Lines in the Sand

A Baseline Assessment of Beach Access Trails and Roads in Rondeau Provincial Park

Ministry of Natural Resources and Forestry
Parks and Protected Areas Policy Section
November 2014

Webpage Title: Lines in the Sand

Webpage description: This document is a baseline assessment of beach access trails and roads in Rondeau Provincial Park

Ontario

Ontario

Table of Contents

Introduction

Rondeau Provincial Park is one of the oldest protected areas in Ontario, established in 1894 (OMNR, 1991). It has the highest number and diversity of species at risk of any Provincial Park in Ontario (Steinberg, 2012). It also includes several critically imperilled ecosystems (Dobbyn and Pasma, 2012). Much of the surrounding region has had natural forest cover removed for agriculture and development (Henson and Brodribb, 2005), making Rondeau particularly important for conserving biodiversity and meeting Ontario's conservation targets.

A long history of use means that many activities have occurred that are no longer permitted by policy in Provincial Parks. One of these legacy uses is the presence of private cottage leases within the Park. Existing management direction to phase out the private leases in 2017 (OMNR, 1991) is controversial, and information is required to fully support any review of existing policies. The purpose of this report is to provide a scientifically sound and measurable snapshot of the state of access trails within imperilled dune and savannah ecosystems, in addition to basic information about roads in the park. This can be used to identify changes in the condition or amount of this infrastructure over time.

This report is a summary and analysis of field work conducted by Ontario Ministry of Natural Resources and Forestry (OMNRF) staff in September 2012 in Rondeau Provincial Park. Further desktop GIS and floristic analysis was conducted by OMNRF staff in 2013.

Objectives

The primary objective of this study is to measure and report on the number and condition of access trails associated with the beach, dune, and savannah ecosystems in Rondeau Provincial Park, and to briefly discuss the context in which this information is relevant. Exotic species and human trampling are threats to coastal dunes, including those in provincial parks (Bakowsky and Henson, 2014). The park management objective for the study area is to maintain open dune and beach bar communities and their natural successional processes, and to restore these values where they have been

degraded from past or current human use impacts (OMNR, 2001). Previous work has identified that invasive species are common at the back of cottage lots in this area of Rondeau, and further investigation into pathways of invasion, including the use of formal and informal trails, has been recommended (Savanta, 2009). This study addresses this previous recommendation and will establish a baseline from which to measure changes over time.

A review of roads within the park has also been conducted, along with a brief discussion as to the context in which this information is relevant.

The study area is also habitat for several species at risk including the Eastern Hognose Snake, Eastern Foxsnake, Fowler's Toad, Common Five-lined Skink, and Common Hoptree. Recreational use, roads, habitat loss and invasive species have already been established as threats to these species (COSEWIC 2007a; 2007b; 2008; 2010). Destruction of dune habitat adjacent to cottage leaseholds in Rondeau has been identified as a threat to some of these species (Dobbyn and Pasma, 2012). By definition, ecological integrity includes healthy and viable populations of native species including species at risk and the maintenance of the habitat on which they depend (PPCRA, 2006). An in-depth discussion of impacts of trails or roads on these species is not in scope for this analysis. However, this study can provide baseline information to inform future studies on changes on the habitat of these species in Rondeau.

The bulk of the trails surveyed (approximately 92% by length) were associated with private cottage leases, with public access trails examined, as well.

This analysis includes three parts. The first is a GIS desktop exercise, mapping and measuring the length and density of trails and roads in Rondeau Provincial Park. The second is a qualitative assessment of access trails, ranking them by width, depth, and damage to vegetation. The third part is a complete plant species assessment of every fourth trail to determine floristic quality, weediness, and wetness, as per Oldham *et al*., (1995).

These three analytical methods can be used to measure changes in the condition of access trails and to inform management objectives for dune and savannah regions of the park. This analysis should be repeated periodically and comparisons made to report on any changes to these features over time.

Study Area

Roads and trails within Rondeau Provincial Park were analyzed as part of this report. This included hiking trails, roads, and both public and private beach access trails. All of the beach access trails examined were on the eastern shore of Rondeau Provincial Park.

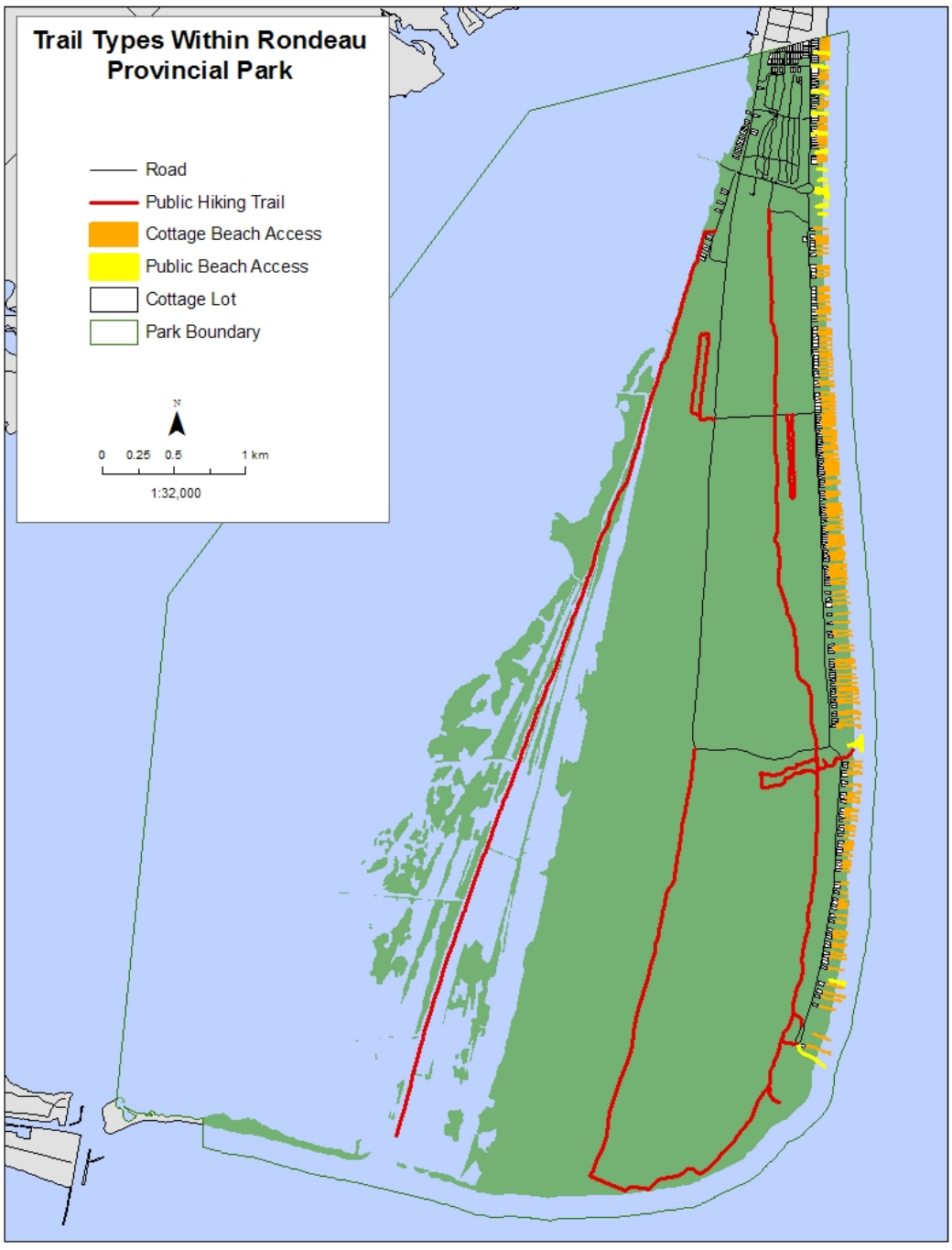

Figure 1 - Trail types examined

GIS Analysis

Roads and trails often are necessary to provide practical access to recreational features in protected areas. However, their existence and use can have impacts on the integrity of ecosystems through a wide suite of impacts. The study of the environmental effects of roads has grown into a branch of science called road ecology (Forman *et al*., 2003). Roads can spread invasive species (Birdsall *et al*., 2012; Meunier and Lavoie, 2012), change the microclimate (Chen *et al*., 1999), impact wildlife populations (Findlay and Houlahan, 1997), stress breeding birds, even at low travel volumes (Dietz *et al*. 2013), increase nest predation (Bassett-Touchell 2008), create barriers that limit the movement of some species (Merriam *et al*., 1989; Marsh *et al*., 2005; Proulx *et al*., 2014; DiLeo *et al*., 2010), in addition to reducing biodiversity (Goetz *et al*., 2009; Findlay and Houlahan 1997).

