



Lake Huron Grasshopper

(*Trimerotropis huronia*) in Ontario

Ontario Recovery Strategy Series

2018

About the Ontario Recovery Strategy Series

This series presents the collection of recovery strategies that are prepared or adopted as advice to the Province of Ontario on the recommended approach to recover species at risk. The Province ensures the preparation of recovery strategies to meet its commitments to recover species at risk under the *Endangered Species Act 2007* (ESA) and the Accord for the Protection of Species at Risk in Canada.

What is recovery?

Recovery of species at risk is the process by which the decline of an endangered, threatened, or extirpated species is arrested or reversed, and threats are removed or reduced to improve the likelihood of a species' persistence in the wild.

What is a recovery strategy?

Under the ESA a recovery strategy provides the best available scientific knowledge on what is required to achieve recovery of a species. A recovery strategy outlines the habitat needs and the threats to the survival and recovery of the species. It also makes recommendations on the objectives for protection and recovery, the approaches to achieve those objectives, and the area that should be considered in the development of a habitat regulation. Sections 11 to 15 of the ESA outline the required content and timelines for developing recovery strategies published in this series.

Recovery strategies are required to be prepared for endangered and threatened species within one or two years respectively of the species being added to the Species at Risk in Ontario list. Recovery strategies are required to be prepared for extirpated species only if reintroduction is considered feasible.

What's next?

Nine months after the completion of a recovery strategy a government response statement will be published which summarizes the actions that the Government of Ontario intends to take in response to the strategy. The implementation of recovery strategies depends on the continued cooperation and actions of government agencies, individuals, communities, land users, and conservationists.

For more information

To learn more about species at risk recovery in Ontario, please visit the Ministry of the Environment, Conservation and Parks Species at Risk webpage at: www.ontario.ca/speciesatrisk

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Declaration

The recovery strategy for the Lake Huron Grasshopper was developed in accordance with the requirements of the *Endangered Species Act, 2007* (ESA). This recovery strategy has been prepared as advice to the Government of Ontario, other responsible jurisdictions and the many different constituencies that may be involved in recovering the species.

The recovery strategy does not necessarily represent the views of all of the individuals who provided advice or contributed to its preparation, or the official positions of the organizations with which the individuals are associated.

The recommended goals, objectives and recovery approaches identified in the strategy are based on the best available knowledge and are subject to revision as new information becomes available. Implementation of this strategy is subject to appropriations, priorities and budgetary constraints of the participating jurisdictions and organizations.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy.

Responsible jurisdictions

Ministry of the Environment, Conservation and Parks
Environment and Climate Change Canada – Canadian Wildlife Service, Ontario
Parks Canada Agency

Executive summary

The Lake Huron Grasshopper (*Trimerotropis huroniana*) is Threatened in Ontario. It is a mottled silver-grey insect with a broad dark band through the hind wing. It may be distinguished from the Seaside Grasshopper (*T. maritima*), also found on dunes, by a wide black blotch and narrow band on the inside of the hind leg. The Lake Huron Grasshopper is found only on dunes on the northern Great Lakes. In Canada it occurs only in Ontario on Manitoulin Island, Great Duck Island, north of Sault Ste. Marie, and on eastern Georgian Bay, at a total of 13 locations. The species is extirpated from Southampton and Wasaga Beach where it occurred historically. There are many dune sites not yet surveyed.

Suitable habitat for the Lake Huron Grasshopper consists of open sand sparsely vegetated with native dune plants. Dunes are dynamic habitats that change due to wind, wave-wash, ice-scour, changes in lake levels, and other factors. They are subjected to extremes of temperature, light, drought, etc., so the Lake Huron Grasshopper is likely adapted to survive a great range of conditions. The Lake Huron Grasshopper feeds primarily on native dune plants, especially native dune grasses and Field Wormwood (*Artemisia campestris*). Adults may be able to fly several kilometres. The Lake Huron Grasshopper is almost never found at the same sites as the Seaside Grasshopper, but the reasons for this are not known.

Shoreline development, heavy recreational usage including all-terrain vehicle use, invasive species, intentional removal of vegetation, and potentially climate change, are threats to the Lake Huron Grasshopper and its habitat. Natural limitations include a lack of suitable dune habitat, predation by native and non-native species, and the natural dynamic factors which maintain the habitat but occasionally also wipe out grasshoppers. Knowledge gaps include whether the Lake Huron Grasshopper is present at unsurveyed dune sites; the size of populations and whether they are stable, increasing or decreasing; and details on the biological requirements of the species that may affect its survival.

The recommended recovery goal is to maintain or increase the current number of populations and to maintain or increase the current range of the species for the next ten years. The recommended objectives are to: protect the species and its habitat with on-the-ground actions to reduce threats; assist municipalities and planning authorities in protecting the Lake Huron Grasshopper and its habitat; increase awareness about the Lake Huron Grasshopper and its habitat; and fill knowledge gaps related to species distribution, abundance and biology. A number of approaches to achieve these objectives and address threats are given in the text.

The specific habitat required by the Lake Huron Grasshopper is found within dune systems which change over time and which are subject to changes in lake levels. It is suggested that the area to be considered for a habitat regulation have tree and shrub cover $\leq 25\%$; contain vegetation of either Little Blue-stem-Long-leaved Reed Grass – Great Lake Wheatgrass (SDO1-2) or American Dune Grass – Beach Pea – Sand Cherry Dune Grassland (SDO1-3); have native dune grasses or wormwood present;

have been occupied by the Lake Huron Grasshopper in the last 15 years; and include a 15 m area adjacent to the dunes to include natural vegetation involved in maintaining dune dynamics. A further explanation of these characteristics with rationale is provided in this document.

