtle cross a road**. If you need to move a turtle from the road do so only when it is safe and with the help of adults. Carry the turtle to the side of the road in which it is headed. (Get help if there is traffic.) Don't carry a turtle by its tail. For a snapping turtle or other large turtle, gently push it across with a stick.
6. Ride ATV's only in areas designated for ATV use. ATVs can run over turtles and crush nests.
7. Protect your town's open spaces. You can learn where the natural habitats are in your community. Help to protect wetlands.
8. Learn and teach. The more you know about turtles, their homes, nesting areas and their needs, the more you can teach those around you to value them. Host a turtle talk in your neighbourhood to help others understand these spectacular animals!

Resources

Natural Resources Canada. Turtles of Ontario.

Ontario Nature, www.ontarionature.org

Royal Ontario Museum, www.rom.on.ca

Environment Canada Environnement Canada

Assistance for this project was provided by the Habitat Stewardship Program for Species at Risk

Photo of Midland Painted Turtle—specially protected reptile
Photo credit— Natural Resources Canada

Photo of Wood Turtle—endangered
Photo credit— Ontario Nature

LAKE HURON CENTRE FOR COASTAL CONSERVATION

Beach Conservation

Monarch Butterfly

A Species of Special Concern

In the fall, monarchs migrate thousands of kilometres, travelling from Canada to Mexico. The annual southward migration of the eastern monarch populations begins in Canada in early August and continues through to mid-October.

Through the summer there are two, possibly three, generations raised in Ontario. The life cycle from egg to adult can take only a month, however, most large butterflies take about 45 days .The generations that emerge in late summer and autumn are somehow triggered to become migratory.

Monarchs overwinter in Mexico and mate there in early spring. On their way north, eggs are laid on fresh milkweed and the adult dies some time thereafter. A few monarchs that have overwintered in Mexico return to Ontario (during May), a journey of 3000 kilometres! However, it is the generation that is produced between Mexico and Canada that

Monarchs gather at the edge of the cedar bush bordering the shore to roost for the evening. The trees offer the monarchs protection from extreme temperatures, predators, and precipitation.

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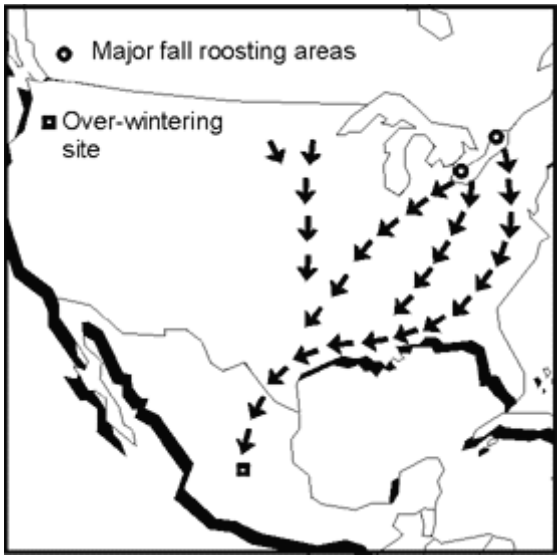

Parks Canada

returns in numbers, mainly in June.

Monarch caterpillars ingest toxins (cardenolides) from milkweeds that make them, and the butterflies they develop into, unpalatable to most birds and other vertebrates.

They are commonly seen along the Oliphant shore particularly during their annual autumn migration to Mexico.

Wildflowers, which are particularly prevalent in abandoned farmlands and roadsides, are used as nectar sources by the adult butterflies and are also an important component of Monarch habitats. They are especially important during the fall migration, when sugars obtained from nectar are converted to the fat that is essential for the butterflies to complete their migration and overwinter successfully. Common Milkweed (*Asclepias syriaca*), and Swamp Milkweed (*A. incarnata*) are both key plants for the Monarch, and both occur at Oliphant. The milkweeds, goldenrods (*Solidago*) and asters (*Aster*), as well as Purple Loosestrife (*Lythrum salicaria*), are the nectar sources used most frequently by Monarchs.

You Can Help Protect this Species

- Help to protect milkweed and other plants that are a nectar source for the monarch.
- Participate in monarch research, conservation and education projects.

References

Hinterland Who's Who, Insect Fact Sheets

Insectarium de Montreal, Monarch's Without Borders

Parks Canada, Point Pelee National Park, Monarch factsheet.

LAKE HURON CENTRE FOR COASTAL CONSERVATION

Beach Conservation

Eastern Ribbon Snake

Special Concern

The Eastern Ribbon Snake (*Thamnophis sauritus*) is a slim snake with three bright yellow, longitudinal stripes running down its sides, contrasting sharply with the dorsal background colour of chocolate brown or black. Another more common Ontario species, the Eastern Garter Snake, is also striped, making dentification in the field tricky. Adults can grow to about 70 cm long, and females typically grow larger than males. An adult female gives birth to 5-12 live young in late summer. The baby snakes are independent and begin hunting for insect prey almost immediately.

The Eastern Ribbon Snake is usually found close to water, especially in marshes where it hunts for frogs and small fish. A good swimmer, it will occasionally dive in shallow water. At the onset of cold weather, individuals congregate in burrows or rock crevices to hibernate together in what is termed a "hibernaculum."

Like their Common Garter Snake relative, Eastern Ribbon Snakes also give birth to live young. Mating occurs in spring, and the young are born in midsummer. The brood size is typically from 5 to 20.

The Eastern Ribbon Snake is usually found close to water, especially in marshes where it hunts for frogs and small fish. A good swimmer, it will occasion-

Photo of Eastern Ribbon Snake

Photo: University of Georgia

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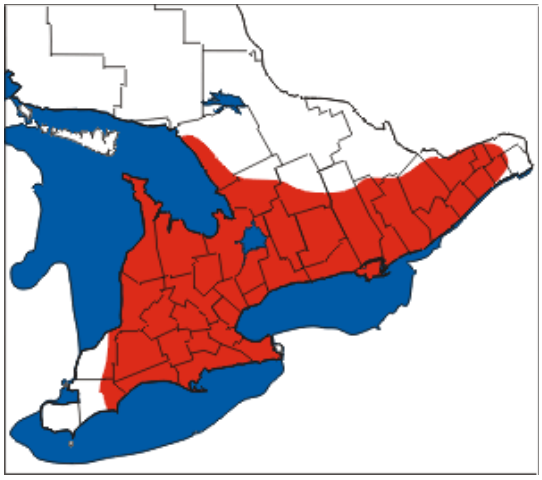

Approximate range of Eastern Ribbon Snake distribution in Canada.

ally dive in shallow water. At the onset of cold weather, individuals congregate in burrows or rock crevices to hibernate together in what is termed a "hibernaculum."

The Eastern Ribbon Snake is a Species at Risk of *Special Concern* provincially and nationally.

How You Can Help:

- Report sightings or poaching to the Ontario Ministry of Natural Resources. Call 1-877-TIPS-MNR (847-7667) toll-free any time or contact your local ministry office during regular business hours. You can also call Crime Stoppers anonymously at 1-800-222-TIPS (8477).
- Leave snakes and their habitat alone. Inform others about the plight of the Eastern Ribbon Snake.
- All terrain vehicles can harm this species, and is generally damaging to coastal areas. ATVs should not be driven in coastal areas.

References:

Royal Ontario Museum—www.rom.on.ca

Wildlife.ca

LAKE HURON CENTRE FOR COASTAL CONSERVATION

Beach Conservation

American White Pelican

Threatened in Ontario

The American White Pelican (*Pelecanus erythrorhynchos*) is one of the largest and most distinctive birds in North America, with a 3 m wing span, a large yellow-orange bill and throat pouch, and glistening white plumage, save for the black wing tips. Pelicans nest in colonies, sometimes at quite high densities, on isolated islands in freshwater lakes of central and western North America. A nesting pair produces two or occasionally three white eggs. The nest is a shallow debris-rimmed depression in the ground, or a low mound of matted vegetation and earth. Flocks of this gregarious waterbird sometimes hunt communally for prey, which consists mostly of fish with little or no sport or commercial value and amphibians. Unlike other pelicans that drop from high in the sky to catch fish, the American White Pelican simply floats along the water and scoops up fish with its enormous bill.

American White Pelicans feed almost exclusively on fish, although some crustaceans are eaten. Fish are taken in shallow waters between 0.3 to 2.5 m deep or at the surface over deeper waters when cooperatively feeding with Double-crested Cormorants

The importance of the Baie du Dore coastal wetland (Municipality of Kincardine) as a staging area for migrating waterfowl and shorebirds is evidenced by the observations

Photo of American White Pelican

Photo: Canadian Press

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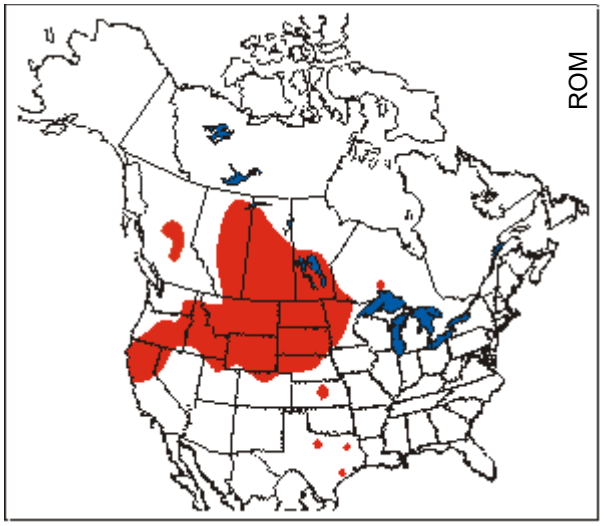

Approximate range of American White Pelican in North America

of three American White Pelicans, designated Threatened in Ontario, in early May 2011.

On their localized breeding grounds in northern and northwestern Ontario, American White Pelicans are vulnerable to high water levels, disturbance of nesting sites by recreational boaters, and disease. Threats on migration and on their wintering grounds include human persecution and pollution

References:

Royal Ontario Museum—www.rom.on.ca

Ontario Ministry of Natural Resources, Recovery Strategy for the American White Pelican in Ontario, 2011.

Environment Canada Environnement Canada

THE MUNICIPALITY OF KINCARDINE great energy, balanced life.

nwmo NUCLEAR WASTE MANAGEMENT ORGANIZATION SOCIÉTÉ DE GESTION DES DÉCHETS NUCLÉAIRES

Appendix G

Common Reed Factsheet

Invasive Common Reed Threatens Lake Huron's Coastal Environments

Common Reed — or *Phragmites australis* (frag-MY-teez) — is an alien, invasive plant with origins in Europe and Asia. Common Reed has recently found its way to some of Lake Huron's beaches and has raised much concern over its potential effects on the beach environment.

The invasive Common Reed creates tall, dense stands of grass which degrade coastal areas and wetlands by crowding out native plants and animals, blocking shoreline views, reducing access for swimming, fishing and hunting and, in addition, can create fire hazards from dry plant material. Common Reed typically grows on coastal beaches, interior wetlands, roadside ditches and other low, wet areas, although occasionally it has been found to grow in dry areas.

Common Reed typically colonizes a new area from seeds or small fragments of rhizomes (underground stems), dispersed by water, animals, machinery and humans. Once established, new stems grow from the underground rhizomes and the plant begins to spread. During the growing season, rhizomes spread horizontally in all directions and, when fragmented, readily grow into new plants.

Seeds — as well as rhizomes broken by natural actions such as waves, or human actions such as dredging, tilling or operating motorized vehicles along beaches — quickly spread and take root in new locations. Rapid expansion is also promoted by other disturbances that give this invasive plant a competitive edge, including soil disturbance and the clearing of vegetation.