Many of these environmental pressures can affect the ecological integrity of protected areas (OMNR, 2011), and some of these ecological pressures have been well documented and reported in Rondeau Provincial Park, such as road mortality (Farmer and Brooks, 2012) and the spread of invasive species (Savanta, 2009).

Trails can also spread invasive species (Leung and Marion, 2000), and trails through dune habitats can impair ecological integrity by killing vegetation and causing blowouts (Davidson-Arnott and Ollerhead, 2011). Trampling by humans and the spread of invasive species is a threat to dunes in Ontario, including those in provincial parks (Bakowsky and Henson, 2014), and this pathway of invasion has been recommended to be examined further in Rondeau (Savanta, 2009). In recognition of this pressure, cottage leaseholders have been asked to share trails to reduce the density of this feature in dune habitats (Connor, 2014).

With a wide suite of reported environmental impacts associated with them, the total length of trails and roads, and/or their density, can be used in tandem with assessment of their condition to measure and report on restoration efforts and changes to ecological integrity. Using road density as an indicator of ecological integrity is consistent with approaches used by other protected area agencies (Rivard and Seaby, 2003; Parks Canada 2008). Reducing road density in species at risk habitat is an objective within other provincial parks in Ontario (Cummings, 2015).

Analysis was completed using the computer program ArcGIS 9.3 using data available through Land Information Ontario (LIO) and supplemented by information gathered using hand-held GPS units. Appendix 2 includes a table that summarizes this GIS information in a format that will aid in replicating this study in the future.

Trails

Trail length and disturbance area were examined to set benchmarks for measuring future changes to these features. For the purposes of this calculation, two roads that are used as walking trails by the public have been included. Trails were defined as being visually identifiable walking paths, and varied in width from small paths of 30 cm width to abandoned roads measuring over 5 metres in width.

Table 1 - Access and Hiking Trail Measurements

Trail	Length (km)	Number of trails	Proportion of total
Public hiking	22.4	8	51.61%
Public beach access	1.7	15	3.92%
Cottage beach access	19.3	202	44.47%
Total	43.4	225	100%

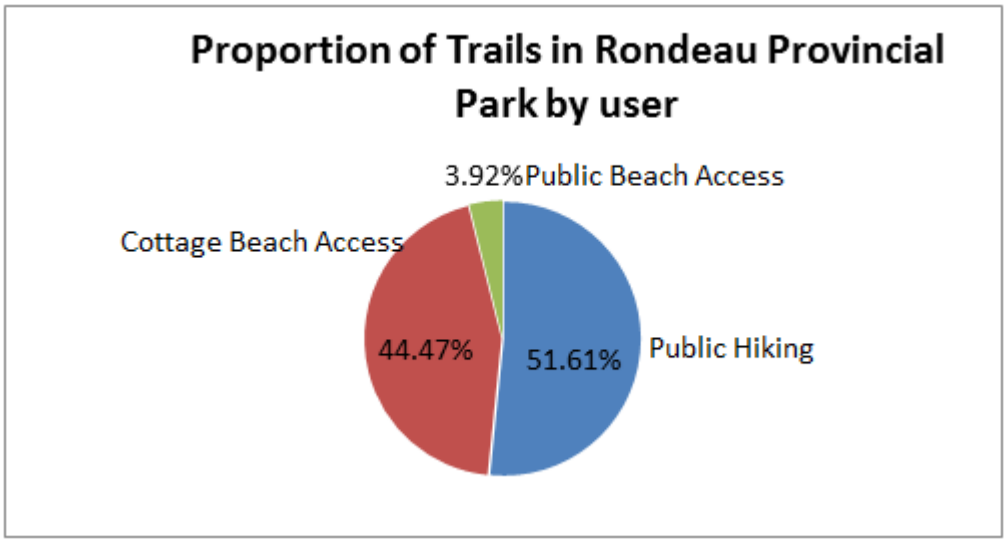

Figure 2 - Proportion of Trails in Rondeau Provincial Park by User

Beach Access Trail Disturbance Area

The sand dune ecosystems through which the public and cottagers access the beach are fragile, imperilled in Ontario, and particularly susceptible to damage and destruction from recreational use (Dobbyn and Pasma, 2012; Bakowsky and Henson, 2014). The area disturbed by access trails was calculated in the beach/dune area in Rondeau Park, and was measured as a percentage of the area that was trail. For ease of analysis, the 7 km stretch of beach was divided up into blocks bounded by public access points. The total area within each block disturbed by trails (both cottage and public) was calculated. These measurements can be used to monitor and report on changes in the amount of disturbance within the dune ecosystem.

Figure 3 - Examination Area 1

Table 2 - Beach Access Trail Disturbance

Segment	% trail	Area (ha)
Public Access 1	5.6	0.9475
Public Access 2	4.3	0.8619
Public Access 3	4.2	1.5486
Public Access 4	5.6	1.2064
Public Access 5	3.7	1.0438
Public Access 6	5.7	1.0083
Public Access 7	5.1	1.1582
Public Access 8a-9b	6.6	3.3689
Public Access 10	5.5	48.2892
Public Access 11	5.6	16.585
Public Access 12	1.3	10.3253

Roads

Rondeau consists of 16.1 square kilometres of terrestrial and wetland habitat. Approximately 29.3 kilometres of road provide access to park features, including access to private cottage leases, giving Rondeau a road density of 1.82 kilometres of road per square kilometre. Not all of these roads are driveable by the public or leaseholders; some have been converted to walking trails. These roads have been included in the overall calculation of road density, as some of the ecological impacts of roads exist independent of use by vehicles (Legros *et al*., 2014; Merriam *et al*., 1989; Marsh *et al*., 2005; Proulx et. al 2014).

While overall road density can be used as an indicator of ecological integrity (Rivard and Seaby 2003; Parks Canada 2008), to date most literature on road density targets in relation to biodiversity conservation focuses on large carnivores, and is not easily transferable to Rondeau Provincial Park. Despite this, there are enough ecological stressors associated with roads that their removal in protected areas is an accepted practice to restore habitat and ecological integrity (Dobbie *et al*., 2007; Parks Canada, 2008).

Rondeau Park officials have implemented seasonal closures of some roads to reduce road mortality on park wildlife. However, 9.9 km of roads within the park provide direct access to cottages and other park features such as the Visitor Centre, and must remain open year-round to allow access. This limits the ability of park staff to mitigate the ecological impacts of some roads on species at risk and other wildlife. It should be noted that the 9.9 km of roads which provide direct access to cottages are also used by park staff and the public. As such, the impacts of these roads cannot be linked to any one user group. Removal and restoration of roads and reduction of road density has been used in other area parks to restore ecological integrity (Dobbie *et al*., 2007).

Fragmentation

Fragmentation occurs when there are barriers to movements of plants and/or animals among habitat patches. This lack of connectivity between habitats can reduce or prevent some species from successfully completing all of their life's processes and can have impacts on biodiversity (Fahrig, 2003). Human development that leads to habitat loss and fragmentation has impacts on biodiversity in reserves (Goetz *et al*., 2009), and is a leading cause of biodiversity loss worldwide (IUCN, 2013).

Discussion

Fragmentation and loss of habitat can occur at multiple scales. Although studies on fragmentation at Rondeau have not occurred, some species that occur at the park have been studied elsewhere and have been shown to be impacted by fragmentation at scales comparable to the park. These include the white-footed mouse (Merriam *et al*., 1989), red-backed salamander (Marsh *et al*., 2005) and Blanding's turtle (Proulx *et al*., 2014). Other studies have shown that mall scale mowing can affect the behaviour of pollinators such as bumblebees (Goverde *et al*., 2002) and change insect diversity (Zschokke *et al*. 2000). Other species may not experience a barrier effect from cottages and roads as the impacts of roads vary based on individual species behaviour and life history.

Reductions in trail and road density would be consistent with ecological restoration activities practiced at nearby Point Pelee National Park, another park in the Carolinian life zone of Ontario that had road infrastructure similar to that of Rondeau, until more than half of the roads were removed and restored to improve ecosystem function (Dobbie *et al*., 2007). The trail and road lengths referenced in this report can be used as

a benchmark to track changes through time. Additionally, other tools such as using computer modelling (Koen *et al*., 2014) to measure the connectivity within Rondeau Provincial Park would be useful in determining priority areas for restoration of ecological integrity.

Floristic Quality Assessment Index

The Floristic Quality Assessment Index (FQI) is a conservation tool used to evaluate biodiversity in natural areas through the diversity of plant species encountered (Oldham *et al*., 1995). Every plant species is assigned a numerical value based on its habitat preferences, wetness tolerance, and weediness. These numbers can be used to compare two or more natural areas or to analyze change within a natural area over time. FQI was used to assess access trails on the lakeshore (east) side of Rondeau Provincial Park. These access trails included both public and cottage trails used to travel through savannah and sand dune habitats to the beach.