Table of contents

Recommended citation.....	i
Authors.....	i
Acknowledgments	ii
Declaration	ii
Responsible jurisdictions.....	ii
Executive summary.....	iii
1.0 Background information.....	1
1.1 Species assessment and classification.....	1
1.2 Species description and biology	1
1.3 Distribution, abundance and population trends.....	4
1.4 Habitat needs.....	7
1.5 Limiting factors.....	9
1.6 Threats to survival and recovery.....	9
1.7 Knowledge gaps	12
1.8 Recovery actions completed or underway	12
2.0 Recovery	14
2.1 Recommended recovery goal	14
2.2 Recommended protection and recovery objectives	14
2.3 Recommended approaches to recovery	15
2.4 Performance measures.....	20
2.5 Area for consideration in developing a habitat regulation	20
Glossary	23
References.....	25
Appendix A.....	28

List of figures

Figure 1. The Lake Huron Grasshopper.....	2
Figure 2. a. Hind wing of the Lake Huron Grasshopper showing dark band. b. Inside of the back leg.....	2
Figure 3. Global range of Lake Huron Grasshopper.	5
Figure 4. Current distribution of the Lake Huron Grasshopper in Ontario.	6
Figure 5. Habitat of the Lake Huron Grasshopper.....	7

List of tables

Table 1. Species assessment and classification of the Lake Huron Grasshopper	1
Table 2. Recommended protection and recovery objectives.....	14
Table 3. Recommended approaches to recovery of the Lake Huron Grasshopper in Ontario.	15
Table 4. List of sites where the Lake Huron Grasshopper currently occurs	28
Table 5. List of some dune sites with suitable habitat	28

1.0 Background information

1.1 Species assessment and classification

Table 1. Species assessment and classification of the Lake Huron Grasshopper (*Trimerotropis huroniana*). The glossary on page 21 gives definitions for abbreviations and technical terms used in the table below and in the rest of this document.

Assessment	Status
SARO list classification	Threatened
SARO list history	Added to Schedule 3, June 2, 2017.
COSEWIC assessment history	Threatened (2015)
SARA schedule 1	Threatened (2017)
Conservation status rankings	GRANK: G2G3 NRANK: N2 SRANK: S2

1.2 Species description and biology

The Lake Huron Grasshopper, like all grasshoppers, has large back legs which are used for jumping, a flat-sided head with large eyes, and forewings (tegmina) which close over the hind wings and body when at rest (Milne and Milne 1980). The Lake Huron Grasshopper is a mottled silver-grey to brownish colour and from 24 to 40 mm in size (Figure 1). Occasionally some individuals may be more orange. The forewings are clear with random speckles and bands while the hind wings are clear or yellowish with a broad, dark band through the middle (COSEWIC 2015) (Figure 2a).

The Lake Huron Grasshopper may be distinguished from the very similar Seaside Grasshopper (*T. maritima*) by the two black bands on the inside of the upper hind leg (femur)—a broad one which covers almost half the femur and a second narrower one (Walker 1902; Bland 2003) (Figure 2b). The Seaside Grasshopper has only narrow black bands (Marshall 2003; Bland 2003). To see the inside of the back legs, it may be necessary to catch an individual (Marshall 2003), which is not advised.

The Lake Huron Grasshopper was formerly known as the Lake Huron Locust (Rabe 1999; Scholtens et al. 2005). However, locusts form swarms of large numbers of individuals, and swarm behavior is not known in this species (COSEWIC 2015).



Figure 1. The Lake Huron Grasshopper (Photo: Allan Harris)



Figure 2. a. Hind wing of the Lake Huron Grasshopper showing dark band. b. Inside of the back leg showing large dark blotch and narrow stripe (Photos: Robert Foster)

Species biology

The Lake Huron Grasshopper overwinters as an egg. Nymphs hatch in late spring and develop through five stages (instars). Adults may be found by mid-July and may survive until hard frosts in the fall (Rabe 1999). Mating occurs in late summer or early fall. The specifics of reproduction for the Lake Huron Grasshopper are not known, but the biology is thought to be similar to the closely-related Pallid-winged Grasshopper (*T.*

pallidipennis) (Otte 1970) which lays eggs in sandy soil. Since the Lake Huron Grasshopper is a species of dunes and beaches, presumably it lays eggs in its habitat and the eggs overwinter in the sand. Each female produces several egg clusters for a single generation (Milne and Milne 1980).

The Lake Huron Grasshopper feeds primarily on native dune plants and secondarily on dried plant debris and dead insects (Bland 2003; Scholtens et al. 2005). Preferred food plants include American Beachgrass (*Ammophila breiligulata*; also known as Marram Grass or American Dune Grass), Great Lakes Sandreed (*Sporobolus rigidus*; also known as Long-leaved Reed Grass), Field Wormwood (*Artemisia campestris*), and Sanddune Wildrye (*Elymus lanceolatus* ssp. *psammophilus*; also known as Great Lakes Wheatgrass) although most non-woody plants may be eaten including Pitcher's thistle (*Cirsium pitcheri*) (Rabe 1999), a threatened species in Ontario which usually occurs with the Lake Huron Grasshopper.

Courtship among Lake Huron Grasshoppers involves complex communication and attraction behaviours which may include flight displays of hovering or flashing of wings, sounds such as crackling (crepitation) and rubbing the femur on the forewings (stridulation), and male-male aggressive displays with shaking and tipping of their femurs (Otte 1970). These behaviours usually occur on sunny days with temperatures above 25°C (Rabe 1999).

The Lake Huron Grasshopper does not migrate, yet it is found on islands in Lake Huron and Lake Michigan (Rabe 1999; COSEWIC 2015)—some as much as 15 km from other land—suggesting that adults may be able to fly several kilometres over open water (COSEWIC 2015). As well, the Lake Huron Grasshopper has been observed to return to at least one site after an absence (Providence Bay in COSEWIC 2015), so presumably adults have the ability to move between sites when required. Within the habitat, on calm sunny days individuals may be found on sparsely vegetated sand, in evenly spread out territories of about 1 m². On windy or overcast days, the grasshoppers shelter together in areas of heavy dune grass (Rabe 1999).

The Seaside Grasshopper is found in the same types of dune and beach habitats as the Lake Huron Grasshopper. It is a much more common and widely occurring species, yet the two species almost never occur together (Walker 1902; Hubbell 1929; Marshall 2003; Scholtens et al. 2005; COSEWIC 2015). It is unknown why the two species generally do not occur together. It may be due to competition between the two for food, space, or other resources (Hubbell 1929; Otte 1970; COSEWIC 2015), to requirements for certain environmental conditions which may change, to different tolerances for disturbance which may increase or decrease, or to some other factor.

It has been speculated that the Seaside Grasshopper may be replacing the Lake Huron Grasshopper because some sites occupied in the 1990s by the Lake Huron Grasshopper no longer have that species present but were occupied by the Seaside Grasshopper in 2002 (Marshall 2003). On the other hand, in 2015 only the Lake Huron Grasshopper was present at two Manitoulin Island sites (COSEWIC 2015) where the Seaside Grasshopper had been present in 2002 (Marshall 2003). Thus there may be

some situations in which one species is better able to survive than the other. Many other species of grasshoppers are also present on beaches and dunes where the Lake Huron Grasshopper is present (see COSEWIC 2015) and may also compete with the species and reduce its presence.