— See other side

*Phragmites australis

Invasive Common Reed*

the Coastal Centre

THE LAKE HURON CENTRE FOR COASTAL CONSERVATION

P.O. Box 178, Blyth, Ontario N0M 1H0
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Threats to the Lakeshore

Stands of Common Reed on beaches act as a physical barrier, preventing the movement and exchange of sand between the beach and the dune. Some dune plants depend on sand burial as part of their ecology.

• The organic layer produced from the decay of Common Reed could change the physical structure of the sand, creating a barrier to the flow of shallow groundwater. If the local groundwater has become affected by pollution from nearby septic systems or other sources, this could increase people's exposure to pathogens in wet sand.

• Common Reed is aggressive and can displace native beach plant populations — many of which are rare species.

• It may be confused with other beneficial vegetation. Learn to distinguish Common Reed from the critically important native coastal plants before undertaking any control program.

Controlling Common Reed

• Cutting the full-grown plant is season-sensitive: it should be cut by mid-August to interrupt its flow of food reserves between the roots and the flower.

• Care must be taken to remove cut shoots to prevent their sprouting and forming new growth. To ensure that seeds are destroyed, stalks and seed heads must be either bagged and removed from the site, or burned.

• Do not disturb the rhizomes. Breaking them up may result in an increased population and encourage its spreading.

Control is best accomplished using a well-planned approach. • Check with your municipality to see if they have a Common Reed control program in place. • Herbicide use is regarded as an option of last resort. **Note that herbicide use near open water is banned and, elsewhere, is strictly controlled.** *The Pesticides Act* allows for a municipality to seek an exception for certain natural resource management projects. In order for this exception to apply, the municipality must obtain a *written letter of opinion* from a director of the Ministry of Natural Resources (MNR). To apply for this *written letter of opinion,* the municipality must contact its local MNR district office to initiate the application process. • In response to an application, the MNR may issue a written opinion stating that the project is needed for natural resources management and that the use of a pesticide may be necessary. • The local Conservation Authority office may also be involved with a municipal program.

Funding support from the Alien Invasive Species Partnership Program Canada

For more information about coastal conservation, contact the Lake Huron Centre for Coastal Conservation
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Appendix H

Reconnaissance Ecological Study of Kincardine's North Coast

J. Jalava, 2011

RECONNAISSANCE ECOLOGICAL STUDY

OF

LAKE HURON COAST OF NORTHERN KINCARDINE

2011

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For

Lake Huron Centre for Coastal Conservation

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Table of Contents

1. Introduction

In order to inform the development of a Coastal Stewardship Plan for Kincardine, in June 2011 the Lake Huron Centre for Coastal Conservation requested the services of an ecological consultant to undertake a reconnaissance ecological study of the coastline north of Baie du Dore to McGregor Point Provincial Park. The study, which involved field surveys on June 15, July 7 and July 26, 2011, focused on the lands within the municipality west of the shore road, identifying any aspects of ecological significance, present and emerging ecological threats. This report summarizes the findings of the site visits and offers recommendations in support of informed stewardship of this significant ecosystem.

Project Summary:

1. Preliminary biological review of the study area, identifying elements of ecological significance (e.g. are there any Species at Risk, or SAR habitat present);
2. What are the present and emerging threats to local and regional ecology;
3. Stewardship recommendations.

2. Methodology

This project consisted of three site visits to the study area, as well as a review of ecological survey information gathered during a previous study of the Bruce Addition and MacGregor Point Provincial Park, conducted by the author in 2004 (Jalava 2005) and 2010 (Jalava 2010).

Pre-field Investigations

Prior to fieldwork, key information sources obtained included NHIC (2011), mapping and air photos provided by the Bruce County Planning Department, and a life science inventory of the Bruce Addition, MacGregor Point Provincial Park by Jalava (2005) and updated in 2010 (Jalava 2010).

Field Investigations

Fieldwork commenced on the morning of June 15, 2011, continued on July 7, and was completed July 26, 2011. The timing of these visits permitted adequate surveys of most species of flora in the study area. There is no doubt that more bird, mammal, reptile and invertebrate species are found at the site than have been documented by this or previous studies. The surveys took place during the breeding season for most bird species found in the area. As a result, the importance of the area to migratory and wintering species was not documented. The shoreline and adjacent waters are important staging areas for waterfowl and shorebirds, and provide a migratory corridor for many landbirds and raptors as well.

Mammals (particularly small mammals) require special survey techniques, which were not part of the terms of reference of this study. Reptiles and amphibians tend to be most conspicuous soon after they emerge from hibernation and were not fully documented because of the timing of the inventory work. Invertebrate surveys also require specialised expertise and methods.

Vegetation Surveys

Transects were walked to document each vegetation community type (*i.e.*, habitat) evident from air photo interpretation. A Global Positioning System (GPS) unit was used to determine the Universal Trans Mercator (UTM) grid reference of the community. Normally, the grid reference was taken near the centre of the community patch, but often more than one GPS reading was taken, particularly at larger patches. The accuracy of the GPS unit was typically in the 3 to 10 m range.

Vegetation community structure was described with separate fields for tree, sapling, tall shrub, low shrub, herbaceous and non-vascular plant layers. Percent cover of each

physiognomic layer, and of each dominant species within each layer, was recorded. Percent cover of non-vascular plants, exposed rock and open water was also noted, where appropriate. Notes on the landscape context of each community were made, with commentary on adjacent communities, mosaic features, estimated patch size and estimated extent of the community type within the site. Successional dynamics, including stand age and seral stage, and natural and anthropogenic disturbance factors were recorded. Notes were taken on the landform type, topographic position, geology, soil description and type, as well as moisture regime, drainage and hydrological influences of a community. The presence of rare flora and fauna and other special features was also noted for each community sampled. Digital photographs were taken of characteristic vegetation communities, habitats, disturbance impacts, and other interesting natural heritage features. After fieldwork, each sampled community was assigned a standard ecosite and vegetation type codes, based on Southern Ontario Ecological Land Classification (ELC) type name and ELC code (Lee *et al.* 1998).

Botanical Surveys

Botanical surveys were conducted concurrently with vegetation community sampling. Plant species lists were usually compiled for each vegetation community sampled. Plant records were thus generally georeferenced using GPS to the community patch in which they were observed. Sight records of rare or otherwise interesting species and features were more precisely georeferenced. Voucher specimens of difficult to identify taxonomic groups (such as Poaceae and Cyperaceae) were collected, as were specimens of locally and provincially rare species as long as the site population was considered large enough to sustain itself even if a specimen was taken. Where populations appeared too small to make a collection, digital photographs of the plant were taken.[1]

Breeding Bird and Other Faunal Surveys

Breeding bird surveys were conducted according to methods used by the Ontario Breeding Bird Atlas (OBBA 2001, Cadman et al. 2007). Standard breeding evidence criteria for each species seen or heard was recorded in the field during the breeding season. All breeding bird data were georeferenced using GPS.

Project timing prevented surveying for early-season breeding birds and emerging herpetofauna in spring, when they are most conspicuous. Mammal, reptile and amphibian observations were made opportunistically during botanical and breeding bird surveys, although efforts were made in suitable habitats to overturn stones and logs in search of herpetofauna. All faunal observations were georeferenced and associated with

[1] - A widely agreed-upon rule is that a specimen should not be collected if there are fewer than 20 individuals present. In some cases, where fewer than 20 individuals are present, a portion of a plant, such as a leaf, may be collected for verification without causing serious harm to the plant.

specific habitat or vegetation community types. More detailed notes, such as number of individuals, sex and age were taken for provincially rare or otherwise significant fauna.

3. Biological Summary and Significant Ecological Features

3.1. Ecological Land Classification

The table below provides a summary of vegetation community types documented during the present study and by Jalava (2005) within the Kincardine north of Baie du Dore coastal area, based on the most current Ecological Land Classification (ELC) for southern Ontario (Lee et al. 1998, Lee pers. comm. 2010). Additional fieldwork in the area would result in a more comprehensive and refined listing. Mapping of community types would also be helpful to guide land use planning and stewardship of the area.

System	Vegetation Type	ELC Code	Location(s)
Terrestrial	Little Bluestem – Long-leaved Reed Grass – Great Lakes Wheatgrass Open Graminoid Sand Dune Type	SBOD1-2	Backshore sand beach ridge in the Sunset Drive area. Sand beach ridges elsewhere in the study area (e.g., north portion of Baie du Dore) do not support as diverse a suite of significant dune species, but structurally would also be classified as graminoid sand dune.
Terrestrial	Common Juniper Shrub Sand Dune Type	SBSD1-5	Backshore sand beach ridges at Bay du Dore (north portion) and Sunset Drive areas.
Terrestrial	Tallgrass Red Pine - White Cedar Treed Sand Dune Type	SBTD1-22	Backshore sand beach ridges in the Sunset Drive area.
Wetland	Silky Dogwood Mineral Thicket Swamp Type	SWTM2-2	Small patches of Silky Dogwood thicket swamp occur locally in backshore depressions.
Wetland	Sweet Gale Organic Deciduous Thicket Swamp Type	SWTO5-2	Small patches of Sweet Gale organic thicket swamp occur in backshore depressions, mainly along the edges of fens.
Wetland	Graminoid Open Fen Ecosite	FEOG1	Graminoid open fen communities occur at several backshore areas, usually behind the first beach ridge.
Wetland	Twig-rush Open Fen Type	FEOG1-1	Various locations, usually behind first beach ridge, from Baie du Dore to Bruce Addition; occasionally co-dominant with the provincially rare Beaked Spike-rush
Wetland	Graminoid Coastal Meadow Marsh Type	MAMM4-1	Entire study area along shoreline
Wetland	Shrubby Cinquefoil Coastal Meadow Marsh Type	MAMM4-2	Small areas of coastal meadow marsh are dominated primarily by Shrubby Cinquefoil; this community is more common on the bedrock shoreline at the Bruce Addition than elsewhere in the study area.

System	Vegetation Type	ELC Code	Location(s)
Wetland	Bulrush Mineral Shallow Marsh Type	MASM1-2	Small patches of shallow marsh dominated by Small's Spike-rush, Softstem Bulrush and/or Three-square are found at various sheltered areas along the coastline.
Aquatic	Bladderwort Mixed Shallow Aquatic Type	SAM_1-6	Fen ponds in backshore areas behind the main beach ridge are often dominated by bladderworts (Utricularia spp.).
Aquatic	Stonewort Submerged Shallow Aquatic Type	SAS_1-3	Some of the marl fen ponds are dominated by the algae, Stonewort (*Chara* sp.).
Aquatic	Open Aquatic	OAO	Open water of fen ponds in the Baie du Dore, Sunset Drive and Bruce Addition areas.
Aquatic	Open Water	OAW	Open water of Lake Huron.

3.2. Significant Vegetation Community Types

Four provincially rare vegetation community types predominate along the Lake Huron shoreline in the study area.

Great Lakes Coastal Meadow Marsh Type **G2? S2**
Shrubby Cinquefoil Coastal Meadow Marsh Type **G2? S1**

The predominant community in the study area is the Great Lakes Coastal Meadow Marsh Type (Figure 1), which is not only provincially but also globally rare. It occurs in the zone between the long term high water mark and current water levels, and thus its extent fluctuates from year to year. Substrate is typically a combination of cobbles (large or small), sand and pebbles; in some areas it is almost entirely sand, whereas in others it can be almost entirely cobbles. It is highly variable, with a great diversity of species, but the most common native dominants are Baltic Rush (*Juncus balticus*), Ohio Goldenrod (*Solidago ohioensis*), Twig-rush (*Cladium mariscoides*), Three-square (*Symphyotrichum pungens*), Silverweed (*Potentilla anserina*), Capillary Beak-rush (*Rhynchospora capillacea*), Shrubby Cinquefoil (*Dasiphora fruticosa* ssp. *floribunda*), Acuminate Panic Grass (*Panicum acuminatum* var. *acuminatum*) and Lindheimer's Panic Grass (*P.a.* var. *lindheimeri*). Other common herbaceous species are Swamp Goldenrod (*Solidago uliginosa*), Kalm's Lobelia (*Lobelia kalmii*), Variegated Scouring-rush (*Equisetum variegatum*), Calamint (*Calamintha arkansana*), Sticky Tofieldia (*Tofieldia glutinosa*), Grass-of-Parnassus (*Parnassia glauca*), Four-flowered Loosestrife (*Lysimachia quadriflora*), Short-headed Rush (*Juncus brachycephalus*), Porcupine Sedge (*Carex hystericina*), Small's Spike-rush (*Eleocharis smallii*) and Elliptic Spike-rush (*Eleocharis elliptica*). Shrubs are sparsely scattered, with the most common species being Kalm's St. John's-wort (*Hypericum kalmianum*) and Shrubby Cinquefoil (*Dasiphora fruticosa* ssp. *floribunda*). Unfortunately this community is under great threat from the spread of the invasive Common Reed (*Phragmites australis* ssp. *australis*), and much of it is now dominated by this highly-aggressive plant.