FQI assessment does have some limitations. While FQI is a convenient and replicable approach to assigning a score to a natural area, and is useful for comparisons and tracking change, it does not track changes in the populations of a plant species, simply presence of species. As such, it should be used as one of the tools to inform the tracking of access trail conditions, not as the sole indicator.

A second limitation in this case is the lack of a control site, or survey work conducted in non-trail areas. As a result, comparing the FQI or weediness of trails to non-trailed natural areas cannot be conducted as part of this analysis. In depth sampling for invasive species has already occurred in Rondeau (Savanta, 2009), and recommendations are contained within that report. Future FQI work in Rondeau should include staff with similar expertise, be conducted at the same time of year (mid-September), and should include control sites to better gauge the difference between trails and natural areas.

Floristic Quality Index

Field work was completed over a three-day period in September 2012. Two botanical experts from the Ministry of Natural Resources and Forestry, each with over 20 years of experience in identifying plants, including grasses and sedges, and with extensive

familiarity with the ecosystems being surveyed, completely surveyed all plant species encountered on every fourth access trail. Six person-days of effort (for a total of 48 person-hours) were expended completing this survey during mid-September 2012.

All plant species recorded within 1 metre of either side of the trail were identified, recorded and subsequently summarized in Microsoft Excel 2010. A total of 57 trails was completely surveyed, with a total of 164 plant species recorded. Of these, 54 species were non-native or invasive plant species.

Each plant species has a coefficient of conservatism value, as per Oldham *et al*., (1995) related to its habitat requirements, and the mean coefficient of conservatism was calculated for each trail, and for the entire trail network. A Floristic Quality Index was calculated by multiplying the mean coefficient of conservatism with the square root of the total number of native plant species documented, or FQI = (Mean C) x √N(native).

Wetness

In addition to a co-efficient of conservatism, each plant species found in Ontario has been assigned a coefficient of wetness. This Wetness coefficient is a numerical ranking of how moisture-tolerant plants are, and can be useful in determining wetland boundaries. In the case of trail assessment in Rondeau, the dune and savannah ecosystems through which the trails run are primarily sandy and dry. Changes in mean wetness over time can be used in addition to other measures to elucidate vegetation responses to changing lake levels or precipitation. As trampling of plants may lead to water-stress and frost damage (Bowles and Maun, 1982) changes in the mean wetness may also indicate changes in trail use. This indicator should not be used in isolation – rather it can be used to indicate areas for further study.

Weediness

Non-native species in Ontario have been assigned a ‘weediness’ value, based on how invasive they are. While many non-native plant species in Ontario have been introduced over time and persist on the landscape, only a few are invasive enough to create a conservation concern by out-competing native species and changing ecosystem composition. The weediness index can be used to measure the changes in the number of alien and invasive species along trails in the dune and savannah

ecosystems in Rondeau Provincial Park. Mean weediness was calculated for each trail, and for the entire site.

Results

Table 3 - Floristic Quality Assessment of beach access trails in Rondeau Provincial Park.

Trail ID (* = public beach access trails)	Sum C	Mean C	Mean C (w/adventive)	N	N (native)	N (adventive)	Mean Wetness (w/adventives)	Mean Wetness (native)	Weediness
1-1	94	4.7	3.48	27	20	7	2.22	1.6	-2.14
1-5	115	3.97	2.95	39	29	10	2.15	1.66	-2
1-8	77	4.53	3.5	22	17	5	2.18	1.77	-1.8
1-12	93	4.23	3.21	29	22	7	2.03	1.41	-1.86
1-16	78	3.9	2.89	27	20	7	1.85	1.1	-2.29
1-20	81	5.06	4.05	20	16	4	1.95	1.31	-2.25
1-24	50	3.33	2.27	22	15	7	1.86	1.2	-2.43
1-28	47	4.27	2.94	16	11	5	1.31	0.45	-2.2
1-32	60	3.75	2.86	21	16	5	2.33	1.69	-2
1-36	68	4.53	3.78	18	15	3	1.38	0.87	-2.67
1-40*	139	4.21	3.16	44	33	11	2.31	1.79	-1.81
1-44*	140	4.38	3.18	44	32	12	1.63	1.19	-2
1-48	138	4.45	3.29	42	31	11	2.38	1.97	-2.27
1-51	129	5.61	3.91	33	23	10	2.57	2.17	-1.9
1-55	94	4.27	3.36	28	22	6	1.57	1.14	-2.17
1-59	103	4.48	3.43	30	23	7	2.4	1.87	-2.57
1-63	109	4.19	3.41	32	26	6	1.9	1.46	-2.33
1-67	119	4.25	3.31	36	28	8	2.55	2.25	-2.25
1-71	118	4.92	4.21	28	24	4	1.75	1.5	-2.5
1-75	94	5.22	4.7	20	18	2	1.75	1.5	-2.5
2-19	107	4.28	3.06	35	25	6	2.22	1.36	-2.7
2-3	72	4.5	3.43	21	16	5	2.66	2.43	-2.2

Trail ID (* = public beach access trails)	Sum C	Mean C	Mean C (w/adventive)	N	N (native)	N (adventive)	Mean Wetness (w/adventives)	Mean Wetness (native)	Weediness
2-7	97	4.62	3.13	31	21	10	2.32	2.19	-1.6
2-11	71	4.44	3.94	18	16	2	2.27	2.1	-2.5
2-15	79	4.16	2.72	29	19	10	2.31	1.79	-2
2-23	88	4.4	3.38	26	20	6	2.38	1.85	-2.5
2-27	102	5.1	3.92	26	20	6	2.46	2.1	-1.83
2-31	70	85	3.68	19	14	5	2.42	1.86	-2
2-35	54	4.15	2.7	20	13	7	2	1.15	-1.57
2-39	76	4.75	3.8	20	18	2	2.75	2.38	-2
2-43	66	5.06	4.71	14	13	1	2.35	2.31	-3
2-47	69	4.93	3.63	19	14	5	2.89	2.86	-2.4
2-51	91	4.33	3.37	27	21	6	1.96	1.19	-2
2-55	63	3.94	3	21	16	5	1.52	1.13	-2.4
2-59	57	4.07	3.35	17	14	3	1.64	1.29	-2.33
2-63	76	4.75	4.22	18	16	2	2.16	2.13	-2.5
2-67	89	4.94	4.05	22	18	4	1.86	1.22	-2.5
2-71	88	4.4	3.38	26	20	6	2.38	1.75	-2.33
2-75	101	4.81	4.04	25	21	4	1.88	1.38	-2.25
2-79	102	5.1	4.43	23	20	3	2.73	2.75	-2
2-82	80	4.21	3.48	23	19	4	1.91	1.59	-1.75
2-87	48	3.69	3	16	13	3	2.12	1.47	-2.33333
291	83	4.37	3.96	21	19	2	0.52	0.11	-2
2-95	120	4.29	3.87	31	28	3	1.96	1.71	-2.67

Trail ID (* = public beach access trails)	Sum C	Mean C	Mean C (w/adventive)	N	N (native)	N (adventive)	Mean Wetness (w/adventives)	Mean Wetness (native)	Weediness
2-99*	57	4.75	4.38	13	12	1	0.61	0.42	-3
3-3	87	4.83	2.9	30	18	12	2.36	2.28	-1.75
3-8	75	5.36	5	15	14	1	2.13	1.86	-3
3-12	79	6.06	4.65	17	13	4	2.88	2.92	-2.5
3-16	56	5.6	4.67	12	10	2	2.16	1.8	-3
3-20	47	3.92	2.61	18	12	6	2.72	2.25	-2.33
3-24	75	3.95	3.41	22	19	3	1.68	1.32	-3
3-29	95	4.32	3.8	25	22	3	2.36	2.09	-2.67
3-33	107	5.1	4.65	23	21	2	2.65	2.52	-2
3-37	100	5	4.35	23	20	3	2.34	2.05	-2.33
3-41*	84	4.42	3.36	25	19	6	0.88	0.32	-1.67
3-45	125	4.81	4.17	30	26	4	1.5	1	-2.25

Table 4 - Floristic Quality Summary of Beach Access Trails in Rondeau Provincial Park

Total Native Species (includes hybrids)	109
Total Alien/invasive species	56
Total Alien/invasive species on cottage trails	52
Total Alien/invasive species on public trails	24
Total species	164
Mean Number of Species per trail	24.5
Mean Coefficient of Conservatism (native species only)	5.96
Mean Coefficient of Conservatism (with alien/invasive species)	3.63
Floristic Quality Index (native species only)	62.29
Floristic Quality Index (with adventives)	37.85
Mean Wetness (native species only)	2.05
Mean Wetness (with adventives)	1.63
Mean Weediness	-2.26

Discussion

The information in Tables 5 and 6 can be used to monitor changes in the condition of beach access trails in Rondeau Provincial Park. A subsequent survey following similar protocols should be conducted periodically and compared against the 2012 benchmark. As invasive species and human trampling are both threats to dune ecosystems (Bakowsky and Henson, 2014), changes in the Floristic Quality Index (both with and without adventives) can be used in conjunction with trail condition, length and area to assess changes in the ecological integrity of these trails over time.