The Lake Huron Grasshopper lives in dune and beach habitats which experience extremes of temperature, light, moisture level, wind, and shifting substrate (Albert 2000; Maun 2009), so presumably the species must be adapted to survive a wide range of environmental conditions and must have a broad tolerance to many factors. See Section 1.4: Habitat Needs.

1.3 Distribution, abundance and population trends

The global distribution of the Lake Huron Grasshopper is shown in Figure 3 below. The species is found on the shores of Lakes Huron, Michigan and Superior, in Ontario, Michigan, and Wisconsin (Ballard 1989; Scholtens et al. 2005; COSEWIC 2015). In Canada, the Lake Huron Grasshopper occurs only in Ontario. Its current range encompasses 13 populations, with 10 on Lake Huron along the south shore of Manitoulin Island and on Great Duck Island, two on Georgian Bay, and one on southern Lake Superior at Pancake Bay (Figure 4). A list of all localities where the species occurs is provided in Appendix A. There are still many dune sites on Lake Huron and Georgian Bay that have not been surveyed (Appendix A). The Lake Huron Grasshopper appears to be extirpated from Wasaga Beach and Southampton where it was reported historically.

COSEWIC (2015) listed eight populations at 11 sites, lumping Deans Bay, Lonely Bay, and Square Bay together. However, there is justification for treating all as separate populations. Lonely Bay and Square Bay are more than 1 km from each other, and all three sites are separated along the shore by stretches of unsuitable rocky or marshy habitat (Jones pers. obs.) or in a straight line distance by forested habitat. With the addition of two populations discovered in 2017, a total of 13 populations are considered extant.

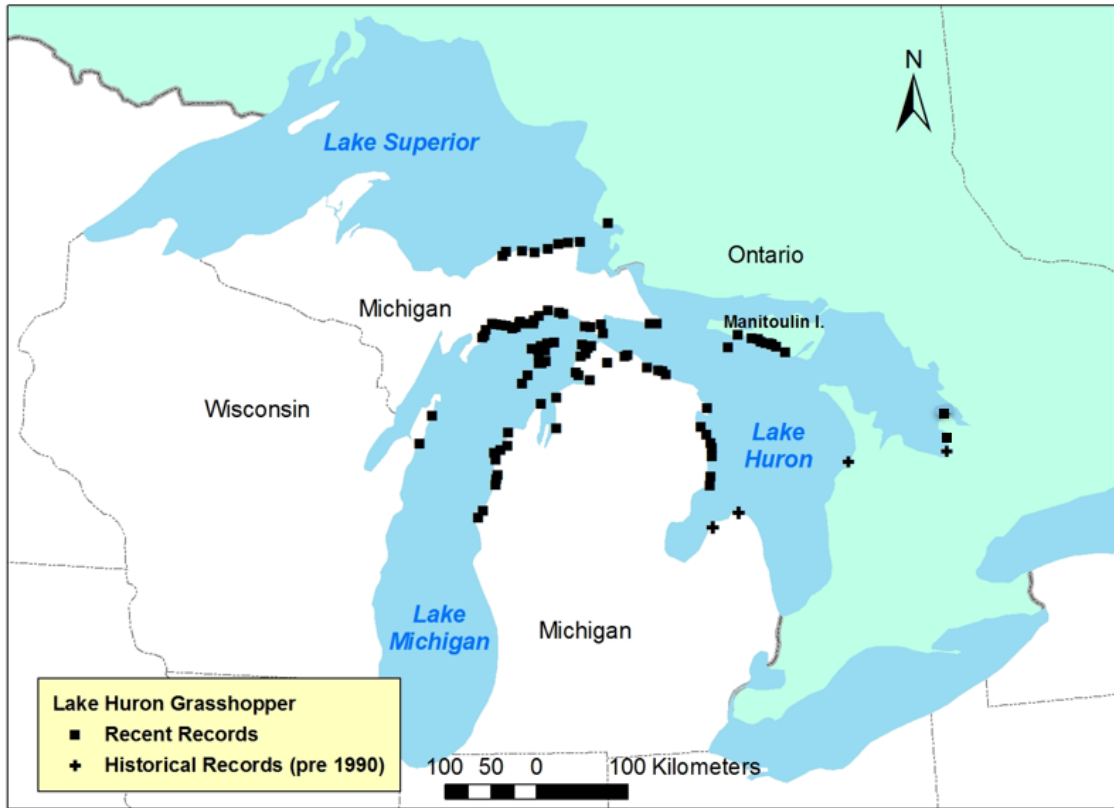


Figure 3. Global range of Lake Huron Grasshopper. Black squares indicate extant populations (observations within the last 20 years) (COSEWIC 2015; NHICa 2018).