Figure 1. Extensive Great Lakes coastal meadow marsh at Baie du Dore

At the Bruce Addition in the north end of the study area, the substrate includes cobbles, limestone fragments and exposed bedrock, and occasional boulders are also present along the shoreline. As along the shoreline further south, dominants are extremely variable and patchy, with the most common taxa being Twig-rush, the globally and provincially rare Stiff Yellow Flax, Silverweed, Three-square, Short-headed Rush, Meadow Spike-moss (*Selaginella apoda*), the provincially rare Low Nut-rush (*Scleria verticillata*), Hair-like Beak-rush, Baltic Rush and Swamp Goldenrod. Drier backshore bedrock areas often have patches of Poverty Oat Grass, Tufted Hairgrass, Balsam Ragwort (*Senecio pauperculus*) and Calamint, giving these communities a resemblance to alvars, which are so characteristic of the northern part of Bruce County.

Juniper Dune Shrubland Type G? S2
Little Bluestem-Long-leaved Reed Grass-Great Lakes Wheat Grass Dune Grassland G? S2
White Cedar, Bracken Treed Sand Dune Type
Red Pine - White Cedar Treed Sand Dune Type
White Cedar Treed Sand Dune Type

In several of the backshore areas along the Lake Huron shoreline, a relict sandy beach ridge paralleling the coast supports vegetation typical of Great Lakes coastal dune systems (Figure 2). Great Lakes dune systems, and many of the vegetation types occurring on them, are considered globally, nationally and provincially rare (NHIC 2011). In the Kincardine coastal study area, the dominant herbs on the beach ridges include grasses such as the globally and provincially rare Long-leaved Reed Grass

(*Calamovilfa longifolia* var. *magna*), as well as Indian Grass (*Sorghastrum nutans*) and Little Bluestem (*Schizachyrium scoparium*). The forbs Bracken Fern (*Pteridium aquilinum*) and Starry False Solomon's-seal (*Maianthemum stellatum*) are also often common. Other frequently encountered herbs on the beach ridges include Ebony Sedge (*Carex eburnea*), Hairy Goldenrod (*Solidago hispida*) and Wormwood (*Artemesia campestris*). More disturbed open beach ridges have a herb layer dominated by the Canada Blue Grass (*Poa compressa*), Common Milkweed, as well as introduced species White Sweet Clover (*Melilotus alba*), Crown Vetch (*Coronilla varia*) and Gold-moss (*Sedum acre*). Shrub-rich sections are typically dominated by combinations of Creeping Juniper (*Juniperus horizontalis*), Common Juniper (*Juniperus communis*), Bearberry (*Arctostaphylos uva-ursi*), Sand Cherry (*Prunus pumila*), Buffaloberry (*Shepherdia canadensis*) and Ninebark (*Physocarpus opulifolius*). Trembling Aspen (*Populus tremuloides*) saplings and seedlings have established very sparsely in this community, and there are occasional low shrubs of Smooth Rose (*Rosa blanda*).

Figure 2. Sand "dune" community on relict beach ridge

Small copses of treed sand dune occur at several locations on the beach ridges. In most cases they are found in the higher, inland portions of the ridges in association with shrub and open sand dune communities found on the lakeward side. Tree cover usually ranges from 10-30%, although it can be as high as 90% in denser copses. The most common tree species are Eastern White Cedar (*Thuja occidentalis*), White Spruce (*Picea glauca*) and White Birch (*Betula papyrifera*), with Red Pine (*Pinus resinosa*) and Tamarack

(*Larix laricina*) being locally common. The shrub species noted above for open and shrub sand dunes typically occur along the fringes of the treed copses.

Graminoid Open Fen Ecosite
Twig-rush Open Fen Type
Bladderwort Mixed Shallow Aquatic Type
Stonewort Submerged Shallow Aquatic Type
Although not provincially rare, the marl fens and associated aquatic communities in the fen ponds occurring along backshore portions of the study area are significant in that they are host to a number of rare plant and animal species, and they are extremely sensitive to human disturbance.

3.3. Significant Species

A diversity of designated Species At Risk (SAR) and other provincially rare species was documented northern Kincardine coastal area during the present study. Additional SAR are known or believed to occur in the area.

3.3.1. Designated Species At Risk (SAR)

Turtle Species At Risk
Although not documented during the present study, the Kincardine coastline and adjacent inland wetlands north from Baie du Dore provide habitat for at least two turtle SAR (NHIC 2011). Turtles are highly prone to road mortality from vehicles, particularly during the month of June when gravid females leave the wetlands in search of egg-laying locations. Sand ridges and sandy road embankments make ideal nesting sites, making turtles travelling to these areas particularly vulnerable. The coastline between the northern part of Baie du Dore and the boat launch at the south end of Institute Road is likely a refuge for SAR turtles, as it is one of the last remaining roadless areas along the Lake Huron shore south of the Bruce Peninsula.

Eastern Ribbonsnake ***Thamnophis sauritus***
An Eastern Ribbonsnake, designated Special Concern both federally and provincially, was observed in the coastal meadow marsh at Baie du Dore. Eastern Ribbonsnakes are associated with a wide variety of wetland habitats, including streams, rivers, swamps, marshes, bogs, fens, wet meadows, sloughs, ponds and lakes (Ernst 2003), habitats which are plentiful along the Lake Huron coast and adjacent inland areas in northern Kincardine Township.

American White Pelican ***Pelecanus erythrorhynchos*** **OMNR-THR S2B**
The importance of Baie du Dore as a staging area for migrating waterfowl and shorebirds is evidenced by the observations of three American White Pelicans, designated

Threatened in Ontario, in early May 2011. On their localized breeding grounds in northern and northwestern Ontario, American White Pelicans are vulnerable to high water levels, disturbance of nesting sites by recreational boaters, and disease. Threats on migration and on their wintering grounds include human persecution and pollution (ROM 2011).

Bald Eagle ***Haliaeetus leucocephalus*** **OMNR-SC S4B,S1S2N**
The Bald Eagle, designated Special Concern in Ontario, is a fairly common sight along the Lake Huron shoreline in Kincardine Township. This impressive bird of prey feeds mainly on fish, but also catches birds and small mammals, scavenges for carrion, and steals food from other birds such as osprey. Its nest is a huge stick platform, usually placed high in a tree, near water. In the 1950's, Bald Eagle populations in eastern North America started to decline rapidly as a result of the widespread application of organochlorine pesticides such as DDT. The use of these chemicals is now restricted in Canada and the United States, and Bald Eagle populations in many areas are no longer experiencing pesticide-related reproductive failures. Today Bald Eagles remain susceptible to illegal shooting, accidental trapping, poisoning and electrocution on high-voltage power lines (ROM 2011).

Chimney Swift ***Chaetura pelagica*** **COSEWIC-THR S4B**
A few Chimney Swifts, a federally Threatened species, were observed feeding over the shoreline and waters at Baie du Dore in mid-June during the present study, suggesting that they are breeding nearby. Chimney Swifts formerly nested and roosted in hollow trees, but they have almost completely adapted to man-made structures, in particular chimneys. The biggest threat to Chimney Swifts is the loss of such breeding and roosting sites. In particular, changes in chimney construction and the shift to gas furnaces reduces suitable habitat for breeding and roosting. Additionally, insecticide spraying may be a factor in population declines affecting a broad suite of birds that feed on flying insects. (ROM 2011)

Barn Swallow ***Hirundo rustica*** **COSEWIC-THR G5 S4B,SZN**
The Barn Swallow, the most widespread swallow species in the world, is following the pattern of declining trends seen in many migratory birds across North America that eat flying insects. It was recently designated as Threatened by COSEWIC (2010). The reasons for declines of up to 76% in the past 40 years continue to baffle bird experts but changes in habitats, insect communities and climate have all been implicated. Barn Swallows typically nest on protected ledges, both natural and artificial, utilizing such structures on cliffs, bridges and buildings such as barns. A few individuals were observed during the present study hunting over Baie du Dore and the adjacent shoreline in June and July, suggesting breeding in the vicinity.

Bobolink ***Dolichonyx oryzivorus*** **COSEWIC-THR, OMNR-THR G5 S4B,SZN**

Recently designated as Threatened in Canada and in Ontario due to dramatic population declines in recent decades, the Bobolink is a bird of native North American grasslands. It adapted to nesting in hayfields and pastures when forests were cleared and its traditional prairie habitats were converted to grain crops. During the present study a Bobolink was heard singing in the extensive meadows in the southeastern part of Baie du Dore, suggesting possible breeding in this area. The presence of other grassland species in this area during the survey, such as Savannah Sparrow and Field Sparrow, further suggests that the habitat is suitable for breeding grassland birds such as Bobolink.

3.3.2. Provincially Rare Species

Great Egret ***Ardea alba*** **G5 S2B**
A single Great Egret was observed along the shoreline off Sunset Drive during the present study. This majestic species, which is more common to the south in North and Central America, feeds primarily on small fish, amphibians and crustaceans and is an uncommon denizen of wetlands in southern Bruce County. Birds seen along the Kincardine coast are probably visitors from the nesting colony to the north at Chantry Island.

Caspian Tern ***Hydroprogne caspia*** **G5 S3B**
With the exception of Antarctica, the Caspian Tern occurs on all continents, breeding or wintering along coastlines and inland along rivers, lakes, and marshes. In North America, it breeds at scattered localities along the Pacific, Atlantic and Gulf Coasts, and inland in the western interior, the Prairie Provinces of Canada, and along the Great Lakes. It generally nests in colonies, often with other tern and gull species. Flat rocky islands, beaches, and sandy shores, sparsely vegetated and littered with driftwood, are typical breeding habitat for this species. Birds seen along the Kincardine coast are probably visitors from nesting colonies to the north at Chantry Island or The Fishing Islands.

Blue-leaf Willow ***Salix myricoides*** **var.** ***myricoides*** **G4T4 S2S3**
This globally uncommon and provincially rare variety of willow is restricted to Great Lakes sand dunes and similar habitats. It was found during the present study on a sandy beach ridge north of Concession 10 along Sunset Drive.

Stiff Yellow Flax ***Linum medium*** **var.** ***medium*** **G5T3? S3**
Stiff Yellow Flax, is a taxon endemic to the Great Lakes basin and it is almost entirely restricted to Ontario, along Lake Huron. It is found in Great Lakes coastal meadow marshes, and its populations expand when open shore habitats are exposed during low water-levels. Large populations were found during the present study in stony coastal meadow marsh in the Baie du Dore area (both to the north and south of Concession 5). At the Bruce Addition, well over 500 plants were documented in drier portions of exposed Lake Huron shoreline (Jalava 2005).

Cylindric Blazing-star ***Liatris cylindracea*** **G5T3T5 S3**
This attractive provincially rare flower prefers the harsh conditions of sand dunes, interdunal swales and exposed limestone bedrock habitats. Small populations were found in three locations on sand beach ridges along Sunset Drive south of Concession 10 (Figure 3).