Weediness is another factor that can be used to measure changes on these trails. All of the trails surveyed had non-native or invasive species on them to varying degrees, which is not surprising considering that previous survey work had identified non-native plants at all survey sites within Rondeau (Savanta, 2009). Some of the species encountered as part of the survey included garden plants that had escaped and are colonizing trails such as Yucca (*Yucca filamentosa*) identified in Figure 4. The mean

weediness of the beach access trails was -2.26. Non-native and alien species are ranked by their invasiveness and propensity to spread with -1 being low and -3 being high. A score of -2.26 is on the higher end of the scale.

The wetness coefficient can also be used to identify potential changes in hydrology, precipitation or trail use for further study.

It is important to note that none of these indicators should be used in isolation. Rather, the FQI, wetness and weediness can be used together with the qualitative analysis, and compared against control sites to measure changes in trail condition and composition.

Figure 4 - Escape of the exotic ornamental plant *Yucca filamentosa* from cottage leasehold in Rondeau Provincial Park. Yellow circles identify spreading plants.

Qualitative Analysis

A qualitative assessment was completed on a total of 221 beach access trails that cross through the endangered dune and savannah ecosystems of Rondeau Provincial Park. This assessment was conducted concurrently with the Floristic Quality Assessment in September 2012. It was conducted by MNRF ecologist and biologist staff during mid-September 2012 and involved 9 person days (72 person-hours) of field work. This

qualitative assessment was modified from protocols developed by Parks Canada to measure ecological integrity within dune ecosystems in Prince Edward Island National Park (Wagener and Giroux, in prep).

A total of 220 beach access trails were photographed and evaluated. These photographs are on file with the Parks and Protected Areas Policy Section of the MNRF. Of the trails surveyed, 15 were public access trails and the remainder were associated with private cottage leases in Rondeau Provincial Park. Each one of these trails was assessed for width, depth, and presence of damaged vegetation. The presence of 'blowouts' or areas where vegetation loss has resulted in dune erosion, was also noted. Each criterion (width, depth, and vegetation damage) was given a rank of 0-4 depending on severity, according to the following table:

Table 5 - Access Trail Assessment Form

Rank	Trail Width (m)	Trail depression (m)	Vegetation damage
0 (no impact)	0	none	Intact
1	0-0.5	Slight (0-.05)	Flattened alive
2	0.5-1	Moderate (.05-.1)	Flattened dead
3	>1		
4 (severe impact)		Severe (>.1)	No plants

A condition ranking is determined for every trail by adding together the scores and calculating the mean condition for each trail. Data collected for each trail can be found in Appendix 1; Table 8 provides a summary.

Figure 5 - Variation in beach access trail size and condition

Figure 6 - Variation in beach access trail size and condition

Results

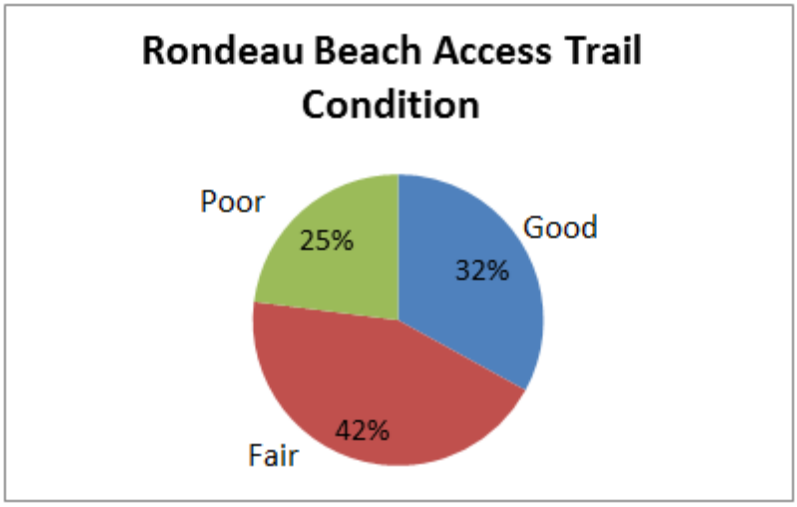

Figure 7 - Beach access trail condition

Table 6 - Trail condition summary

Number of public trails evaluated	15
Number of cottage trails evaluated	206
Cottage trails with obvious off-lot vegetation management (mowing, etc.)	28
Cottage trail blowouts - Vegetated	105
Cottage trail blowouts - Active	33
Public trail blowouts - Vegetated	7
Public trail blowouts - Active	3
Average condition cottage trails	1.42
Average condition public trails	1.57
Number of poor condition trails (≥2)	55

Number of fair condition trails (>1<2)	94
Number of good condition trails (≤1)	72
Public Beach access trails - Length	1.7 km
Public Beach access trails -Proportion	8%
Cottage Beach access trails - Length	19.3 km
Cottage Beach access trails - Proportion	92%

Discussion

The average condition of beach access trails associated with private cottage leases is slightly better than that of public trails. This is not unexpected as the volume of use on public trails is significantly higher than that on cottage trails. Despite this slight difference in condition, the cumulative effect of these cottage trails is greater than the public trails, simply due to scale; cottage trails outnumber public trails tenfold in total length and their spatial arrangement is such that a large area of dunes is exposed to human traffic, an identified threat to dunes (Bakowsky and Henson, 2014). These trails can be expected to grow in length over time because the dunes in Rondeau are growing in size as sand accumulates on the beach and is blown inland (OMNR, 2013), and access to the beach will be farther away.

There is evidence of over 130 ‘blowouts’ on trails where vegetation has died and parts of the dune have blown away. Analysis of historic photographs has revealed that there is less disturbance today than there was historically, and that dunes can recover from this type of disturbance (OMNR, 2013). Opportunities to reduce the number and length of trails, and to actively or passively rehabilitate them, is consistent with the goals of the park (Connor 2014), and will reduce these known threats to dune ecosystems in Rondeau Provincial Park.

Summary

The purpose of this report is to summarize baseline information for use in tracking change associated with beach access trails and roads in Rondeau Provincial Park. Periodic re-assessment should occur following the same protocols and with equally skilled staff. As noted, the establishment of control sites in natural areas would make the FQI analysis stronger and more relevant.

Used together, the three assessment techniques summarized in this report can be used to elucidate changes in trails over time. This report summarizes the total area disturbed by trails, the total length of trails, the density of roads and trails, the number of native, non-native and invasive species on trails, and the condition of these trails, including length, width, and the number of blowouts. All features have been mapped and are available in a digital, GIS format.

Other studies of recreational trails in dunes have noted that numerous, low use trails can have a greater impact than those under high visitor use (Kutiel *et al*., 2000). A future study using this baseline information and following the same assessment techniques will note changes in trail condition and inform success of the park in meeting its objective to “maintain open dune and beach bar communities and their natural successional processes, and to restore these values where they have been degraded from past or current human use impacts”.

References

Bakowsky, W.D. and B.L. Henson. 2014. Rare Communities of Ontario: Freshwater Coastal Dunes. Natural Heritage Information Centre. Ontario Ministry of Natural Resources. 10pp + appendices.

Bassett-Touchell, C. A. 2008. Anthropogenic influences on the ecology of forest songbirds within Sleeping Bear Dunes National Lakeshore: focusing on roads. PhD thesis. Michigan Technological University, Ann Arbor, MI.

Birdsall, J. L., W. McCaughey, and J. B. Runyon. 2012. Roads impact the distribution of noxious weeds more than restoration treatments in a lodgepole pine forest in Montana, USA. Restoration Ecology 20: 517-523.

Bowles, J.M. and M.A. Maun. 1982. A study of the effects of trampling on the vegetation of Lake Huron sand dunes at Pinery Provincial Park. Biological Conservation 24: 273-283.

Chen, Jiquan, S.C. Saunders, T.R. Crow, R. J. Naiman, K.K. Brosofske, G.D. Mroz, B.L. Brookshire, and J.F. Franklin, J.F. 1999. Microclimate in Forest Ecosystem and Landscape Ecology – Variations in local climate can be used to monitor and compare the effects of different management regimes. BioScience 49(4): 288-297.

Connor, Brad. 2014. Rondeau Leaseholder Welcome Letter. Rondeau Provincial Park, Morpeth Ontario. 4pp.

COSEWIC. 2007a. COSEWIC Assessment and Update Status Report on the Eastern Hog-nosed Snake Heterodon platirhinos in Canada. Committee on the Status of Endangered Wildlife in Canada. viii + 36 pp.