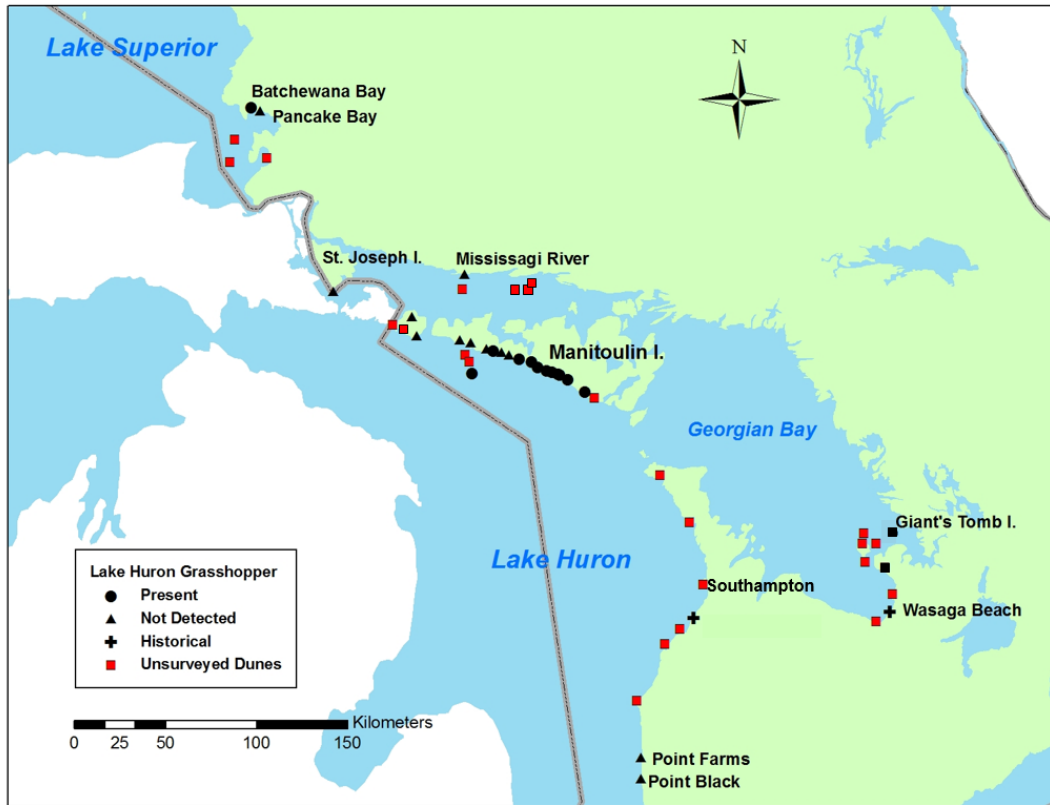


Figure 4. Current distribution of the Lake Huron Grasshopper in Ontario. Black circles indicate extant populations based on surveys in 2014 and 2017 (COSEWIC 2015; NHIC 2018a).

The species was first described from Southampton, Ontario (Walker 1902) and was present historically at Wasaga Beach but it is no longer present at these two sites (Marshall 2003; COSEWIC 2015). A historical population reported from Sauble Beach (COSEWIC 2015) is an error. The report authors did not know there were dunes at Southampton and so presumed the Southampton record must have come from Sauble Beach (Harris pers. comm. 2018). In fact, the Chantry Dunes at Southampton still contain intact dune vegetation (Jones 2002; Jones pers. obs. 2016) and are a completely separate dune system from that of Sauble Beach, which is more than 15 km away.

It is possible the distribution of the Lake Huron Grasshopper may be influenced in some way by the Seaside Grasshopper. Historically, Walker (1902) noted that the two species did not co-occur, and Hubble (1929) found that the Lake Huron Grasshopper replaced the Seaside Grasshopper at northern sites in Michigan. Between the 1940s and the 1960s the boundary between the two species on the western side of Lake Huron apparently moved northward by about 80 km although it moved southward on Lake Michigan in the same time period (Otte 1970). Collections of both species on Manitoulin Island in 2002-2003 (COSEWIC 2015) show the two species have been present at the same site but in different years, and that the two species were actually

present together once at one site.

There is no information about population abundance or trends for the Lake Huron Grasshoppers. However, fluctuations in population size are probably natural for dune species due to the changing nature of the habitat (see 1.4 Habitat needs). Fluctuations in population sizes may be tied to changing lake levels which periodically submerge portions of the habitat (Scholtens et al. 2005; Jones unpublished data 2000-2017). The dune species Pitcher's Thistle also exhibits fluctuations in population size probably as a result of natural dune dynamics (Parks Canada Agency unpublished data 2004-2017; Nantel et al. in prep).

1.4 Habitat needs

Lake Huron Grasshopper occurs only on dunes and beaches that have nearly bare sand and sparse vegetation of scattered grasses and herbaceous plants with little or no duff (Otte 1970, COSEWIC 2015) (Figure 5). Sparse conditions are found mainly on the foredune (the area closest to the lake after the wet, wave-wash zone) but may also be found further back (towards the forest) if disturbance has removed vegetation and opened the sand. Thus, the Lake Huron Grasshopper mainly occupies the foredune but is occasionally found further back from the water in sparser spots (Harris pers. comm. 2018).



Figure 5. Habitat of the Lake Huron Grasshopper showing patches of sparse vegetation on the foredune (Photo: Judith Jones).

On Lake Huron, the vegetation community that contains suitable habitat is classified as Little Bluestem – Long-leaved Reed Grass – Great Lakes Wheat Grass Dune Grassland

SDO1-2 (Lee et al. 1998). On Lake Superior (Great Lakes - St. Lawrence region), it may be classified as American Dune Grass – Beach Pea – Sand Cherry Dune Grassland SDO1-3 (NHIC 2018b; Bakowsky pers. comm. 2018) or less specifically as Active Eolian Sand G006X (Banton et al. 2009; Webster et al. 2015) although total vegetation cover is usually greater than 25% (Jones personal observations 2017; Bakowsky pers. comm. 2018). In both regions, these dune vegetation types are of conservation concern and considered imperiled in Ontario or S2 (NHIC 2018b).

Dune habitats are dynamic and are subject to forces that move sand, such as wind, wave-wash, ice movement, and changes in lake levels (Albert 2000; Maun 2009). These forces maintain open sand conditions and prevent the long-term growth of most tree species (Dech et al. 2005; Maun 2009). In the absence of dynamic forces, more plant growth occurs and sand may become too vegetated for the Lake Huron Grasshopper.

As well, water levels in the Great Lakes naturally fluctuate in cycles of approximately 30 years with 120 to 160 year extremes (Quinn and Sellinger 2006; Wilcox et al. 2007). At high levels, lake water submerges large portions of beach, but when the water recedes again, newly exposed bare sand becomes suitable habitat (Scholtens et al. 2005; Jones unpublished data 2000-2017).

The presence of preferred food plants, such as American Beachgrass, Great Lakes Sandreed, and especially Field Wormwood, may be required for habitat suitability for the Lake Huron Grasshopper (COSEWIC 2015). Although the Lake Huron Grasshopper has been found to eat most dune plant species (Rabe 1999), studies in Michigan have found the Lake Huron Grasshopper is more likely to be found where Wormwood and other native species are present and less likely to be found where some invasive species are present (Marshall and Storer 2007).

The sparse microhabitat occupied by the Lake Huron Grasshopper in Ontario ranges in size from 1.2 ha to 30 ha and in width from approximately 3 m to 400 m (COSEWIC 2015). Interestingly, the shape of the dunes or beaches used by the species varies greatly. Some systems may be long and narrow, such as the 10 ha Pancake Bay site which is more than 4 km in length but only ~70 m at the widest. Others are shorter and wider, such as the 8 ha Shrigley Bay site which is 1 km in length and 130 m at the widest or the 19 ha Carter Bay site, which is 1 km in length and 260 m wide at the widest (Jones unpublished data 2018). Scholtens et al. (2005) working in Michigan also found that the size of the dune system (length, width or both) was not correlated with the presence or absence of the Lake Huron Grasshopper. Thus, it seems that size is not necessarily a factor in habitat suitability.