Figure 3. Provincially rare Cylindric Blazing-star on sand beach ridge

Low Nut-rush ***Scleria verticillata*** **G5 S3**
This provincially rare species is locally common in graminoid fens and coastal meadow marshes near the Lake Huron shoreline in Bruce County. Several hundred plants were found at Baie du Dore during the present study in Great Lakes coastal meadow marsh. Low Nut-rush was also found to be abundant in a section of the Lake Huron shoreline at the northwest end of the Bruce Addition during the 2004 field season, with the population estimated at between 2,400 and 4,000 plants. A smaller population was also found in 2004 in a nearby graminoid fen just inland from the coast.

Beaked Spike-rush ***Eleocharis rostellata*** **G5 S3**
This provincially rare species is associated with fen habitats along the Lake Huron coast in southern Bruce County. It is a rhizomatous perennial herb growing up to 1.2 meters tall with spongy, compressible stems. The stem bends and droops and if the tip touches

moist soil it may root there and grow more stems. The plant also reproduces by seed and vegetatively by sprouting from bits of rhizome. It was found at six locations during the present study, from the backshore fens in the northern part of the Baie du Dore area (Figure 4) north to the Bruce Addition. All but one of these locations was on the inland side of the relict sand beach ridge, but within the coastal study area wherever the beach ridge occurs on the west side of the shore road. Beaked Spike-rush has also been documented at three fen locations within the Bruce Addition, two of them during the fieldwork of Jalava (2005).

Figure 4. ATV tracks through a population of the provincially rare Beaked Spike-rush

Great Lakes Sand Reed ***Calamovilfa longifolia*** **var.** ***magna*** **G5T3T5 S3**
Also known as Long-leaved Reed Grass, this globally significant and provincially rare variety of grass is endemic to Great Lakes dune grasslands, in Canada only along the Lake Huron shore. It was found at two locations on the beach ridge along Sunset Drive during the present study (Figure 5). This plant is a dune stabilizer, spreading through rhizomes but reproducing primarily by seed. It is well adapted to withstand low moisture and higher temperature conditions of the foredune.

Figure 5. Great Lakes Sand Reed on beach ridge along Sunset Drive

3.3.3. Other Species of Interest

Other species of interested noted at Baie du Dore included four Sandhill Cranes on June 15. Sandhill Cranes were extirpated from southern Ontario in the last century due to hunting pressures and habitat loss, but have been making a comeback for the past few decades and are now a regular sight in Bruce County. Also of interest was a pair of Green Herons at Baie du Dore. This small heron species is somewhat secretive and infrequently observed in southern Bruce County, although it is widespread in the area's wetlands.

Locally rare plant species noted during the present study included Beach Pea (*Lathyrus japonicus*), Elk Sedge (*Carex garberi*) and Needle Spike-rush. Jalava (2005) also found the locally rare Brown Beak-rush (*Rhyncospora fusca*), Deer-grass (*Scirpus cespitosus*) and Tall Cord Grass (*Spartina pectinacea*) in coastal areas of the Bruce Addition.

4. Ecological Threats and Human Impacts

Threats and human impacts affecting the ecological processes, natural heritage features, significant habitats, Species At Risk and rare species found in the northern Kincardine coastal study area are summarized in the table below.

Table 1. Ecological Threat Ranking for the Lake Huron Coast in northern Kincardine Townsihpo

Threat	Associated Stresses	Near-shore Waters of Lake Huron	Lake Huron Shoreline (Coastal Meadow Marshes)	Sand Dunes and Beach Ridges	Inland Wetlands (fens, marshes and ponds)	Overall	Comments
Invasion of habitat by Common Reed (*Phragmites australis*)	1. Compete with native species for resources & displace native plants 3. Reduced food and habitat quality for native plants and animals 4. Control measures may add to impacts 5. Filling, succession of wetlands from volume of the biomass	HIGH	VERY HIGH	HIGH	VERY HIGH	VERY HIGH	Invading the entire shoreline, especially along the water's edge and moister substrates. Very difficult to control and eradicate. Very serious impacts on native plant communities.
Recreational Activities -- Motorized off-road vehicles	1. Disturb wildlife 2. Direct damage to habitat and vegetation 3. Soil erosion & compaction 4. Introduction of invasive species		HIGH	VERY HIGH	VERY HIGH	VERY HIGH	Ongoing ATV and other off-road vehicle use noted as causing serious localized damage, especially in backshore marl fens, which are very sensitive to such disturbance. Sand dunes and beach ridges are also highly susceptible to erosion, blow-outs, etc.

Threat	Associated Stresses	Near-shore Waters of Lake Huron	Lake Huron Shoreline (Coastal Meadow Marshes)	Sand Dunes and Beach Ridges	Inland Wetlands (fens, marshes and ponds)	Overall	Comments
Invasion of habitat by European Black Alder (*Alnus glutinosa*)	1. Compete for resources with native plants 2. Reduce food and habitat quality for wildlife 3. Control measures add to impacts 4. Filling, succession of wetlands from volume of the biomass		HIGH	LOW	HIGH	HIGH	European Black Alder is common in the thicket swamp and along the roadside just west of the corner of Concession 10 and Sunset Drive. It has high potential to invade other wetlands and shoreline communities, displacing native plants.
Invasion of habitat by other introduced plants, including garden cultivars	1. Compete for resources with native plants 2. Allelopathic spp. have broader ecosystem impacts 3. Reduced food and habitat quality for wildlife 4. Control measures add to impacts 5. Filling, succession of wetlands from volume of the biomass		MED	HIGH	MED	HIGH	A number of garden cultivars and other introduced species (not listed separately in this table) were noted as spreading in localized areas, particularly in the vicinity of paths that cottagers have built to access the beach, and in other "landscaped" locations where cottagers have attempted to "beautify" the shore.
Housing & Cottage Development	1. Habitat loss & fragmentation 2. Predation by household pets 3. Light pollution 4. Invasive / non-native species. 5. Encroachment (habitat modification)		MED	HIGH	MED	HIGH	Although buildings and other structures may not be built within the coastal zone, impacts of adjacent uses and encroachment (i.e., introduction of garden cultivars and household pets, increased vehicle traffic and use of the beach for recreation, etc.) are amplified as new seasonal and permanent homes are built.

Threat	Associated Stresses	Near-shore Waters of Lake Huron	Lake Huron Shoreline (Coastal Meadow Marshes)	Sand Dunes and Beach Ridges	Inland Wetlands (fens, marshes and ponds)	Overall	Comments
Agricultural Effluents	1. Herbicides and insecticides (drift) 2. Nutrient inputs contribute to a) algae blooms; b) natural succession if fertilizer gets into groundwater runoff 3. Reduced resilience of species; more prone to disease	VERY HIGH?	HIGH?		LOW?	HIGH?	The degree to which agricultural run-off is impacting on nearshore waters and coastal habitats could not be determined on the basis of this study. It is suspected that agricultural run-off may be a major contributor to the algae blooms and associated foul-smelling rotting algal sludge noted in sheltered locations along the shore during the present study.
Invasion of habitat by Knapweeds (*Centaurea* spp.), White Sweet Clover (*Melilotus alba*) and Crown Vetch (*Coronilla varia*)	1. Compete with native plants for resources 2. Allelopathic spp. (e.g., Knapweeds) have broader ecosystem impacts 3. Reduce food and habitat quality for wildlife 5. Control measures may add to impacts 6. Nitrogen-fixing by legumes alters soil chemistry and may displace rare native plant species adapted to nutrient-poor environments		LOW	VERY HIGH		HIGH	White Sweet Clover and Crown Vetch were noted as invasive species in some localized areas, the former species being quite widespread along the coast. Both can be serious invasives in drier open habitats.
Air-Borne Pollutants	1. Impacts of climate change, including lower water levels, higher water temperatures 3. Impacts of increased severe weather events 4. Burning of plastic releases carcinogens (dioxins, furans)	HIGH	HIGH	MED	MED	HIGH	Climate change due to CO_2 and other airborne pollutants will likely have serious impacts on Lake Huron coastal communities, but dealing with this threat is largely beyond the capacity of the municipality. Burning of plastics and other toxic materials, although not noted during this study, could potentially pollute the coastal environment.

Threat	Associated Stresses	Near-shore Waters of Lake Huron	Lake Huron Shoreline (Coastal Meadow Marshes)	Sand Dunes and Beach Ridges	Inland Wetlands (fens, marshes and ponds)	Overall	Comments
Hunting & Collecting Terrestrial Animals (Species At Risk turtles)	1. Population decline or loss (SAR turtles)		LOW	HIGH	HIGH	HIGH	Collecting for the pet trade is a serious threat to turtle Species At Risk. Such species are known to occur in the wetlands along the coast and likely use the nearby sandy beach ridges as nesting habitat.
Household Sewage & Urban Waste Water	1. Reduced resilience of species; more prone to disease. 2. Chemicals impact soil quality and water quality; smell 3. Diseases, pathogenic bacteria (e.g., ecoli), prions 4. Nutrient loading	HIGH?	LOW		MED?	MED	The degree to which household sewage (from improperly installed septic systems) and urban waste water is impacting on nearshore waters and coastal habitats could not be determined on the basis of this study. It is suspected that these may contribute to the algae blooms and associated foul-smelling rotting algal sludge noted in sheltered locations along the shore during the present study.
Problematic Native Species – Canada Goose, White-tailed Deer	1. Increased nutrients, habitat destruction 2. Decreased biodiversity 3. Impede natural succession / regeneration	MED	MED	MED	MED	MED	Canada Geese are common along the coast, and are among the most destructive native species in shoreline and wetland habitats, feeding on native vegetation and polluting waters with their feces. White-tailed Deer were noted at several locations along the shore and may also cause damage to native vegetation.

Threat	Associated Stresses	Near-shore Waters of Lake Huron	Lake Huron Shoreline (Coastal Meadow Marshes)	Sand Dunes and Beach Ridges	Inland Wetlands (fens, marshes and ponds)	Overall	Comments
Tourism & Recreational Development	1. Direct habitat loss 2. Household pets (predation) 3. Light pollution 4. Invasive species 5. Encroachment (habitat modification)	MED	MED	MED	MED	MED	Increased recreational use of the area would likely result in a variety of impacts on habitat and wildlife, including damage to vegetation and substrates, disturbance to wildlife and increased road mortality.
Shoreline Alteration	1. Alteration of shoreline processes 2. Direct habitat loss 3. Loss of biodiversity & changes to species composition	MED	MED	MED	LOW	MED	Modifications to the shoreline, including docks, channels, dredging, and erosion control structures (e.g., boulders), were noted at numerous locations. These structures and activities directly alter habitat and may affect natural shoreline process (e.g., sand erosion and deposition, dune-building). They also usually contribute to the introduction of invasive species.
Roads	1. Habitat fragmentation and loss 2. Road mortality of amphibians, reptiles, birds and mammals 3. Run-off (salt, chemicals) 4. Invasive species introduction	LOW	LOW	MED	MED	MED	The roads that parallel the Lake Huron shoreline are lightly-travelled, and are used solely for cottage and lake access. The roads nevertheless have brought in invasive species, caused habitat fragmentation and undoubtedly result in occasional road mortality.
Renewable Energy – Wind Turbines	1. Death and damage to flying and migratory species.	MED?	MED?		LOW?	MED?	Offshore or on-shore wind turbine construction, if planned, may have impacts on migratory birds and cause habitat destruction.