COSEWIC. 2007b. COSEWIC Assessment and Update Status Report on the Five-lined Skink Eumeces fasciatus (Carolinian population and Great Lakes/St. Lawrence population) in Canada. Committee on the Status of Endangered Wildlife in Canada. vii + 50 pp.

COSEWIC. 2008. COSEWIC Assessment and Update Status Report on the Eastern Foxsnake, Elaphe gloydi, Carolinian Population and Great Lakes/St. Lawrence

Population, in Canada. Committee on the Status of Endangered Wildlife in Canada. vii + 45 pp.

COSEWIC. 2010. COSEWIC assessment and status report on the Fowler's Toad Anaxyrus fowleri in Canada. Committee on the Status of Endangered Wildlife in Canada. vii + 58 pp.

Cummings, G. 2015. Ten-Year Forest Management Plan for the Algonquin Park Forest Management Unit, Phase II Planned Operations 2010-2020. Ministry of Natural Resources and Forestry, Southern Region and Algonquin Forestry Authority. 90pp.

Davidson-Arnott, R. and J. Ollerhead. 2012. Coastal dune integrity monitoring protocol. PEINP Ecological Integrity Monitoring program. PEINP, Charlottetown PEI. Unpublished manuscript.

Dietz, M. S., C.C. Murdock, M.L. Romero, A. Ozgul, and J. Foufopoulos. 2012. Distance to a Road is Associated with Reproductive Success and Physiological Stress Response in a Migratory Landbird. The Wilson Journal of Ornithology, 125(1): 50-61.

Dileo, M.F., J.R. Row, and S.C. Lougheed. 2010. Discordant patterns of population structure for two co-distributed snake species across a fragmented Ontario landscape. Diversity and Distributions 16: 571-581.

Dobbie, T., T. McFadyen, , P. Zorn, J. Keitel, and M. Carlson. 2007. Point Pelee National Park of Canada State of the Park Report 2006. Parks Canada. 51pp.

Dobbyn, S. and L. Pasma. 2012. A life science inventory and evaluation of Rondeau Provincial Park. Ontario Parks, Southwest Zone. 206pp.

Fahrig, L. 2003. Effects of habitat fragmentation on biodiversity. Annual Review of Ecology and Systematics. Ecology and Society 14(1): 21.

Farmer, R. G. and R. J. Brooks. 2012. Integrated risk factors for vertebrate roadkill in southern Ontario. The Journal of Wildlife Management 76: 1215-1224.

Findlay, S. and J. Houlahan. 1997. Anthropogenic correlates of species richness in southeastern Ontario wetlands. Conservation Biology 11: 1000-1009.

Forman, R.T.T., Spering, D., Bissonette, J.A., Clevenger, A.P., Cutshall, C.D., Dale, V.H., Fahrig, L., France, R., Goldman, C.R. Heanue, K., Jones, Swanson, F.J., Turrentine, T., Winter, T.C. 2003. Road Ecology, Science and Solutions. Island Press. Washington, DC, USA. Pp104-105, 130-133.

Goetz, S. J., P. Jantz, and C. A. Jantz. 2009. Connectivity of core habitat in the Northeastern United States: Parks and protected areas in a landscape context. Remote Sensing of Environment 113: 1421-1429.

Goverde, M., Schweizer, K., Baur, B., and A. Erhardt. 2002. Small-scale habitat fragmentation effects on pollinator behaviour: experimental evidence from the bumblebee Bombus veteranus on calcareous grasslands. Biological Conservation 104(3): 293-299.

Henson, B. L. and K. E. Brodribb. 2005. Great Lakes Conservation Blueprint for Terrestrial Biodiversity, Volume 2: Ecodistrict Summaries.

International Union for the Conservation of Nature. 2013. Why is biodiversity in crisis? <http://www.iucn.org/iyb/about/biodiversity_crisis/> accessed April 2013.

Koen, E. L., Bowman, J., Sadowski, C., and A. Walpole. 2014. Landscape connectivity for wildlife: development and validation of multispecies linkage maps. Methods in Ecology and Evolution 2014, (5) 626-633.

Kutiel, P., Zhevelev, H. and R. Harrison. 1999. The effect of recreational impacts on soil and vegetation of stabilised Coastal Dunes in the Sharon Park, Israel. Ocean & Coastal Management 42 (1999) 1041-1060.

LeGros D, Steinberg B, Lesbarrères D. 2014. Out of the Woods: Mitigating Negative Impacts of Unused Forest Roads on Amphibians with Woody Debris. J Biodivers Manage Forestry 3:1.Volume 3

Leung, Yu-Fai. And Marion, J.L. 2000. Recreation Impacts and Management in Wilderness: A State of Knowledge Review. USDA Forest Service Proceedings RMRS-P-15-Vol5.

Marsh, D.M., G.S. Milam, N.P. Gorham and N.G. Beckman. 2005. Forest roads as partial barriers to terrestrial salamander movement. Conservation Biology. 19: 2004-2008.

Merriam, G., K. Michal, E. Tsuchiya, and K. Hawley. 1989. Barriers as boundaries for metapopulations and demes of Peromyscus leucopus. Landscape Ecology 29:227-35.

Meunier, G. and C. Lavoie. 2012. Roads as corridors for invasive plant species: new evidence from smooth bedstraw (Galium mollugo). Invasive Plant Science and Management 5: 92-100.

Oldham, M.J., W.D. Bakowsky and D.A. Sutherland. 1995. Floristic Quality Assessment System for Southern Ontario. Natural Heritage Information Centre. Ont. Min. Nat. Resour. Peterborough Ontario. Unpublished Manuscript. 23p.

Ontario Ministry of Natural Resources. 1991. Rondeau Provincial Park Management Plan. Morpeth Ontario. 47pp.

Ontario Ministry of Natural Resources. 2013. Coastal Vegetation and Dune Disturbance Change Analysis for Rondeau Provincial Park, 1955-2006. Parks and Protected Area Policy Section, Natural Heritage, Lands and Protected Spaces Branch, Ontario Ministry of Natural Resources. Unpubl. Rep. 19pp.

Ontario Ministry of Natural Resources. 2011. State of Ontario's Protected Areas Report. Parks and Protected Areas Policy Section, Natural Heritage, Lands and Protected Spaces Branch. Peterborough. 82 p.

Ontario Parks. 2001. Rondeau Vegetation Management Plan. Morpeth Ontario. Queens Printer for Ontario. 69pp.

Parks Canada and the Canadian Parks Council. 2008. Principles and Guidelines for Ecological Restoration in Canada's Protected Natural Areas. 98pp.

Proulx, C.L., G. Fortin, and G. Blouin-Demers. 2014. Blanding's turtles (Emydoidea blandingii) avoid crossing unpaved and paved roads. Journal of Herpetology 48(2): 267–271.

Savanta, Inc. 2009. Lake Erie Sand Spit Savannas and Species at Risk: Invasive Species Inventory and Vegetation Restoration Strategy. St. Catherines, Ontario. Unpubl. Rep. 149 p.

Seaby M and Rivard D. 2003. Using geographic information system (GIS) technology to study the impacts of roads on Canada's national parks. Road Ecology Center, John Muir Institute of the Environment, UC Davis. In: Proceedings of the 2003 International Conference on Ecology and Transportation, Eds. Irwin CL, Garrett P, McDermottt KP. Centre for Transportation and the Environment, North Carolina State University, Raleigh, NC.

Steinberg, B.D. 2012. Species at Risk in Ontario Parks. Parks and Protected Areas Policy Section, Natural Heritage, Lands and Protected Spaces Branch. Peterborough Ont. Unpubl. Rep. 40 p.

Wagener, D. and P. Giroux. (in prep). Unauthorized trail monitoring protocol: PEI National Park Ecological Integrity Monitoring Program. Unpublished manuscript. Parks Canada.

Zschokke, S., Dolt, C., Rusterholz, H-P., Oggier, P., Braschler, B., Thommen G.H., Ludin, E., Erhardt, Baur, B. 2000. Short-term responses of plants nad invertebrates to experimental small-scale grassland fragmentation. Oecologica 125(4); 559-572.