Sites occupied in 2015 were observed to have lower levels of human disturbance and more intact dune flora than sites where the Lake Huron Grasshopper has been extirpated (COSEWIC 2015). On the other hand, Scholtens et al. (2005) found that Lake Huron Grasshopper presence on Michigan dunes was reduced only at high levels of anthropogenic disturbance or great presence of invasive species, so it is possible that the species tolerates moderate levels of disturbance. As well, dune habitats may

recover from some types of disturbance if activities causing disturbance are restricted (COSEWIC 2010). Also, if dunes become highly vegetated because natural disturbance is low, light human disturbance (such as light foot traffic) is sometimes the only force creating sparse conditions (Jones unpublished data 2000-2017) and thus could be somewhat beneficial. In general, however, higher quality habitat has natural disturbance dynamics rather than disturbance from human activities.

1.5 Limiting factors

Suitable habitat for the Lake Huron Grasshopper is naturally limited. It is estimated that only 1800 ha of freshwater coastal dunes exist in Canada, with 492 ha on Lake Huron, 100 ha on Lake Superior, and the remaining 1,208 ha on Lakes Erie and Ontario (where the Lake Huron Grasshopper does not occur) (Bakowsky and Henson 2014). Dunes with suitable vegetation are imperiled in Ontario (NHIC 2018b).

Natural predation may limit the Lake Huron Grasshopper. There are many species that prey on grasshoppers including mammals such as Northern Raccoon (*Procyon lotor*), Red Fox (*Vulpes vulpes*); birds including American Kestrel (*Falco sparverius*), Common Grackle (*Quiscalus quiscula*), and probably most gulls; American Toad (*Anaxyrus americanus*); and arthropods such as robber flies and spiders (COSEWIC 2015). The larvae of some types of insects including some species of blister beetle (Coleoptera: *Meloidae*) and bee flies (Diptera: *Bombyliidae*) eat grasshopper eggs (COSEWIC 2015).

In addition, natural dune dynamics may limit the Lake Huron Grasshopper. In times of high natural disturbance (high lake levels, years with more frequent winter storms, etc.) areas of dune habitat may be periodically wiped out or drastically changed (Jones personal observations 2016-2017), which may reduce the presence of the grasshopper (Scholtens et al. 2005). There may also be periods in which natural disturbance is low (low lake levels, fewer winter storms, less wind, etc.), in which dune vegetation may increase in density, again creating unsuitable conditions. Presumably, species that live on dunes must be adapted to survive natural change cycles since these dynamics also create suitable habitat. However, population sizes and even presence/absence may be affected by these natural limitations.

1.6 Threats to survival and recovery

Factors that alter or degrade dune or beach habitats are threats to the Lake Huron Grasshopper. These include shoreline development, heavy recreational usage including inappropriate all terrain vehicle (ATV) use and trampling, invasive species, and intentional removal of all vegetation. Climate change may also be a potential threat.

Shoreline Development

Development of shorelines with the construction of homes, cottages, and other buildings may alter or destroy backdune habitats and lead to increased recreational usage. Construction of structures on dunes such as residences, driveways, breakwaters or retaining walls, may interfere with the natural movement of sand and change dune dynamics. A high density of homes, cottages, and retail operations probably caused the extirpation of the Lake Huron Grasshopper from historical sites at Wasaga Beach and Southampton (COSEWIC 2015). However, on many Manitoulin Island dune sites cottage development has already taken place and habitats have recovered to their current status (Jones pers. obs. 2000-2017), and three populations are in or adjacent to protected areas where shoreline activities are managed (Pancake Bay; parts of Taskerville on western Manitoulin Island; Giant's Tomb Island). In addition, landowner presence may reduce damaging behavior, compared to beaches perceived to be "uninhabited", because landowners tend to be vigilant of what occurs in front of their properties and usually discourage excessive use by non-residents (Jones pers. obs. 2000-2017). Still, the potential for future cottage development remains at some sites, which may have damaging effects on the habitat.

Heavy Recreational Usage

Heavy use of beaches and dunes for recreation may result in trampling and damage of dune vegetation. Recreation may result in heavy foot traffic, or may involve clearing vegetation for volleyball courts, fire pits, and boat storage. In addition, off-trail use of ATV may damage large areas of vegetation, cause erosion, and introduce invasive species. Off-trail ATV use is a widespread occurrence on Manitoulin Island dunes (COSEWIC 2015; Parks Canada unpublished data 2004-2017). Light recreational activities (occurring only infrequently and by few people, such as a small amount of foot traffic over the dunes or an occasional picnic) may not be harmful as the Lake Huron Grasshopper is tolerant of moderate disturbance, but heavy usage, especially by ATVs, may reduce the presence of the Lake Huron Grasshopper (Scholtens et al. 2005).

Invasive Species and Problematic Native Species

Invasive plant species grow quickly and spread rapidly, densely covering and stabilizing the sand. This eventually eliminates native plants including those needed by the Lake Huron Grasshopper for food and shelter. When non-dune species become established, it may lead to different insects being present. For example, sites with Spotted Knapweed (*Centaurea stoebe* ssp. *micranthos*) were found to have greater numbers of ants and beetles (Marshall et al. 2008), some of which may compete with the Lake Huron Grasshopper or prey on its larvae (COSEWIC 2015). Invasive species in the habitat of the Lake Huron Grasshopper include White Sweet-clover (*Melilotus alba*), European Common Reed (*Phragmites australis* ssp. *australis*), Scots Pine (*Pinus sylvestris*), Glandular Baby's Breath (*Gypsophila scorozonerifolia*), and Spotted Knapweed (Jones unpublished data 2000-2017). Invasive species are most likely to

occur at sites with a high degree of public access or ATV use (COSEWIC 2015; Jones pers. obs. 2011-2017).

An increase in competing native grasshopper species may lead to a reduction or loss of local populations of the Lake Huron Grasshopper. Scholtens et al. (2005) observed that the Mottled Sand Grasshopper (*Spharagemon collare*) displaced the Lake Huron Grasshopper at sites where heavy disturbance had occurred. They speculated that changes in the vegetation resulting from the disturbance favoured the Mottled Sand Grasshopper over the Lake Huron Grasshopper. The Seaside Grasshopper may also out-compete and displace the Lake Huron Grasshopper. As yet it is unknown what types of conditions favour the Lake Huron Grasshopper over its competitors.