Threat	Associated Stresses	Near-shore Waters of Lake Huron	Lake Huron Shoreline (Coastal Meadow Marshes)	Sand Dunes and Beach Ridges	Inland Wetlands (fens, marshes and ponds)	Overall	Comments
Utility & Service Lines	1. Habitat fragmentation 2. Hydrological impacts		LOW		LOW	MED	Utility corridors have had only minor impacts within the study area, but further development could result in more serious habitat fragmentation and destruction.
Gathering Terrestrial Plants	1. Cumulative impact of losing individuals, seed sources, genes, food sources. 2. Damage to vegetation (trampling). 3. Habitat loss.		LOW	MED	LOW	MED	Many of the plants that are found along the shoreline and beach ridges are attractive, showy flowers, some of them being provincially and/or locally rare.
Industrial Effluents (warm water and other discharges from Bruce Power)	1. Algae blooms? 2. Reduced resilience of species; more prone to disease 3. Contaminants, toxins from industrial waste water	HIGH?	LOW			MED?	
Garbage & Solid Waste	1. Habitat loss 2. Introduction of non-native species 3. Leachate	LOW	LOW	LOW	LOW	LOW	
Invasion of habitat by Basket Willow (*Salix purpurea*)	1. Competition for resources 2. Displace native plants 4. Reduced food and habitat quality for wildlife 5. Control measures add to impacts		MED	LOW	LOW	LOW	

Threat	Associated Stresses	Near-shore Waters of Lake Huron	Lake Huron Shoreline (Coastal Meadow Marshes)	Sand Dunes and Beach Ridges	Inland Wetlands (fens, marshes and ponds)	Overall	Comments
Invasion of habitat by Purple Loosestrife (*Lythrum salicaria*)	1. Competition for resources 2. Allelopathic spp. have broader ecosystem impacts 3. Displace native plants 4. Reduced food and habitat quality for wildlife 5. Control measures add to impacts 6. Filling, succession of wetlands from volume of the biomass		LOW		MED	LOW	
Recreational Activities (sunbathing, beachcombing, swimming, etc.)	1. Trampling of vegetation 2. Soil compaction 3. Introduction of invasive species 4. Litter	LOW	LOW	LOW		LOW	
Fishing & Harvesting Aquatic Resources	1. Potential for overfishing 2. Introduction of non-native bait-fish 3. Habitat damage in boat launch areas	LOW	LOW		LOW	LOW	
Logging & Wood Harvesting	1. Habitat damage 2. Soil compaction & erosion 3. Invasive species 4. Reduced forest interior & extent 5. Siltation			LOW	LOW	LOW	

5. Recommendations

The following recommendations for stewardship, management and land use planning are made for the northern Kincardine study area, based on the ecological features and processes, significant vegetation communities, the biological requirements of Species At Risk and other rare species documented in the area, and the threats and human impacts noted during the present study. The recommendations are categorized and prioritized based on what are considered the most significant threats as noted in Section 4, above.

5.1. Control the Spread of Invasive Species

Appropriate methods to control the following invasive alien plant species should be considered, in consultation with the Lake Huron Centre for Coastal Conservation and invasive species experts. These species are listed in order of priority for action, based on the observations and experience of the author:

1. Common Reed
2. European Black Alder
3. Knapweeds, White Sweet Clover and Crown Vetch
4. Basket Willow
5. Purple Loosestrife

Of great concern is the spread of Common Reed, which, if left uncontrolled, could very well invade most of coastal habitat (Figure 6), as it has done in areas further south. Not only is it an extremely serious invasive from an ecological perspective, Common Reed also affects shoreline access for recreation and is an aesthetic bane because it often completely obscures views of the lake. Common Reed is highly aggressive and very difficult to eradicate once established. Many of the control measures, such as herbicides, may have negative impacts on native species, so an informed approach using the most effective but nevertheless environmentally appropriate techniques should be used.

Figure 6. Shoreline habitat at Baie du Dore invaded by Common Reed

European Black Alder is another potentially serious invasive along the coast, but it is currently localized in the study area. It can be more easily controlled because it is slower-growing and reproduces less rapidly than Common Reed. Manual removal (cutting) from impacted areas over several years may produce satisfactory results.

Knapweeds (*Centaurea* spp.), White Sweet Clover and Crown Vetch are also quite localized in the area and have not impacted large areas of natural habitat, but each could potentially become a serious problem on the sand beach ridge (sand dune) habitats. Manual removal and/or other control methods should be considered for these species. The spread of Basket Willow and Purple Loosestrife should be monitored, and control measures undertaken if populations show significant increases from their current (relatively low) levels.

Residents of the area should be educated regarding invasive plant species, and strongly encouraged not to plant garden cultivars in the significant coastal habitats. Residents should especially be encouraged to plant native species specifically suited to the local ecological conditions in their gardens.

5.2. Prevent Further Habitat Damage by Recreational Activities: Off-road Vehicles
After invasive species, the unrestricted use of motorized off-road vehicles is probably the most serious ongoing impact on sensitive habitats (fens, coastal meadow marshes and

sand beach ridges) in the study area. Off-road vehicles are damaging substrate, vegetation, altering hydrology, causing erosion, rutting, and almost certainly introducing invasive species to otherwise high-quality, diverse and often globally and provincially significant ecosystem types (Figure 7). Appropriate bylaws, their enforcement, signage and construction of barriers (such as boulder piles) at access points, combined with public education, are all methods that may be used to alleviate this problem.

Figure 7. Severe habitat damage caused by off-road vehicles in fen at Baie du Dore

Other more minor habitat damage may be occurring due to recreational activities associated with beach access (walking, sunbathing, swimming, boating, etc.), but impacts from such activities are minor compared to the effects of off-road vehicles (ATVs).

5.3. Restrict and Reduce the Impacts of Housing & Cottage Development

The impacts of increased housing and cottage development in the area may include: direct habitat loss at building and landscaping sites; shoreline alteration; habitat loss and fragmentation caused by the construction of access roads, driveways, utility lines, septic beds, etc.; and predation of native wildlife by domestic pets. With the exception of provincial park lands, most of the shoreline in southern Bruce County has already been developed. The coastal area in northern Kincardine presents an opportunity to preserve a

highly significant element of the region's natural heritage, with many globally and provincially significant ecological features.

5.4. Reduce the Impacts of Agricultural Effluents

Algae blooms in shallow, sheltered areas along the coastline (Figure 8) are of great concern from the ecological perspective, as well as from an aesthetic and economic point of view, given the importance of this area to ecotourism and other recreational activities that require clean beaches and waters. The fact that algae concentrations are particularly high in the north Kincardine area suggests that nutrient loading, perhaps from intensified agriculture and fertilizer- use, is originating from locations in the watershed that are feeding Lake Huron long-shore currents that bring water to the study area. The sources of nutrient-loading need to be better understood, and appropriate remedial action needs to be taken once the causes are determined.

Figure 8. Rotting nutrient-rich algae at shore near Scott Point

5.5. Prevent Pollution by Household Sewage & Urban Waste Water

Appropriate inspections and monitoring should be undertaken to ensure that septic systems are functioning properly and that untreated wastewater from roads and urban

areas does not enter Lake Huron and end up transported by water currents to the north Kincardine coastal area.

5.6. Prevent Collecting of Species At Risk and Native Plants
Public education campaigns should be undertaken to raise awareness of the biological needs and human-caused threats to SAR and other significant species found in the study area. Reporting of violators and enforcement of the Endangered Species Act should be encouraged, particularly with respect to collecting of reptile SAR and provincially rare wildflowers.

5.7. Monitor and Reduce the Impacts of Hyperabundant Native Species
Canada Geese were observed in the study area during the 2011 surveys. Numbers were relatively low, and it is suspected that current impacts are minor. If populations exceed the ecosystem's natural carrying capacity, Canada Geese can cause severe damage to wetland vegetation, and their droppings can pollute coastal waters. The introduced Mute Swan, which also occurs in the study area, may have similar impacts, and populations should be monitored.

Although observed near the shoreline during the present study, White-tailed Deer tend to browse in the more wooded areas and are not considered a major ecological threat to the coastal habitats. Similarly, although populations of Double-crested Cormorant have exploded in the lower Great Lakes in the past few decades, their impact within the study area is considered minor, as they visit the area only to feed, generally in low to moderate numbers, and tend to keep their distance from the shore.

5.8. Encourage Regulation of Lake Huron Water Levels
Chronically low water levels will result in natural succession of the current coastal environment to a more densely vegetated, wooded ecosystem. Should credible studies demonstrate that ongoing declines in Lake Huron water levels are due to dredging of the St. Clair River, responsible jurisdictions should be encouraged by local governments around the lake to develop the infrastructure to regulate the water flow to emulate more typical lake-level fluctuations.

5.9. Promote Sustainable Low-Impact Tourism and Recreational Development
Tourism and recreational development along the north Kincardine coastal area should be carefully planned so as not to increase the threats and impacts noted above. The attractiveness of the area for such development poses the risk of the area being "loved to death" from an ecological perspective, as has occurred in many other coastal areas.

5.10. Ensure Low Impacts of Renewable Energy Developments
Utility companies and appropriate jurisdictions should ensure that any new renewable energy developments, such as wind farms, do not negatively impact migratory birds and

other fauna, SAR and significant coastal habitats, not to mention the human population, in the study area.

5.11. Study and Limit Impacts of Industrial Effluents

The impacts of warm water discharges from the Bruce Nuclear Generating Station, as well as other industrial effluents that may be affecting coastal habitats in the study area, should be studied and remediated if necessary.

5.12. Lobby for Reduced Impacts of Air-Borne Pollutants

Climate change is probably a factor in the low water levels of Lake Huron, and if predictions prove correct, will impact the ecology of the coastal zone in a variety of ways. Local communities can do their part to reduce carbon emissions through energy conservation and transitioning to renewable energy sources.

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APPENDIX A. VASCULAR PLANTS OF THE NORTH KINCARDINE COAST

The following list of vascular plants documented in the study area is based on the findings of the present study and observations in coastal areas of the Bruce Addition and adjacent Wolfe Property (immediately south of MacGregor Point Provincial Park) by Jalava (2005) in 2004. The list is arranged phylogenetically by family, then alphabetically by species within each genus, in the order provided in Newmaster *et al.* (1998).

Conservation Status
The global and provincial conservation rank (GRANK, SRANK) are based on NHIC (2004). Nomenclature and status for southern Bruce County (SB) are based on BGPC (2003). Southern Bruce County status codes are as follows:

X = Common to uncommon (or status not determined)
V = Very uncommon
R = Rare
I = Introduced

FAMILY	SCIENTIFIC NAME	COMMON NAME	GRANK	SRANK	SB	Present Study	Jalava 2005
SELAGINELLACEAE	*Selaginella eclipes Buck*	Buck's Meadow Spike-moss	G4	S4	U	X	X
EQUISETACEAE	*Equisetum arvense L.*	Field Horsetail	G5	S5	X	X	X
EQUISETACEAE	*Equisetum variegatum Schleic. ex Fried, Weber & Mohr*	Variegated Scouring-rush	G5	S5	X	X	X
DENNSTAEDTIACEAE	*Pteridium aquilinum (L.) Kuhn*	Eastern Bracken	G5T	S5	X		X
DRYOPTERIDACEAE	*Dryopteris carthusiana (Villars) H.P. Fuchs*	Spinulose Wood Fern	G5	S5	X		X
PINACEAE	*Abies balsamea (L.) Miller*	Balsam Fir	G5	S5	X		X
PINACEAE	*Larix laricina (Du Roi) K. Koch*	Tamarack	G5	S5	X	X	X
PINACEAE	*Picea glauca (Moench) Voss*	White Spruce	G5	S5	X	X	X
PINACEAE	*Pinus resinosa Aiton*	Red Pine	G5	S5	X	X	X
PINACEAE	*Pinus strobus L.*	Eastern White Pine	G5	S5	X	X	X
CUPRESSACEAE	*Juniperus horizontalis Moench*	Creeping Juniper	G5	S5	X	X	X
CUPRESSACEAE	*Juniperus communis*	Common Juniper	G5	S5	X	X	X
CUPRESSACEAE	*Thuja occidentalis L.*	White Cedar	G5	S5	X	X	X
RANUNCULACEAE	*Anemone canadensis L.*	Canada Anemone	G5	S5	X	X	X
RANUNCULACEAE	*Aquilegia canadensis L.*	Wild Columbine	G5	S5	X	X	X
RANUNCULACEAE	*Clematis virginiana L.*	Virgin's-bower	G5	S5	X	X	X
RANUNCULACEAE	*Ranunculus acris L.*	Common Buttercup	G5	SE5	I	X	X
RANUNCULACEAE	*Thalictrum pubescens Pursh*	Tall Meadow-rue	G5	S5	X	X	X
MYRICACEAE	*Myrica gale L.*	Sweet Gale	G5	S5	X	X	X
BETULACEAE	*Alnus incana (L.) Moench ssp. rugosa*	Speckled Alder	G5T5	S5	U	X	X
BETULACEAE	*Alnus glutinosa (L.) Gaertn.*	European Black Alder	G?	SE4	I	X	X
BETULACEAE	*Betula papyrifera Marshall*	White Birch	G5	S5	X	X	X