Appendix 1- Beach Access Trail Qualitative assessment information

Section	Access Type	Trail Width (m)	Trail Depression (m)	Vegetation Damage (off trail)	Trail Condition	Blowout (V or U)
						Section one; Most disturbance/vegetation blow out primarily from bissecting (N-S) deer trails.
1-1	Cottage	1	1	0	0.666667	V
1-2	Cottage	2	1	0	1	
1-3	Cottage	1	1	0	0.666667	
1-4	Cottage	1	1	0	0.666667	
1-5	Cottage	1	1	0	0.666667	
1-6	Cottage	1	1	0	0.666667	
1-6b	Public	2	2	0	1.333333	
1-7	Cottage	2	2	0	1.333333	
1-8	Cottage	2	2	0	1.333333	U,V
1-9	Cottage	2	2	0	1.333333	V
1-10	Public	3	3	0	2	
1-11	Cottage	2	1	0	1	
1-12	Cottage	2	1	0	1	
1-13	Cottage	2	2	Mowed veg 2	2	
1-14	Cottage	2	2	Mowed veg 2	2	
1-15	Cottage	2	1	Mowed veg 2	1.666667	

Section	Access Type	Trail Width (m)	Trail Depression (m)	Vegetation Damage (off trail)	Trail Condition	Blowout (V or U)
1-16	Cottage	1	2	0	1	
1-17	Public	3	2	0	1.666667	U
1-18	Cottage	3	3	3	3	
1-19	Cottage	2	1	0	1	
1-20	Cottage	2	2	0	1.333333	
1-21	Cottage	2	2,3	0	1.5	
1-22	Public	3	1	0	1.333333	
1-23	Cottage	1	2	0	1	
1-24	Cottage	2	2,3	Mowed veg 2	2.166667	
1-25	Cottage	1	2	0	1	
1-26	Cottage	2	1	0	1	
1-27	Cottage	1	2	0	1	V
1-28	Cottage	1	2	0	1	
1-29	Public	3	3	0	2	
1-30	Cottage	2	3	Mowed veg 2	2.333333	
1-31	Cottage	2	2	0	1.333333	
1-32	Cottage	2	2	0	1.333333	
1-33	Cottage	2	2	0	1.333333	
1-34	Cottage	1	2	0	1	
1-35	Public	2	2	0	1.333333	
1-36	Former Cottage	1	1	0	0.666667	
1-37	Cottage	1	2	0	1	
1-38	Cottage	2	2	0	1.333333	

Section	Access Type	Trail Width (m)	Trail Depression (m)	Vegetation Damage (off trail)	Trail Condition	Blowout (V or U)
1-39	Cottage	1	2	0	1	
1-40	Public	3	2	0	1.666667	V
Section	Access Type	Trail Width (m)	Trail Depression (m)	Vegetation Damage (off trail)	Trail Condition	Blowout (V or U)
1-41	Public	2	3	0	1.666667	
1-42	Public	3	2	0	1.666667	U
1-43	Public	0,1	1	0	0.5	
1-44	Public	3	3	0	2	V,V
1-45	Public	3	3	0	2	U
1-46	Cottage	2	2	0	1.333333	U
1-47	Cottage	2	2	0	1.333333	U (flattened/dead)
1-48	Cottage	2	2	0	1.333333	
1-49	Cottage	2	2	0	1.333333	
1-50	Cottage	2	2	0	1.333333	
1-51	Cottage	2	2	0	1.333333	U
1-52	Cottage	2	1	0	1	
1-53	Cottage	1	1	0	0.666667	
1-54	Cottage	2	2	Mowed veg 2	2	
1-55	Cottage	1	2	0	1	
1-56	Cottage	2	2	Mowed veg 2	2	V,V
1-57	Cottage	2	2,3	0	1.5	V
1-58	Cottage	2	2	Mowed veg 2	2	U

Section	Access Type	Trail Width (m)	Trail Depression (m)	Vegetation Damage (off trail)	Trail Condition	Blowout (V or U)
1-59	Cottage	2	2	0	1.333333	V,V
1-60	Cottage	2	2	0	1.333333	V,V
1-61	Cottage	2	2	0	1.333333	V,V
1-62	Cottage	3	2	0	1.666667	U,U
1-63	Cottage	2	2	Mowed Veg 2	2	
1-64	Cottage	1	2	0	1	
1-65	Cottage	2	2	0	1.333333	
1-66	Cottage	3	2	0	1.666667	
1-67	Cottage	1	1	0	0.666667	
1-68	Cottage	2	2	0	1.333333	V,V
1-69	Cottage	1	1	0	0.666667	
1-70	Cottage	2	2	0	1.333333	U,U
1-71	Cottage	3	3	Mowed veg 2	2.666667	U,U
1-72	Cottage	3	2	0	1.666667	
1-73	Cottage	2	2	0	1.333333	V
1-74	Cottage	1	1	0	0.666667	V
1-75	Cottage	2	2	0	1.333333	V
1-76	Cottage	2	2	0	1.333333	
2-1	Cottage	4	2	0	2	
2-2	Cottage	3	3	2 Mowed Alive Veg	2.666667	
2-3	Cottage	3	3	0	2	V
2-4	Cottage	3	3	0	2	
2-5	Cottage	2	2	0	1.333333	

Section	Access Type	Trail Width (m)	Trail Depression (m)	Vegetation Damage (off trail)	Trail Condition	Blowout (V or U)
2-6	Cottage	3	3	0	2	
2-7	Cottage	2	2	0	1.333333	V
2-8	Cottage	3	2	2 Mowed Alive Veg	2.333333	
2-9	Cottage	2	2	0	1.333333	
Section	Access Type	Trail Width (m)	Trail Depression (m)	Vegetation Damage (off trail)	Trail Condition	Blowout (V or U)
2-10	Cottage	3	2	0	1.666667	V - slight vegetation
2-11	Cottage	3	3	0	2	
2-12	Cottage	3	2	0	1.666667	
2-13	Cottage	2	3	2 Mowed Alive Vegetation	2.333333	
2-14	Cottage	3	3	0	2	V
2-15	Cottage	3	2	2 Mowed Alive Veg	2.333333	
2-16	Cottage	2	1	0	1	
2-17	Cottage	3	2	2 Mowed Alive Veg	2.333333	U
2-18	Cottage	3	3	0	2	U,U
2-19	Cottage	2	2	0	1.333333	
2-20	Cottage	2	2	0	1.333333	
2-21	Cottage	3	2	0	1.666667	
2-22	Cottage	2	1	0	1	
2-23	Cottage	2	1	0	1	V
2-24	Cottage	2	1	0	1	

Section	Access Type	Trail Width (m)	Trail Depression (m)	Vegetation Damage (off trail)	Trail Condition	Blowout (V or U)
2-25	Cottage	2	1	0	1	
2-26	Cottage	2	1	0	1	
2-27	Cottage	3	2	0	1.666667	V
2-28	Cottage	3	2	0	1.666667	V
2-29	Cottage	3	1	0	1.333333	V,V,U
2-29b	Cottage	3	1	4 No plants south	2.666667	U
2-30	Cottage	2	1	4 No plants northside	2.333333	U
2-31	Cottage	2	2	0	1.333333	
2-32	Cottage	2	3	2 Cut along boardwalk	2.333333	
2-33	Cottage	3	3	0	2	
2-34	Cottage	3	3	0	2	
2-35	Cottage	2	2	0	1.333333	V
2-36	Cottage	2	1	0	1	
2-36b	Cottage	3	2	0	1.666667	
2-37	Cottage	3	2	0	1.666667	V
2-38	Cottage	3	3	2 Mowed Alive	2.666667	U,V
2-39	Cottage	3	2	0	1.666667	U
2-40	Cottage	2	3	0	1.666667	V,V
2-41	Cottage	2	2	0	1.333333	
2-42	Cottage	2	2	0	1.333333	U
2-43	Cottage	2	3	0	1.666667	V
2-44	Cottage	3	2	0	1.666667	V

Section	Access Type	Trail Width (m)	Trail Depression (m)	Vegetation Damage (off trail)	Trail Condition	Blowout (V or U)
2-45	Cottage	3	2	0	1.666667	V
2-46	Cottage	2	2	0	1.333333	
2-47	Cottage	3	3	0	2	V
2-48	Cottage	3	3	0	2	V,V
2-49	Cottage	3	3	0	2	V
2-50	Cottage	3	2	0	1.666667	V
2-51	Cottage	3	2	0	1.666667	V
Section	Access Type	Trail Width (m)	Trail Depression (m)	Vegetation Damage (off trail)	Trail Condition	Blowout (V or U)
2-52	Cottage	3	2	2 Mowed Alive	2.333333	V
2-53	Cottage	3	2	0	1.666667	
2-54	Cottage	3	1	2 Some Mowed Alive Vegetation	2	
2-55	Cottage	1	1	0	0.666667	
2-56	Cottage	2	1	0	1	V
2-57	Cottage	2	2	2 Mowed Alive	2	V
2-58	Cottage	2	1	0	1	V
2-59	Cottage	2	2	0	1.333333	
2-60	Cottage	2	1	2 Mowed Alive	1.666667	V
2-61	Cottage	4	3	0	2.333333	V
2-62	Cottage	3	2	0	1.666667	
2-63	Cottage	2	3	0	1.666667	