At low lake levels when natural disturbance from wave-wash and ice buildup is low, native woody vegetation may grow quickly and reduce the size of the suitable habitat. During the period of years when this occurs, it is possible that populations of the Lake Huron Grasshopper may be reduced in abundance or increased in density within a smaller area. How Lake Huron Grasshopper populations respond to natural lake and vegetation cycles is unknown. COSEWIC (2015) noted there was some evidence that woody vegetation was growing in at a faster rate than new dunes were developing. However, those observations were made at only one point in time during a low water year within the 30-year lake level cycle. At the time of this writing in 2018, water levels in Lake Huron had risen again, inundating beaches and removing vegetation, so likely the dune-building dynamics remain intact at most sites. Still, in the presence of other threats, it is unknown whether Lake Huron Grasshopper populations remain able to rebound from natural disturbance cycles.

Intentional Removal of Vegetation

Landowners adjacent to beachfront property sometimes remove all vegetation from parts of the dunes, desiring a beach with only bare sand and no plant matter (Jones unpublished data 2000-2017). This removes habitat for the Lake Huron Grasshopper as well as all other dune species that were present. It also allows wind to move greater quantities of sand, often resulting in unwanted build up on walkways, streets, lawns, and elsewhere. Some municipalities on Manitoulin Island have by-laws prohibiting alteration of beaches without permission, but enforcement can be difficult. Large machinery is often a vector for invasive species (Halloran et al. 2013) as dirt or mud stuck in tracks and pinch points can harbor seeds or plant fragments. Thus, the use of machinery to remove vegetation may be especially harmful.

Climate Change

A study in Michigan (Lee et al. 2011) found the Lake Huron Grasshopper to be moderately vulnerable to the effects of climate change and predicted a decrease in its geographic range as a result. Many potential changes such as late spring frosts, unusually cool and wet growing seasons or increased temperature (leading to lower

lake levels) may all have effects on the species (COSEWIC 2015). So far, no direct threats to the Lake Huron Grasshopper from climate change have been documented, so the impacts of climate change are unknown.

1.7 Knowledge gaps

Many dune sites on Lake Huron have not been surveyed for the Lake Huron Grasshopper, so the full distribution and abundance of the species is unknown. A list of sites with potentially suitable habitat that have not been surveyed is presented in Appendix A.

The sizes of Lake Huron Grasshopper populations are not known, so it is unknown whether populations are stable, increasing, or declining, and if so at what rate. In addition, how the populations respond to lake level cycles is unknown, including whether the species undergoes periodic episodes of low abundance or whether there are periods in which density increases in smaller habitat areas.

Additional information on the biological requirements of the Lake Huron Grasshopper is needed to ensure the species and its required habitat parameters are adequately protected. Biological knowledge gaps include (but are not limited to) the egg-laying process, the effects of predators, and the mechanisms that prevent the species from co-occurring with the Seaside Grasshopper and other species, and habitat conditions that may favour competing species over the Lake Huron Grasshopper (COSEWIC 2015).

1.8 Recovery actions completed or underway

2004-2011 Lake Huron Grasshopper co-occurs with Pitcher's Thistle. The Pitcher's Thistle - Dune Grasslands Recovery Team has overseen many recovery initiatives to benefit dune habitats, including installation of signage, preparation of outreach materials, and implementation of monitoring of all dunes on Manitoulin Island and southern Lake Huron (Parks Canada Agency 2011; Jones unpublished data 2000-2017; Parks Canada Agency unpublished data 2004-2017).

2017 The Township of Central Manitoulin has received a permit to do work on the Providence Bay beach that will lead to an overall benefit for Pitcher's Thistle and the dune habitat. Beneficial actions include removal of large patches of non-dune shrub species, invasive species, and ground thatch to increase available open sand. This should also improve habitat for the Lake Huron Grasshopper.

2017 Pancake Bay Provincial Park has put information about the Lake Huron Grasshopper in the park's visitor information tabloid (Morris, pers. comm. 2018).

2016-on-going The Manitoulin Phragmites Project is reducing the presence of invasive European Common Reed (*Phragmites australis australis*) across Manitoulin and Cockburn Islands. The Project has already brought Phragmites under control at all Manitoulin sites where the invasive was in the habitat of the Lake Huron Grasshopper.

An annual Beach Action Day to remove invasive species from the Providence Bay beach with the public has also been hosted.

2.0 Recovery

2.1 Recommended recovery goal

The recommended recovery goal for the Lake Huron Grasshopper is to maintain or increase the current number of populations at 13 or more, and maintain or increase the current range of the species by maintaining and protecting habitat and reducing other threats.

There is no information on abundance for any population of Lake Huron Grasshopper, therefore abundance cannot be used at present to measure the success of recovery. The number of populations is known and can be tracked, and may be used to measure recovery results. Lake levels also rise and fall, causing habitat size and species abundance to change periodically. Therefore, the recommended goal of maintaining populations and current range is a reasonable way to ensure the Lake Huron Grasshopper is able to survive and recover.

2.2 Recommended protection and recovery objectives

Table 2. Recommended protection and recovery objectives.

Number	Protection or recovery objective
1	Protect the species and its habitat with on-the-ground actions to reduce threats.
2	Assist municipalities and planning authorities in protecting the Lake Huron Grasshopper and its habitat.
3	Increase awareness about the Lake Huron Grasshopper and its rare habitat.
4	Fill knowledge gaps related to species distribution, abundance and biology.

2.3 Recommended approaches to recovery

Table 3. Recommended approaches to recovery of the Lake Huron Grasshopper in Ontario.

Objective 1: Protect the species and its habitat with on-the-ground actions to reduce threats.

Relative priority	Relative timeframe	Recovery theme	Approach to recovery	Threats or knowledge gaps addressed
Critical	Ongoing	Management, Stewardship	<p>1.1 Reduce off-trail ATV use and trampling from foot traffic.</p> <ul style="list-style-type: none"> • Designate trails, install signage, place barriers. • Assist landowners and municipalities with on-the-ground actions. 	<p>Threats:</p> <ul style="list-style-type: none"> • Heavy recreational use. • Invasive species. • Problematic native species.
Critical	Ongoing	Management, Stewardship	<p>1.2 Remove or control invasive species in the habitat of the Lake Huron Grasshopper.</p> <ul style="list-style-type: none"> • Follow species-specific best management practices for control. • Assist landowners and municipalities with on-the-ground actions. • Explain and encourage the use of the clean equipment protocol for any vehicle that must enter the beach. 	<p>Threats:</p> <ul style="list-style-type: none"> • Invasive species.
Critical	Ongoing	Protection, Communication	<p>1.3 Reduce or stop the removal of native dune vegetation.</p> <ul style="list-style-type: none"> • Work with by-law and conservation officers to identify sites where increased compliance may be needed. • Provide positive information to landowners and beach users which suggest balanced alternatives. 	<p>Threats:</p> <ul style="list-style-type: none"> • Heavy recreational use • Intentional removal of vegetation

Recovery Strategy for the Lake Huron Grasshopper in Ontario

Objective 2: Assist municipalities and planning authorities in protecting the Lake Huron Grasshopper and its habitat.