FAMILY	SCIENTIFIC NAME	COMMON NAME	GRANK	SRANK	SB	Present Study	Jalava 2005
CARYOPHYLLACEAE	*Arenaria serpyllifolia L.*	Thyme-leaved Sandwort	G?	SE5	I		X
CARYOPHYLLACEAE	*Silene vulgaris*	Bladder Campion	G?	SE5	I	X	
POLYGONACEAE	*Rumex crispus*	Curly Dock	G?	SE5	I	X	X
CLUSIACEAE	*Hypericum kalmianum L.*	Kalm's St. John's-wort	G4	S4	X	X	X
CLUSIACEAE	*Hypericum perforatum L.*	Common St. John's-wort	G?	SE5	I	X	X
CLUSIACEAE	*Triadenum fraseri (Spach) Gleason*	Marsh St. John's-wort	G4G5	S5	X	X	X
SARRACENIACEAE	*Sarracenia purpurea L.*	Pitcher-plant	G5	S5	X	X	X
DROSERACEAE	*Drosera rotundifolia L.*	Round-leaved Sundew	G5	S5	X	X	X
VIOLACEAE	*Viola nephrophylla*	Le Conte's Marsh Violet	G4G5	S5	X	X	X
SALICACEAE	*Populus balsamifera L. ssp. balsamifera*	Balsam Poplar	G5T?	S5	X	X	X
SALICACEAE	*Populus tremuloides Michaux*	Trembling Aspen	G5	S5	X	X	X
SALICACEAE	*Salix amygdaloides Andersson*	Peach-leaved Willow	G5	S5	X	X	X
SALICACEAE	*Salix discolor Muhlenb.*	Pussy Willow	G5	S5	X	X	X
SALICACEAE	*Salix eriocephala Michaux*	Heart-leaved Willow	G5	S5	X	X	X
SALICACEAE	*Salix exigua*	Sandbar Willow	G5	S5	X	X	
SALICACEAE	*Salix lucida Muhlenb.*	Shining Willow	G5	S5	X	X	X
SALICACEAE	*Salix myricoides Muhlenb.*	Blue-leaved Willow	G3G5	S3	R	X	X
SALICACEAE	*Salix petiolaris*	Slender Willow	G5	S5	X	X	X
SALICACEAE	*Salix purpurea L.*	Basket Willow	G5	SE4	I	X	X
BRASSICACEAE	*Lepidium campestre (L.) R. Br.*	Field Pepper-grass	G?	SE5	I	X	X
BRASSICACEAE	*Nasturtium officinale R. Br. ex Aiton*	Water Cress	G?	SE	I	X	X
ERICACEAE	*Arctostaphylos uva-ursi (L.) Sprengel*	Bear-berry	G5	S5	X	X	X
PRIMULACEAE	*Lysimachia quadriflora Sims*	Four-flowered Loosestrife	G5?	S4	X	X	X
PRIMULACEAE	*Lysimachia thyrsiflora L.*	Tufted Loosestrife	G5	S5	X	X	X
PRIMULACEAE	*Primula mistassinica Michaux*	Bird's-eye Primrose	G5	S4	X	X	X
SAXIFRAGACEAE	*Parnassia glauca Raf.*	Grass-of-Parnassus	G5	S5	X	X	X
ROSACEAE	*Fragaria virginiana Miller*	Wild Strawberry	G5	S5	X	X	X
ROSACEAE	*Physocarpus opulifolius (L.) Maxim.*	Ninebark	G5	S5	X	X	X
ROSACEAE	*Potentilla anserina L. ssp. anserina*	Silverweed	G5	S5	X	X	X
ROSACEAE	*Potentilla fruticosa L. ssp. floribunda*	Shrubby Cinquefoil	G5	S5	X	X	X
ROSACEAE	*Potentilla norvegica L.*	Rough Cinquefoil	G5	S5	I		X
ROSACEAE	*Prunus pumila*	Sand Cherry	G5	S5	X	X	X
ROSACEAE	*Prunus serotina Ehrh.*	Wild Black Cherry	G5	S5	X		X
ROSACEAE	*Prunus virginiana L. ssp. virginiana*	Choke Cherry	G5T?	S5	X	X	X
ROSACEAE	*Rosa acicularis Lindley ssp. sayi*	Prickly Wild Rose	G5TU	S5	X		X
ROSACEAE	*Rosa blanda Aiton*	Smooth Wild Rose	G5	S5	U	X	X
ROSACEAE	*Rosa palustris Marshall*	Swamp Rose	G5	S5	X	X	X
ROSACEAE	*Rubus idaeus L. ssp. melanolasius*	Wild Red Raspberry		S5	X		X
ROSACEAE	*Spiraea alba Duroi*	Meadowsweet	G5	S5	X	X	X
FABACEAE	*Coronilla varia L.*	Crown Vetch	G?	SE5	I	X	
FABACEAE	*Lathyrus japonicus Willd.*	Beach Pea	G5	S4	R	X	X
FABACEAE	*Lathyrus palustris L.*	Marsh Pea	G5	S5	U		X
FABACEAE	*Lotus corniculatus L.*	Birdfoot Trefoil	G?	SE5	I	X	X
FABACEAE	*Medicago lupulina L.*	Black Medick	G?	SE5	I	X	X
FABACEAE	*Melilotus alba Medicus*	White Sweet-clover	G?	SE5	I	X	X

FAMILY	SCIENTIFIC NAME	COMMON NAME	GRANK	SRANK	SB	Present Study	Jalava 2005
FABACEAE	*Melilotus officinalis (L.) Pallas*	Yellow Sweet-clover	G?	SE5	I		X
FABACEAE	*Trifolium pratense L.*	Red Clover	G?	SE5	I	X	X
FABACEAE	*Vicia cracca L.*	Cow Vetch	G?	SE5	I	X	X
ELAEAGNACEAE	*Shepherdia canadensis (L.) Nutt.*	Soapberry	G5	S5	X	X	X
HALORAGACEAE	*Proserpinaca palustris L.*	Mermaid-weed	G5	S4	X	X	X
LYTHRACEAE	*Lythrum salicaria L.*	Purple Loosestrife	G5	SE5	I	X	X
ONAGRACEAE	*Epilobium parviflorum Schreber*	Small-flowered Willow-herb	G?	SE4	I	X	X
ONAGRACEAE	*Oenothera biennis L.*	Hairy Yellow Evening-primrose	G5	S5	X	X	X
CORNACEAE	*Cornus amomum Miller ssp. obliqua (Raf.)*	Silky Dogwood	G5T?	S5	X	X	X
CORNACEAE	*Cornus stolonifera Michaux*	Red-osier Dogwood	G5	S5	X	X	X
SANTALACEAE	*Comandra umbellata (L.) Nutt.*	Bastard-toadflax	G5	S5	X	X	X
CELASTRACEAE	*Celastrus scandens L.*	Climbing Bittersweet	G5	S5	X		X
AQUIFOLIACEAE	*Ilex verticillata (L.) A. Gray*	Winterberry	G5	S5	X		X
VITACEAE	*Vitis riparia Michaux*	Riverbank Grape	G5	S5	X	X	X
LINACEAE	*Linum medium (Planchon) Britton var. medium*	Stiff Yellow Flax	G5T?	S3	X	X	X
POLYGALACEAE	*Polygala paucifolia Willd.*	Fringed Polygala	G5	S5	X		X
ANACARDIACEAE	*Rhus radicans L. ssp. rydbergii*	Rydberg's Poison-ivy	G5T	S5	X	X	X
ANACARDIACEAE	*Rhus typhina L.*	Staghorn Sumac	G5	S5	X	X	X
BALSAMINACEAE	*Impatiens capensis Meerb.*	Spotted Touch-me-not	G5	S5	X	X	X
ARALIACEAE	*Aralia nudicaulis L.*	Wild Sarsaparilla	G5	S5	X		X
APIACEAE	*Cicuta bulbifera L.*	Bulb-bearing Water-hemlock	G5	S5	X	X	X
APIACEAE	*Daucus carota L.*	Wild Carrot	G?	SE5	I	X	X
ASCLEPIADACEAE	*Asclepias incarnata L. ssp. incarnata*	Swamp Milkweed	G5T5	S5	X		X
ASCLEPIADACEAE	*Asclepias syriaca L.*	Common Milkweed	G5	S5	X	X	X
CONVOLVULACEAE	*Calystegia sepium (L.) R. Br.*	Hedge Bindweed	G4G5	S5	X	X	X
MENYANTHACEAE	*Menyanthes trifoliata L.*	Bogbean	G5	S5	X		X
LAMIACEAE	*Calamintha arkansana (Nutt.) Shinn.*	Wild Savory	G5	S4S5	X	X	X
LAMIACEAE	*Clinopodium vulgare L.*	Wild Basil	G?	S5	X	X	X
LAMIACEAE	*Lycopus americanus Muhlenb. ex Bartram*	American Water-horehound	G5	S5	X	X	X
LAMIACEAE	*Lycopus uniflorus Michaux*	Bugleweed	G5	S5	X	X	X
LAMIACEAE	*Nepeta cataria L.*	Catnip	G?	SE5	I	X	X
LAMIACEAE	*Prunella vulgaris L. ssp. lanceolata*	Heal-all	G5T?	S5	X	X	X
CRASSULACEAE	*Sedum acre L.*	Gold-moss / Common Stonecrop	G5	SE5	I	X	
PLANTAGINACEAE	*Plantago lanceolata L.*	English Plantain	G5	SE5	I	X	X
OLEACEAE	*Fraxinus americana L.*	White Ash	G5	S5	X	X	
OLEACEAE	*Fraxinus pennsylvanica Marshall*	Red/Green Ash	G5	S5	X	X	X
BORAGINACEAE	*Myosotis laxa*	Small-flowered Forget-me-not	G5	S5	X	X	X
SCROPHULARIACEAE	*Agalinis paupercula (A. Gray) Britton*	Small-flowered Agalinis	G5	S4S5	X	X	X
SCROPHULARIACEAE	*Castilleja coccinea (L.) Sprengel*	Indian Paintbrush	G5	S5	U	X	X
SCROPHULARIACEAE	*Verbascum thapsus L.*	Common Mullein	G?	SE5	I	X	X
LENTIBULARIACEAE	*Utricularia cornuta Michaux*	Horned Bladderwort	G5	S5	U	X	X
CAMPANULACEAE	*Campanula aparinoides Pursh*	Marsh Bellflower	G5	S5	X	X	X