Section	Access Type	Trail Width (m)	Trail Depression (m)	Vegetation Damage (off trail)	Trail Condition	Blowout (V or U)
2-64	Cottage	2	2	0	1.333333	V,V
2-65	Cottage	2	1	0	1	
2-66	Cottage	3	3	0	2	
2-67	Cottage	2	2	0	1.333333	
2-68	Cottage	2	2	0	1.333333	
2-69	Cottage	3	1	0	1.333333	
2-70	Cottage	2	2	0	1.333333	V,V
2-71	Cottage	3	3	0	2	V
2-72	Cottage	3	3	0	2	V,V
2-73	Cottage	2	1	0	1	
2-74	Cottage	1	1	0	0.666667	
2-75	Cottage	2	2	0	1.333333	V
2-77	Cottage	2	1	0	1	
2-78	Cottage	4	3	0	2.333333	V
2-79	Cottage	2	2	0	1.333333	
2-80	Cottage	2,3	3	0	1.833333	V
2-81	Cottage	2	3	0	1.666667	V
2-82	Cottage	3	3	0	2	V
2-84	Cottage	2	2	0	1.333333	V
2-85	Cottage	2	1	0	1	
2-86	Cottage	2	1	0	1	
2-87	Cottage	2	1	0	1	V
2-88	Cottage	2	1	0	1	V
2-89	Cottage	1	1	0	0.666667	

Section	Access Type	Trail Width (m)	Trail Depression (m)	Vegetation Damage (off trail)	Trail Condition	Blowout (V or U)
2-90	Cottage	3	1	0	1.333333	V,V
2-91	Cottage	2	1	0	1	
2-92	Cottage	3	3	0	2	V
2-94	Cottage	4	2	0	2	V
2-95	Cottage	3	3	0	2	V
2-97	Cottage	3	1	0	1.333333	V
2-98	Cottage	4	2	0	2	V
2-99	Public	3,4	1	0	1.5	V
2-76						
2-83						
Section	Access Type	Trail Width (m)	Trail Depression (m)	Vegetation Damage (off trail)	Trail Condition	Blowout (V or U)
2-93						
2-96						
3-1	Cottage	1	1	0	0.666667	V (natural)
3-2	Cottage	2	1	0	1	
3-3,4	Cottage	3	1	0	1.333333	V, V,V
3-5	Cottage	2	1	0	1	U,U
3-6	Cottage	1	1	0	0.666667	U
3-7	Cottage	3	1	3,4	2.5	V,U
3-8	Cottage	3	1	0	1.333333	V,V
3-9	Cottage	3	1	3,4	2.5	V,V, U
3-10	Cottage	1	1	0	0.666667	V,V
3-11	Cottage	3	2	0	1.666667	V,V,V

Section	Access Type	Trail Width (m)	Trail Depression (m)	Vegetation Damage (off trail)	Trail Condition	Blowout (V or U)
3-12	Cottage	2	1	0	1	V,V
3-13	Cottage	1	1	0	0.666667	
3-14	Cottage	1	1	0	0.666667	U
3-15	Cottage	3, 4	2,3	0	2	U,U,U
3-16	Cottage	2	1	0	1	V
3-17	Cottage	2	1	0	1	V/U
3-18	Cottage	2	1	0	1	V,V
3-19	Cottage	2	1	0	1	U,V
3-20	Cottage	2	2	0	1.333333	
3-21	Cottage	3	1	Mowed Alive Vegetation	2	V
3-22	Cottage	3	2	0	1.666667	
3-23	Cottage	2	1	0	1	U
3-24	Cottage	3	2	0	1.666667	
3-25	Former Cottage	3	2	0	1.666667	V,V,V
3-26	Cottage	2	1	0	1	
3-27	Cottage	1	1	0	0.666667	
3-28	Cottage	2	1	0	1	
3-29	Cottage	2	1	0	1	V
3-30	Cottage	3	2	Mowed Alive Vegetation	2.333333	V
3-31	Cottage	2	2	0	1.333333	V, U
3-32	Cottage	2	1	0	1	

Section	Access Type	Trail Width (m)	Trail Depression (m)	Vegetation Damage (off trail)	Trail Condition	Blowout (V or U)
3-33	Cottage	2	2	0	1.333333	V
3-34	Cottage	3	2	0	1.666667	
3-35	Cottage	2	2	0	1.333333	V
3-36	Cottage	2	2	0	1.333333	
3-37	Cottage	2	2	0	1.333333	
3-38	Cottage	1	1	0	0.666667	
3-39	Cottage	3	3	0	2	
3-40	Cottage	2	1	0	1	
3-41	Public	3	3	0	2	V
3-42	Cottage	2	2	0	1.333333	V,V
3-43	Cottage	2	2	0	1.333333	V
3-44	Cottage	2	1	0	1	
Section	Access Type	Trail Width (m)	Trail Depression (m)	Vegetation Damage (off trail)	Trail Condition	Blowout (V or U)
3-45	Cottage	1	0	0	0.333333	V
3-46						
3-47	Former Cottage	1	1	0	0.666667	V
3-48	Cottage	2	1	0	1	V
3-49	Public	2	1	0	1	V,V

Appendix 2 - Species List

SCIENTIFIC NAME	COMMON NAME	SCIENTIFIC NAME	COMMON NAME
Equisetum arvense	Field Horsetail	*Poa pratensis ssp. pratensis*	Kentucky Bluegrass
Equisetum hyemale var. affine	Common Scouring-rush	*Schizachyrium scoparium*	Little Bluestem
Juniperus virginiana	Eastern Red Cedar	*Sorghastrum nutans*	Indian Grass
Carex molesta	Troublesome Sedge	*Sphenopholis obtusata*	Prairie Wedge Grass
Carex pensylvanica	Pennsylvania Sedge	*Sporobolus cryptandrus*	Sand Dropseed
Carex umbellata	Umbellate Sedge	*Sporobolus neglectus*	Overlooked Dropseed
Carex viridula ssp. viridula	Greenish Sedge	*Triplasis purpurea*	Sand Grass
cultivated Irissp.		*Acer negundo*	Manitoba Maple
Juncus balticus	Baltic Rush	*Acer platanoides*	Norway Maple
Juncus dudleyi	Dudley's Rush	*Acer saccharum*	Sugar Maple
Juncus torreyi	Torrey's Rush	*Rhus aromatica*	Fragrant Sumac
Asparagus officinalis	Wild Asparagus	*Rhus typhina*	Staghorn Sumac
Convallaria majalis	Lily-of-the-valley	*Toxicodendron radicans*	Western Poison Ivy
Hemerocallis fulva	Orange Day-lily	*Daucus carota*	Wild Carrot (Queen Anne's Lace)
Maianthemum stellatum	Starry False Solomon's-seal	*Osmorhiza claytonii*	Sweet Cicely
Yucca filamentosa	Yucca	*Apocynum cannabinum*	Indian Hemp
Epipactis	Helleborine	*Asclepias syriaca*	Common Milkweed

SCIENTIFIC NAME	COMMON NAME	SCIENTIFIC NAME	COMMON NAME
helleborine			
Spiranthes magnicamporum	Great Plain's Ladies'-tresses	*Asclepias tuberosa*	Butterfly Weed
Agrostis gigantea	Red Top	*Asclepias viridiflora*	Green Milkweed
Ammophila breviligulata	Sand-reed (Beach Grass)	*Achillea millefolium ssp. lanulosa*	Wolly Yarrow
Andropogon gerardii	Big Bluestem	*Ambrosia artemesiifolia*	Common Ragweed
Bromus inermis	Smooth Brome Grass	*Artemisia campestris ssp. caudata*	Sagewort (Beach) Wormwood
Bromus tectorum	Cheatgrass	*Centaurea stoebe ssp. micranthos*	Spotted Knapweed
Calamagrostis canadensis	Canada Blue-joint	*Conyza canadensis*	Horseweed, Fleabane
Cenchrus longispinus	Long-spined Sandbur	*Erigeron annuus*	Daisy Fleabane
Dichanthelium acuminatum	Woolly Panic Grass	*Euthamia graminifolia*	Grass-leaved Goldenrod
Dichanthelium oligosanthes	Few-flowered Panic Grass	*Helianthus divaricatus*	Woodland Sunflower
Digitaria ischaemum	Small Crabgrass	*Liatris cylindracea*	Cylindrical (Slender) Blazing-star
Elymus canadensis	Canada Wild Rye	*Rudbeckia hirta*	Black-eyed Susan
Elymus repens	Quack Grass	*Solidago canadensis*	Canada Goldenrod
Festuca trachyphylla	Hard Fescue	*Solidago gigantea*	Giant Goldenrod
Panicum acuminatum		*Solidago nemoralis*	Gray Goldenrod
Panicum virgatum	Switch Grass	*Sonchus arvensis ssp. arvensis*	Perennial Sow-thistle