Relative priority	Relative timeframe	Recovery theme	Approach to recovery	Threats or knowledge gaps addressed
Critical	Short-term	Communication	<p>2.1 Ensure municipalities and planning authorities are aware of the Lake Huron Grasshopper and its protection under Ontario's <i>Endangered Species Act 2007</i>.</p> <ul style="list-style-type: none"> • Provide occurrence data and information on threats. 	<p>Threats:</p> <ul style="list-style-type: none"> • Shoreline development. • Heavy recreational usage. • Invasive species. • Intentional removal of vegetation.
Necessary	On-going	Communication, Education and Outreach	<p>2.2 Ensure municipalities and planning authorities have a basic understanding of dune habitats and their dynamics.</p> <ul style="list-style-type: none"> • Discuss dune habitats with planners and other municipal staff or officials. • Provide educational materials about dunes for municipal use which can be given to the public if needed during the planning process. 	<p>Threats:</p> <ul style="list-style-type: none"> • Shoreline development. • Heavy recreational usage. • Invasive species. • Intentional removal of vegetation.
Beneficial	Long-term	Policy, Communication	<p>2.3 Encourage by-laws that prohibit alteration of beaches.</p> <ul style="list-style-type: none"> • Discuss such by-laws with municipalities. • Create an example by-law that can be used as a starting point. 	<p>Threats:</p> <ul style="list-style-type: none"> • Heavy recreational usage. • Intentional removal of vegetation.

Recovery Strategy for the Lake Huron Grasshopper in Ontario

Objective 3: Increase awareness about the Lake Huron Grasshopper and its rare habitat.

Relative priority	Relative timeframe	Recovery theme	Approach to recovery	Threats or knowledge gaps addressed
Critical	On-going	Education and Outreach	<p>3.1 Create educational materials to engage the public in protecting the Lake Huron Grasshopper.</p> <ul style="list-style-type: none"> • Provide materials to nature centres, tourist operations, libraries, and other public sites. • Use different types of media including video and sound in addition to print. 	<p>Threats:</p> <ul style="list-style-type: none"> • Heavy recreational usage. • Invasive species. • Intentional removal of vegetation.
Necessary	On-going	Education and Outreach; Stewardship	<p>3.2 Host events where the public can assist with stewardship and habitat improvement</p> <ul style="list-style-type: none"> • Show participants information about the Lake Huron Grasshopper and dune habitats. • Enlist the public's help, show participants they can make a difference, and create a sense of team work. • Events may involve actions in 1.1, such as removal of invasive species, installation of signs, etc. 	<p>Threats:</p> <ul style="list-style-type: none"> • Heavy recreational usage. • Invasive species. • Intentional removal of vegetation.
Necessary	On-going	Education and Outreach; Stewardship	<p>3.3 Encourage landowners to steward their dunes and to feel pride in ownership of a natural area.</p> <ul style="list-style-type: none"> • Assist landowners with actions on their properties. • Give recognition such as books, caps, etc. for good stewardship. 	<p>Threats:</p> <ul style="list-style-type: none"> • Heavy recreational usage. • Invasive species. • Intentional removal of vegetation.
Beneficial	On-going	Communication	<p>3.4 Provide information on financial incentives to landowners for protection of dune habitat, such as Conservation Land Tax Incentive Program (CLTIP). Habitat Stewardship Program (HSP) etc.</p>	<p>Threats:</p> <ul style="list-style-type: none"> • Heavy recreational usage. • Invasive species. • Intentional removal of vegetation.

Recovery Strategy for the Lake Huron Grasshopper in Ontario

Relative priority	Relative timeframe	Recovery theme	Approach to recovery	Threats or knowledge gaps addressed
Beneficial	On-going	Education and Outreach	<p>3.5 Partner with schools to do outreach with younger people.</p> <ul style="list-style-type: none"> • Discuss the Lake Huron Grasshopper, dune habitats, and species-at-risk. • Work to improve perceptions about insects in general. 	<p>Threats:</p> <ul style="list-style-type: none"> • Heavy recreational usage. • Intentional removal of vegetation.
Beneficial	Long-term	Communication, Stewardship	<p>3.6 Create partnerships with local groups.</p> <ul style="list-style-type: none"> • Enlist help with stewardship, habitat improvement, and outreach activities. 	<p>Threats:</p> <ul style="list-style-type: none"> • Heavy recreational usage. • Invasive species. • Intentional removal of vegetation.

Objective 4: Fill knowledge gaps related to species distribution, abundance and biology.

Relative priority	Relative timeframe	Recovery theme	Approach to recovery	Threats or knowledge gaps addressed
Critical	Short-term	Inventory	<p>4.1 Survey additional dune sites for the Lake Huron Grasshopper.</p> <ul style="list-style-type: none"> • Search during appropriate timing and weather conditions. 	<p>Knowledge gaps:</p> <ul style="list-style-type: none"> • Distribution and abundance of Lake Huron Grasshopper.
Necessary	Long-term	Monitoring and assessment	<p>4.2 Determine relative abundance and population trends for the Lake Huron Grasshopper.</p> <ul style="list-style-type: none"> • Develop and implement a monitoring program to track abundance and threats to habitat so that risk can be better assessed and response to impacts can occur quickly. • Use monitoring data to track population trends and level of risk faced by the Lake Huron Grasshopper. • Use data to determine whether encroaching vegetation is a threat in periods of low lake level. 	<p>Knowledge gaps:</p> <ul style="list-style-type: none"> • Abundance and trends in Lake Huron Grasshopper populations. • Problematic native species.