FAMILY	SCIENTIFIC NAME	COMMON NAME	GRANK	SRANK	SB	Present Study	Jalava 2005
CAMPANULACEAE	*Campanula rotundifolia*	Harebell	G5	S5	X	X	X
CAMPANULACEAE	*Lobelia kalmii L.*	Kalm's Lobelia	G5	S5	X	X	X
CAMPANULACEAE	*Lobelia spicata Lam.*	Pale-spiked Lobelia	G5	S4	U	X	X
RUBIACEAE	*Houstonia longifolia Gaertner*	Long-leaved Houstonia	G4G5	S4?	U		X
CAPRIFOLIACEAE	*Lonicera dioica L.*	Wild Honeysuckle	G5	S5	X	X	X
ASTERACEAE	*Achillea millefolium L.*	Yarrow	G5	S5	X	X	X
ASTERACEAE	*Ambrosia artemisiifolia L.*	Common Ragweed	G5	S5	X	X	X
ASTERACEAE	*Anaphalis margaritacea (L.) Benth. & Hook.f*	Pearly Everlasting	G5	S5	X	X	X
ASTERACEAE	*Artemesia caudate*	Wormwood	G5	S5	X	X	
ASTERACEAE	*Centaurea maculata*	Spotted Knapweed	G5	SE5	I*	X	X
ASTERACEAE	*Centaurea maculosa Lam.*	Spotted Knapweed	G?	SE5	I*	X	X
ASTERACEAE	*Chrysanthemum leucanthemum L.*	Ox-eye Daisy	G?	SE5	I	X	X
ASTERACEAE	*Erigeron philadelphicus L. ssp. philadelphicus*	Philadelphia Fleabane	G5T?	S5	X	X	X
ASTERACEAE	*Eupatorium maculatum L.*	Spotted Joe-Pye-weed	G5	S5	X	X	X
ASTERACEAE	*Eupatorium perfoliatum L.*	Boneset	G5	S5	X	X	X
ASTERACEAE	*Euthamia graminifolia (L.) Nutt. ex Cass.*	Grass-leaved Goldenrod	G5	S5	X	X	X
ASTERACEAE	*Hieracium pilosella L.*	Mouse-ear Hawkweed	G?	SE5	I	X	X
ASTERACEAE	*Liatris cylindracea*	Cylindric Blazing-star	G5	S3	R	X	
ASTERACEAE	*Packera paupercula*	Balsam Ragwort	G5	S5	X	X	X
ASTERACEAE	*Prenanthes racemosa Michaux ssp. racemosa*	Smooth White-lettuce	G5T?	SU	X	X	X
ASTERACEAE	*Rudbeckia hirta L.*	Black-eyed Susan	G5	S5	X	X	X
ASTERACEAE	*Solidago canadensis L.*	Canada Goldenrod	G5	S5	X	X	X
ASTERACEAE	*Solidago hispida*	Hairy Goldenrod	G5	S5	X	X	
ASTERACEAE	*Solidago ohioensis Riddell*	Ohio Goldenrod	G4	S4	U	X	X
ASTERACEAE	*Solidago ptarmicoides (Nees) B. Boivin*	Upland White Goldenrod	G5	S5	U	X	X
ASTERACEAE	*Solidago uliginosa Nutt.*	Bog Goldenrod	G4G5	S5	X	X	X
ASTERACEAE	*Symphyotrichum lanceolatum ssp. lanceolatum*	Panicled Aster	G5T?	S5	X	X	X
ASTERACEAE	*Symphyotrichum lateriflorum*	Calico Aster	G5	S5	X	X	X
ASTERACEAE	*Taraxacum officinale G. Weber*	Common Dandelion	G5	SE5	I	X	X
ASTERACEAE	*Tragopogon dubius Scop.*	Goat's-beard	G?	SE5	I	X	X
ASTERACEAE	*Tussilago farfara L.*	Coltsfoot	G?	SE5	I	X	X
ALISMATACEAE	*Alisma plantago-aquatica L.*	Water-plantain	G5	S5	X	X	X
JUNCAGINACEAE	*Triglochin maritimum L.*	Arrow-grass	G5	S5	X	X	X
JUNCAGINACEAE	*Triglochin palustre L.*	Marsh Arrow-grass	G5	S5	U	X	X
JUNCACEAE	*Juncus articulatus L.*	Jointed Rush	G5	S5	X	X	X
JUNCACEAE	*Juncus balticus Willd.*	Baltic Rush	G5	S5	X	X	X
JUNCACEAE	*Juncus brachycephalus (Engelm.) Buchenau*	Short-headed Rush	G5	S4S5	X	X	X
JUNCACEAE	*Juncus dudleyi Wieg.*	Dudley's Rush	G5	S5	X	X	X
JUNCACEAE	*Juncus nodosus L. var. nodosus*	Knotted Rush	G5	S5	X	X	X
JUNCACEAE	*Juncus tenuis Willd. var. tenuis*	Path Rush	G5T?	S5	X	X	X
CYPERACEAE	*Carex aquatilis Wahlenb.*	Water Sedge	G5	S5	U	X	X
CYPERACEAE	*Carex aurea*	Golden-fruit Sedge	G5	S5	X	X	X
CYPERACEAE	*Carex bebbii*	Bebb's Sedge	G5	S5	X	X	X
CYPERACEAE	*Carex buxbaumiii*	Buxbaum's Sedge	G5	S4	U	X	X

FAMILY	SCIENTIFIC NAME	COMMON NAME	GRANK	SRANK	SB	Present Study	Jalava 2005
CYPERACEAE	*Carex crawei Dewey*	Crawe's Sedge	G5	S4	X	X	X
CYPERACEAE	*Carex cryptolepis Mackenzie*	Northeastern Sedge	G4	S5	X		X
CYPERACEAE	*Carex eburnea Boott ex Hooker*	Bristle-leaf Sedge	G5	S5	X	X	X
CYPERACEAE	*Carex flava L.*	Yellow Sedge	G5	S5	X	X	X
CYPERACEAE	*Carex garberi Fern.*	Elk Sedge	G4	S4	R	X	X
CYPERACEAE	*Carex hystericina Muhlenb. ex Willd.*	Porcupine Sedge	G5	S5	X	X	X
CYPERACEAE	*Carex interior L. Bailey*	Inland Sedge	G5	S5	X		X
CYPERACEAE	*Carex lasiocarpa Ehrh.*	Hairy-fruited Sedge	G5	S5	X	X	X
CYPERACEAE	*Carex pellita Muhl.*	Woolly Sedge	G5	S5	X	X	X
CYPERACEAE	*Carex pseudo-cyperus L.*	Cyperus-like Sedge	G5	S5	X		X
CYPERACEAE	*Carex viridula Michaux ssp. viridula*	Greenish Sedge	G5?T?	S5	U	X	X
CYPERACEAE	*Cladium mariscoides (Muhlenb.) Torrey*	Twig-rush	G5	S5	X	X	X
CYPERACEAE	*Eleocharis acicularis (L.) Roemer & Schulte*	Needle Spike-rush	G5	S5	R	X	X
CYPERACEAE	*Eleocharis elliptica Kunth*	Elliptic Spike-rush	G5	S5	X	X	X
CYPERACEAE	*Eleocharis quinqueflora (F. Hartmann) Schwa*	Few-flowered Spike-rush	G5	S5	X		X
CYPERACEAE	*Eleocharis rostellata (Torrey) Torrey*	Beaked Spike-rush	G5	S3	U	X	X
CYPERACEAE	*Eleocharis smallii Britton*	Small's Spike-rush	G5?	S5	X	X	X
CYPERACEAE	*Eriophorum viridi-carinatum (Engelm.) Fern.*	Cotton-grass	G4	S5	U		X
CYPERACEAE	*Rhynchospora alba (L.) M. Vahl*	White Beak-rush	G5	S5	X		X
CYPERACEAE	*Rhynchospora capillacea Torrey*	Hair-like Beak-rush	G5	S4?	X	X	X
CYPERACEAE	*Rhynchospora fusca (L.) Aiton f.*	Brown Beak-rush	G4G5	S4?	R		X
CYPERACEAE	*Schoenoplectus acutus Muhlenb.ex Bigelow*	Hard-stemmed Bulrush	G5	S5	X		X
CYPERACEAE	*Schoenoplectus pungens (M. Vahl) Palla*	Threesquare	G5	S5	X	X	X
CYPERACEAE	*Schoenoplectus tabernaemontani (Gmelin) Palla*	Soft-stem Bulrush	G5	S5	X	X	X
CYPERACEAE	*Scirpus atrovirens Willd.*	Dark Green Bulrush	G5?	S5	X	X	X
CYPERACEAE	*Scirpus cespitosus L. ssp. cespitosus*	Deer-grass	G5T	S5	R		X
CYPERACEAE	*Scleria verticillata Muhlenb. ex Willd.*	Low Nut-rush	G5	S3	U	X	X
POACEAE	*Agrostis gigantea Roth*	Redtop	G4G5	SE5	I	X	X
POACEAE	*Agrostis scabra Willd.*	Rough Hair Grass	G5	S5	X	X	X
POACEAE	*Bromus inermis*	Smooth Brome	G5	SE5	I	X	
POACEAE	*Calamagrostis canadensis (Michaux) P. Beauv.*	Canada Bluejoint	G5	S5	X	X	X
POACEAE	*Calamagrostis stricta (Timm) Koeler*	Northern Reed Grass	G5T5	S5	U		X
POACEAE	*Calamovilfa longifolia var. magna*	Long-leaved Reed Grass / Great Lakes Reed Grass	G5T3	S3	U	X	
POACEAE	*Danthonia spicata (L.) P. Beauv. ex Roemer*	Poverty Oat Grass	G5	S5	X	X	X
POACEAE	*Deschampsia caespitosa (L.) P. Beauv.*	Tufted Hair Grass		S5	X		X
POACEAE	*Elymus repens*	Quack Grass	G5	SE5	I	X	
POACEAE	*Elymus trachycaulus (Link) Gould in Shinn.*	Slender Wheat Grass	G5	S5	X		X

FAMILY	SCIENTIFIC NAME	COMMON NAME	GRANK	SRANK	SB	Present Study	Jalava 2005
POACEAE	*Festuca arundinaceus*	Tall Fescue	G?	SE5	I	X	X
POACEAE	*Festuca pratensis*	Meadow Fescue	G5	SE5	I		X
POACEAE	*Panicum acutum*	Hairy Panic Grass	G5	S5	X	X	X
POACEAE	*Panicum lindheimeri Nash*	Lindheimer's Panic Grass	G5T	S4	X	X	X
POACEAE	*Phalaris arundinacea L.*	Reed Canary Grass	G5	S5	X	X	X
POACEAE	*Phleum pratense L.*	Timothy	G?	SE5	I		X
POACEAE	*Phragmites australis ssp. australis*	Common Reed Grass	G5	SE5	I	X	
POACEAE	*Poa compressa L.*	Canada Blue Grass	G?	S5	X	X	X
POACEAE	*Poa palustris*	Fowl Meadow Grass	G5	S5	X	X	X
POACEAE	*Poa pratensis L. ssp. pratensis*	Kentucky Blue Grass	G5T	S5	X	X	X
POACEAE	*Schizachyrium scoparium (Michaux) Nees*	Little Bluestem	G5	S4	X	X	X
POACEAE	*Sorghastrum nutans (L.) Nash*	Indian Grass	G5	S4	U	X	X
POACEAE	*Spartina pectinata Link*	Tall Cord Grass	G5	S4	R		X
TYPHACEAE	*Typha angustifolia L.*	Narrow-leaved Cattail	G5	S5	X	X	X
TYPHACEAE	*Typha latifolia L.*	Common Cattail	G5	S5	X	X	X
LILIACEAE	*Hemerocallis fulva (L.) L.*	Orange Day Lily	G?	SE5	I		X
LILIACEAE	*Lilium philadelphicum L.*	Wood Lily	G5	S5	X		X
LILIACEAE	*Maianthemum canadense Desf.*	Wild Lily-of-the-valley	G5	S5	X		X
LILIACEAE	*Maianthemum stellatum (L.) Link*	Starry False Solomon's-seal	G5	S5	X	X	X
LILIACEAE	*Tofieldia glutinosa (Michaux) Pers.*	False Asphodel	G5T4	S4?	X	X	X
LILIACEAE	*Zigadenus elegans*	White Camass	G5	S4	X	X	
IRIDACEAE	*Iris versicolor L.*	Wild Blue-flag	G5	S5	X	X	X
IRIDACEAE	*Sisyrinchium mucronatum Michaux*	Blue-eyed Grass	G5	S4S5	U	X	X
ORCHIDACEAE	*Liparis loeselii (L.) Richard ex Lindley*	Loesel's Twayblade	G5	S4S5	X		X
ORCHIDACEAE	*Platanthera dilatata (Pursh) Lindley ex Bec*	Tall White Bog Orchid	G5	S5	U		X
ORCHIDACEAE	*Platanthera hyperborea (L.) Lindley*	Tall Northern Green Orchid	G5T?	SU	X		X
ORCHIDACEAE	*Platanthera psycodes (L.) Lindley*	Small Purple Fringed-orchid	G5	S5	X		X
ORCHIDACEAE	*Pogonia ophioglossoides*	Rose Pogonia	G5	S4S5	U	X	
ORCHIDACEAE	*Spiranthes cernua (L.) Rich.*	Nodding Ladies'-tresses	G5	S5	U		X
ORCHIDACEAE	*Spiranthes romanzoffiana Cham.*	Hooded Ladies'-tresses	G5	S5	X		X

APPENDIX B. BIRDS OF THE NORTH KINCARDINE COAST

The following list is a summary of bird data collected along the north coast of Kincardine during the present study, and by Jalava (2005) in coastal areas of the Bruce Addition and the adjacent Wolfe Property south of MacGregor Point Provincial Park in 2004.