SCIENTIFIC NAME	COMMON NAME	SCIENTIFIC NAME	COMMON NAME
Phleum pratense	Timothy	*Sonchus asper*	Spiny-leaved Sow-thistle
Phragmites australis ssp. australis	Common Reed	*Symphyotrichum dumosum var strictior*	Bushy Aster
Poa compressa	Canada Bluegrass	*Symphyotrichum ericoides*	Heath Aster
Poa saltuensis ssp. languida	Weak Bluegrass	*Symphyotrichum lanceolatum ssp. lanceolatum*	Panicled Aster
Alyssum murale	Yellow-tuft	*Symphyotrichum lateriflorum*	Calico Aster
Arabis lyrata	Lyre-leaved Rock-cress	*Symphyotrichum oolentangiense*	Azure Aster
Cakile edentula	Sea Rocket	*Symphyotrichum puniceum*	Swamp Aster
Hesperis matronalis	Dame's Rocket	*Symphyotrichum urophyllum*	Arrow-leaved Aster
Lepidium cf. densiflorum	Common Pepperweed	*Taraxacum officinale*	Common Dandelion
Lonicera morrowii	Morrow Honeysuckle	*Tragopogon dubius*	Doubtful Goat's-beard
Lonicera tatarica	Tartarian Honeysuckle	*Tussilago farfara*	Coltsfoot
Arenaria serpyllifolia	Thyme-leaved Sandwort	*Xanthium strumarium*	Cocklebur
Minuartia michauxii	Rock Sandwort	*cult. Ageratum sp.*	Whiteweed
Saponaria officinalis	Bouncing Bet	*Berberis thunbergii*	Japanese Barberry
Celastrus scandens	Climbing Bitter-sweet	*Catalpa speciosa*	Northern Catalpa
Chenopodium album var. album	Lamb's-quarters	*Lithospermum caroliniense*	Golden (Hoary) Puccoon

SCIENTIFIC NAME	COMMON NAME	SCIENTIFIC NAME	COMMON NAME
Corispermum pallassii	Bug-seed	*Alliaria petiolata*	Garlic Mustard
Cycloloma atriplicifolium	Winged Pigweed	*Potentilla inclinata*	Downy Cinquefoil
Salsola kali ssp. ruthenica	Russian Thistle	*Prunus serotina*	Wild Black Cherry
Cornus foemina ssp. racemosa	Gray Dogwood	*Prunus virginiana ssp. virginiana*	Choke Cherry
Sedum acre	Mossy Stonecrop	*Rosa blanda*	Smooth Wild Rose
Sedum ternatum	Wild Live-forever	*Rosa eglanteria*	Multiflora Rose
Chamaesyce maculata	Hairy-fruited Spurge	*Rubus idaeus ssp. strigosus*	Wild Red Raspberry
Chamaesyce polygonifolia	Seaside Spurge	*Rubus occidentalis*	Black Raspberry
Euphorbia cyparissias	Cypress Spurge	*Galium asprellum*	Rough Bedstraw
Euphorbia glyptosperma	Thyme leaved Spurge	*Galium pilosum*	Hairy Bedstraw
Amphicarpaea bracteata	Hog-peanut	*Populus alba*	European White Poplar
Desmodium canadense	Canada Tick Trefoil	*Populus balsalmifera*	Balsalm Poplar
Desmodium paniculatum var. dillenii	Tick Trefoil	*Populus deltoides*	Eastern Cottonwood
Gleditsia triacanthos	Honey-locust	*Populus nigra*	Black Cottonwood
Lathyrus japonicus	Beach Pea	*Salix alba var. vitellina*	White Willow
Melilotus alba	White Sweet Clover	*Salix exigua*	Sandbar Willow
Robinia pseudo-acacia	Black Locust	*Agalinis paupercula*	Purple Gerardia

SCIENTIFIC NAME	COMMON NAME	SCIENTIFIC NAME	COMMON NAME
Strophostyles helvula	Trailing Wild Bean	*Verbascum thapsus*	Common Mullein
Quercus velutina	Black Oak	*Ailanthus altissima*	Tree-of-heaven
Juglans nigra	Black Walnut	*Physalis heterophylla*	Clammy Ground Cherry
Glechoma hederacea	Creeping Charlie	*Ulmus pumila*	Siberian Elm
Monarda fistulosa	Wild Bergamot	*Ulmus thomasii*	Rock Elm
Teucrium canadense ssp. canadense	Wild Germander	*Phryma leptostachya*	Lopseed
Liriodendron tulipifera	Tuliptree	*Parthenocissus quinquefolia*	Virginia Creeper
Morus alba	White Mulberry	*Parthenocissus vitacea*	Virginia Creeper
Fraxinus americana	White Ash	*Vitis riparia*	Riverbank Grape
Ligustrum ovalifolium	California Privet	*Quercus velutina X rubra*	red x black oak hybrid
Syringa vulgaris	Common Lilac	*Lysimachia quadriflora*	whorled loosestrife
Oenothera parviflora	Northern Evening-primrose	*Aquilegia canadensis*	Wild Columbine
Oxalis stricta	European Wood-sorrel	*Fragaria virginiana*	(Common) Wild Strawberry
Plantago lanceolata	English Plantain/Ribgrass	*Geum canadense*	White Avens
Rumex acetosella	Sheep Sorrel	*Malus pumila*	Apple
Anemone cylindrica	Long-headed Anemone	*Potentilla anserina ssp. anserina*	Silverweed

Appendix 3 – GIS Summary

Data used: 2010 aerial imagery from Land Information Ontario (LIO). Data layers from LIO (roads, leasehold lots, trails). Public and cottage beach access data collected by GPS in October 2012.

Total Area (ha) of 296 Cottage lease Lots: 20.548

Total Linear KM's of roads	29.3 km	Includes Marsh trail and South Point Trail. Measured using GIS spatial data/imagery.
Total Linear KM's of cottage access roads	9.9 km	Roads that were measured provided direct access to cottages. GIS spatial data/imagery used. (Bowman Ave.,
Terrestrial area (includes wetlands)	16.1 km sq	Using imagery, a boundary was drawn in ArcGIS around the terrestrial portion of the park. Shape area was then
Road density (total kms of road/terrestrial area of park in kms sq)	1.82 km of road per 1 km sq of park	

Trails	Length (km)	Number of trails	Prop. of total	
Public hiking	22.4	8	51.61%	Includes Marsh trail and South Point Trail
Cottage beach access	19.3	202	44.47%	
Public beach access	1.7	15	3.92%	
Total	43.4	225	100%	

Lengths of trails were calculated/measured using GIS spatial data collected in the field by GPS. Trail types were selected and the lengths totaled. All public trails (other than beach access) were included as "hiking".

Fragmentation:

Lakeside (east of Lakeshore Rd.):			
Total length of shoreline	12.6 km	Measured using GIS spatial data/imagery, measure tool, beginning and ending at park boundary lines.	
Linear length of cottage area	7.2 km	Measured using GIS spatial data, measure too	
Linear length of uninterrupted shore	1.4 km	This is the only portion of the park where species are able to move freely without anthropogenic interruption (does not include the "tail" of the park)	
OR	3.3 km	Includes the "tail" at the southwestern point of the park. Measured from the southern park boundary where it crosses onto shore to where South P	
Bayside (west of Rondeau Rd and Water St):			
Total length of shoreline	18 km	Measured using GIS spatial data, measure tool, beginning and ending at park boundary lines.	
Linear length of cottage area	1.6 km	Measured using GIS spatial data, measure tool, beginning at the most northern lease lot boundary to the most southern lease lot boundary.	
Linear length of uninterrupted shore	N/A	Marsh Trail extends to southern end of park/shore	

Density of trails along the lake erie shore in segments starting from the northernmost trail and proceeding to the southernmost. Measured from the back edge of leaseholder property to the water using GIS spatial data and imagery. Segments are divided up to and including each public access point.

Shore Segment	Area of leasehold tr	Area of leasehol	Area of segment (t	Area of segm	% of segment is tra	m sq of trail per 1 m sq of shore
Public Access 1	0.0535	535m sq	0.9475	9475	5.60%	0.06
Public Access 2	0.0369	369m sq	0.8619	8619	4.30%	0.04
Public Access 3	0.0656	656m sq	1.5486	15486	4.20%	0.04
Public Access 4	0.067	670m sq	1.2064	12064	5.60%	0.06
Public Access 5	0.0381	381m sq	1.0438	10438	3.70%	0.04
Public Access 6	0.0574	574m sq	1.0083	10083	5.70%	0.06
Public Access 7	0.0589	589m sq	1.1582	11582	5.10%	0.05
Public Access 8a-9b	0.222	2220m sq	3.3689	33689	6.60%	0.07
Public Access 10	2.647	26470m sq	48.2892	482892	5.50%	0.05
Public Access 11	0.9215	9215m sq	16.585	165850	5.60%	0.56
Public Access 12	0.1307	1307m sq	10.3253	103253	1.30%	0.01