Breeding evidence is indicated using standard breeding evidence criteria (OBBA 2001), and only the highest level of evidence observed is noted.

LEGEND

Bruce Addition and Wolfe Property bird observations were made by Jalava in 2004.

X	Species observed in its breeding season, but no evidence of breeding
m	Species observed outside of breeding season

POSSIBLE Breeding - PO

H	Species observed during its breeding season in suitable nesting habitat
S	Singing male seen or breeding calls heard during its breeding season in suitable nesting habitat

PROBABLE Breeding - PR

P	Pair observed in their breeding season in suitable nesting habitat
T	Breeding territory presumed through registration of territorial song >1 week apart at same location
D	Courtship or display between male and female observed
V	Visiting probable nest site
A	Agitated behaviour or anxiety calls of an adult
B	Brood patch on adult female or cloacal protuberance on adult male
N	Nest-building or excavation of nest hole

CONFIRMED Breeding - C

DD	Distraction display or injury feigning
NU	Used nest or egg shell found
FY	Recently fledged or downy young
AE	Adults leaving or entering nest in circumstances indicating occupied nest
FS	Adult carrying fecal sac
CF	Adult carrying food for young
NE	Nest containing eggs
NY	Nest with young seen or heard

SCIENTIFIC NAME	COMMON NAME	**COSEWIC**	**OMNR**	**SRANK**	**BREEDING EVIDENCE**	**Present Study**	**Jalava (2005)**
Gavia immer	Common Loon			S4B,SZN	X		X
Phalacrocorax auritus	Double-crested Cormorant			S5B, SZN	X	X	X
Ardea herodias	Great Blue Heron			S5B,SZN	PO	X	H
Casmerodius albus	Great Egret			S2B,SZN	X	X	
Butorides virescens	Green Heron			S4B,SZN	PR	P	
Cathartes aura	Turkey Vulture			S4B,SZN	PO	H	H
Cygnus olor	Mute Swan			SE4	PO	H	
Branta canadensis	Canada Goose			S5B,SZN	PO	H	
Aix sponsa	Wood Duck			S5B,SZN	PO	H	
Anas platyrhynchos	Mallard			S5B,SZN	PO	H	
Anas crecca	Green-winged Teal			S4B,SZN	PR		P
Lophodytes cucullatus	Hooded Merganser			S5B,SZN	PO		H
Mergus merganser	Common Merganser			S5B,SZN	PO	H	H
Mergus serrator	Red-breasted Merganser			S4B,SZN	PO	H	
Haliaeetus leucocephalus	Bald Eagle		SC	S4B,SZN	PO	H	
Falco columbarius	Merlin			S4B,SZN	PR	A	H
Grus canadensis	Sandhill Crane			S4B,SZN	PO	H	
Charadrius vociferus	Killdeer			S5B,SZN	PR	A	A
Tringa flavipes	Lesser Yellowlegs			S4B,SZN	M		M
Tringa melanoleuca	Greater Yellowlegs			S4B,SZN	M	M	
Tringa solitaria	Solitary Sandpiper			S4B,SZN	M	M	
Actitis macularia	Spotted Sandpiper			S5B,SZN	PO	A	H
Scolopax minor	American Woodcock			S5B,SZN	PO		H
Larus philadelphia	Bonaparte's Gull			S4B,SZN	M	M	
Larus delawarensis	Ring-billed Gull			S5B,SZN	X	X	X
Larus argentatus	Herring Gull			S5B,SZN	X	X	X
Sterna caspia	Caspian Tern			S3B,SZN	X	X	
Sterna hirundo	Common Tern			S4B,SZN	X	X	
Zenaida macroura	Mourning Dove			S5B,SZN	PR	T	T
Chaetura pelagica	Chimney Swift	THR		S4B,SZN	PO	H	
Archilochus colubris	Ruby-throated Hummingbird			S5B,SZN	PO		H
Ceryle alcyon	Belted Kingfisher			S5B,SZN	PO	H	
Picoides pubescens	Downy Woodpecker			S5	PR	H	T
Colaptes auratus	Northern Flicker			S5B,SZN	PR	T	T
Empidonax alnorum	Alder Flycatcher			S5B,SZN	PO	T	S
Tyrannus tyrannus	Eastern Kingbird			S5B,SZN	PO	S	
Vireo olivaceus	Red-eyed Vireo			S5B,SZN	PR	T	T
Cyanocitta cristata	Blue Jay			S5	C	H	FY
Corvus brachyrhynchos	American Crow			S5B,SZN	C	H	FY
Tachycineta bicolour	Tree Swallow			S5B,SZN	PO	H	
Stelgidopteryx serripenis	Northern Rough-winged Swallow			S5B,SZN	PO	H	
Hirundo rustica	Barn Swallow	THR		S5B,SZN	PO	H	
Poecile atricapillus	Black-capped Chickadee			S5	C	T	FY
Troglodytes aedon	House Wren			S5B,SZN	PR	T	T
Cistothorus palustris	Marsh Wren			S4B,SZN	PO	S	
Catharus fuscescens	Veery			S4B,SZN	PR	S	A

SCIENTIFIC NAME	COMMON NAME	**COSEWIC**	**OMNR**	**SRANK**	**BREEDING EVIDENCE**	**Present Study**	**Jalava (2005)**
Turdus migratorius	American Robin			S5B,SZN	PR	T	A
Dumetella carolinensis	Gray Catbird			S5B,SZN	PR	S	T
Sturnus vulgaris	European Starling			SE	PO	H	
Bombycilla cedrorum	Cedar Waxwing			S5B,SZN	PO	T	H
Vermivora ruficapilla	Nashville Warbler			S5B,SZN	PR		T
Dendroica petechia	Yellow Warbler			S5B,SZN	PR	T	T
Setophaga ruticilla	American Redstart			S5B,SZN	PR	T	A
Geothlypis trichas	Common Yellowthroat			S5B,SZN	PR	T	A
Spizella passerine	Chipping Sparrow			S5B,SZN	PO	S	
Spizella pusilla	Field Sparrow			S5B,SZN	PR	T	
Passerculus sandwichensis	Savannah Sparrow			S5B,SZN	PR	T	
Melospiza melodia	Song Sparrow			S5B,SZN	C	FY	FY
Melospiza georgiana	Swamp Sparrow			S5B,SZN	PR	S	T
Cardinalis cardinalis	Northern Cardinal			S5	PO	T	S
Passerina cyanea	Indigo Bunting			S5B,SZN	PO		S
Dolichonix orysivorus	Bobolink	THR	THR	S4B,SZN	PO	S	
Agelaius phoeniceus	Red-winged Blackbird			S5B,SZN	PR	NY	T
Quiscalus quiscula	Common Grackle			S5B,SZN	C	H	CF
Icterus galbula	Baltimore Oriole			S5B,SZN	PR	H	T
Carduelis tristis	American Goldfinch			S5B,SZN	PR	S	T

APPENDIX C. REPTILES AND AMPHIBIANS OF THE NORTH KINCARDINE COAST

The following reptiles and amphibians were observed in within the study area during the present study:

Reptiles

Midland Painted Turtle (*Chrysemys picta marginata*) G5 S5– common in inland fen ponds
Eastern Gartersnake (*Thamnophis sirtalis*) G5 S5 – observed in Great Lakes coastal meadow marsh
Northern Ribbonsnake (*Thamnophis sauritus*) COSEWIC-SC, OMNR-SC G5 S3 – one observed in coastal meadow marsh at Baie du Dore

Amphibians

American Toad (*Bufo americanus*) G5 S5 – observed on sand beach ridge at Sunset Drive
Northern Leopard Frog (*Rana pipiens*) G5 S5 – common in Great Lakes coastal meadow marsh
Green Frog (*Rana clamitans*) G5 S5 – occasional in ponds, ditches and shallow, sheltered bays in the study area

Appendix I

Legislation Applicable to Shoreline Activities

Federal and Provincial Legislation Applicable to Shoreline Activities

Planning Act	Provides the ground rules for land use planning in Ontario and describes how land uses may be controlled and who may control them.
Conservation Authorities Act	Provides Conservation Authorities with the jurisdiction to require approval for any activity that may result in filling, the alteration of shorelines, or the construction of buildings and structures in a regulated area, which includes the coastal areas of Lake Huron, wetlands and hazardous lands (floodplain, erosion, dynamic beaches)
Public Lands Act	Provides the Ministry of Natural Resources with authority to regulate any occupation, dredge and fill activity that occurs on Crown shorelands.
Ontario Building Code Act	Provides municipalities with the authority to require the issuance of a building permit for most buildings and structures and to conduct inspections for the construction works.
Fisheries Act	Administered by Fisheries and Oceans Canada, regulations provide that no person shall carry on any work that result in the harmful alteration, disruption or destruction of fish habitat. The Act also provides that no person shall deposit a deleterious substance of any type in water frequented by fish.
Drainage Act	Administered by OMAFRA, this Act provides for two or more owners to enter into a written agreement to construct or improve a drain on their land.
Endangered Species Act	Provides MNR with the authority to require a permit for any activity that may impact a Species at Risk or its habitat.
Environmental Protection Act	Provides many Provincial and municipal agencies with direction for the review and assessment of public works and land management decisions.
Lakes & Rivers Improvement Act	Provides MNR with the authority to regulate activities that may interfere with the flow of water on inland streams, rivers and lake that do not involve Crown land.
Navigable Waters Protection Act	Provides Transport Canada with the authority to regulate any works that may interfere with the public right of navigation and the protection on the environment.
Nutrient Management Act	Provides for the environmentally sustainable use of nutrients through a preventative and proactive planning approach. OMAFRA is responsible for training, certification and approval process and the MOE is responsible for compliance and enforcement.
Ontario Water Resources Act	Provides MOE with the authority to ensure the fair sharing and conservation of water resources through the requirement of a permit to take water.
Municipal Act	Provides municipalities with the tools to pass bylaws to provide "for the protection of the health, safety and well-being of residents in the municipality". This includes the ability to regulate tree cutting on private lands.
Ontario Parks Act	Provides Ontario Parks with the authority to protect natural resources and natural processes in designated provincial parks.
Species at Risk Act	Provides Environment Canada with the authority to require a permit for any activity that may impact a Species at Risk or its habitat.
Health Protection and Promotions Act	Provides through the Ministry of Health and Long Term Care for the implementation of Ontario's ***Beach Management Protocol*** by local health authorities (Grey Bruce Health Unit). Health Units must take water samples at public beaches and post results for the public.

(Adapted from: French, 2010) Note: This is a general list only. Other legislation might be applicable to specific proposals.