Recovery Strategy for the Lake Huron Grasshopper in Ontario

Relative priority	Relative timeframe	Recovery theme	Approach to recovery	Threats or knowledge gaps addressed
Beneficial	Long-term	Research	<p>4.3 Investigate the biology of the Lake Huron Grasshopper.</p> <ul style="list-style-type: none"> • Study interactions with other species, especially Seaside Grasshopper. • Study microhabitat requirements and determine conditions that may favour the Lake Huron Grasshopper over competing species. • Study behaviours such as egg-laying, feeding, etc. 	<p>Knowledge gaps:</p> <ul style="list-style-type: none"> • Biological factors that affect habitat requirements, distribution, and abundance. • Problematic native species.
Beneficial	Long-term	Research	<p>4.4 Based on information from 4.3, study the potential effects of climate change on the Lake Huron Grasshopper, for example:</p> <ul style="list-style-type: none"> • whether higher temperatures favour other species over the Lake Huron Grasshopper; • Whether shorter winters may change phenology such as timing of egg-laying; and • Whether altered climate may affect microhabitat suitability. 	<p>Knowledge Gaps</p> <ul style="list-style-type: none"> • Whether climate change is a threat to the Lake Huron Grasshopper.

Narrative to support approaches to recovery

Working with municipalities will be important for recovery. On most Manitoulin Island shorelines, the land below the historical high water mark is a right-of-way owned by the municipality (Land Information Ontario 2018). This includes most of the area occupied by the Lake Huron Grasshopper. The back dune (inland) part of wider beaches or dunes is usually privately owned. The municipal part of the beach is used by the adjacent landowners and sometimes by visitors from elsewhere if there is access. Helping municipalities find ways to manage and monitor their beaches may be useful.

Some municipalities have by-laws about what activities may occur on the beach and prohibit modification of the beach without permission. It may be helpful for municipalities that do not yet have these by-laws to see sample wording to find out what such by-laws may entail.

Preventing the introduction of invasive species is probably more efficient than trying to remove them once established. Invasive species are often brought in on vehicles, so outreach and education to encourage cleaning vehicles is essential to stop the spread. ATV riders should be encouraged to spray down or dry-brush their machines before leaving home, and larger equipment operators should be encouraged to follow Ontario's Clean Equipment Protocol for Industry (Halloran et al. 2013).

Outreach and education are the primary strategies to help the Lake Huron Grasshopper. Misconceptions about beaches, insects in general, and appropriate use of public property may lead people to damage the habitat or harm the species. Good, clear information about the value of natural dune vegetation in preventing sand erosion, about grasshoppers as part of the web of life, and about harm from off-trail ATV use may help reduce unintended damage as well as intentional removal of vegetation.

2.4 Performance measures

Recovery of the Lake Huron Grasshopper will be successful if 13 or more populations of the Lake Huron Grasshopper are extant in Ontario

- after 30 years or full cycle of lake levels is completed, with levels returning to the current high level of 2018.

2.5 Area for consideration in developing a habitat regulation

Under the ESA, a recovery strategy must include a recommendation to the Minister of the Environment, Conservation and Parks on the area that should be considered in developing a habitat regulation. A habitat regulation is a legal instrument that prescribes an area that will be protected as the habitat of the species. The recommendation provided below by the author will be one of many sources considered by the Minister when developing the habitat regulation for this species.

The Lake Huron Grasshopper is highly restricted to sparse areas of dune and beach habitats, yet it is difficult to constrain the exact area needed by the species within an overall dune system. Dunes and beaches change due to dynamic factors, so within the dunes, the location and size of the sparse patches needed by the species may also change. As well, areas that may be unsuitable for the Lake Huron Grasshopper can become suitable, as for example if disturbance opens sand in a very densely vegetated area. In addition, when lake levels rise and the foredune is submerged, the mid-dune may become the primary habitat for the species although this area may not always be occupied. Finally, open conditions may be found further from the lake in larger dune systems, so distance from the lake is not a defining characteristic for required habitat.

Therefore, it is suggested that habitat with all three of these criteria be regulated:

- Sites occupied by the Lake Huron Grasshopper in the last 15 years regardless of visible presence in any single year;
- Vegetation types of:
 - Little Blue-stem-Long-leaved Reed Grass-Great Lake Wheatgrass Dune Grassland (SDO1-2) or
 - American Dune Grass – Beach Pea – Sand Cherry Dune Grassland (SDO1-3) or
 - Active Eolian Sand G006X;Or
 - Tree and shrub cover less than or equal to 25%, following parameters for dune grasslands (Lee et al. 1998); and native dune grasses or wormwood present;
- An area of 15 metres of natural vegetation of any type adjacent to this area to include the trees and shrubs that may be involved in maintaining dune dynamics.

It is recommended that habitat, even if thought to be unoccupied, remain regulated for a period of at least 15 years. There are several reasons for this. First, it may take a number of years to determine presence/absence; at some times of year surveys may not locate individuals although the species is present. Also, the Lake Huron Grasshopper presumably has the ability to move between sites when required (COSEWIC 2015) such as when habitat conditions are not favourable, and it has been documented occasionally to return to sites after a period of absence. It is possible that the species may be periodically present when conditions permit, but conditions may vary over several years. Finally, habitat suitability may increase or decrease depending on lake levels and other factors. If a complete lake level cycle takes 30 years, then 15 years should encompass a range of levels including those that confer suitable habitat.

An area of 15 m adjacent to dunes was determined on the ground by the Pitcher's Thistle – Dune Grasslands Recovery Team to be involved in the maintenance of habitat for Pitcher's Thistle. In Ontario, this 15 m area is part of regulated habitat for Pitcher's Thistle (OMNRF 2015), and the federal critical habitat identification for that species

(Parks Canada Agency 2011) also includes it. Pitcher's Thistle occurs at almost all sites occupied by the Lake Huron Grasshopper, so it is assumed that the need to protect the factors that drive the overall dune dynamics would be the same for both species although the two may not always occur in the same parts of the dunes.

Glossary

Backdune: Within the dune complex, the area further from the water closer to the trees; the area that is not the foredune (see below).

Committee on the Status of Endangered Wildlife in Canada (COSEWIC): The committee established under section 14 of the Species at Risk Act that is responsible for assessing and classifying species at risk in Canada.

Committee on the Status of Species at Risk in Ontario (COSSARO): The committee established under section 3 of the *Endangered Species Act, 2007* that is responsible for assessing and classifying species at risk in Ontario.

Conservation status rank: A rank assigned to a species or ecological community that conveys its degree of rarity at the global (G), national (N) or subnational (S) level. These ranks, termed G-rank, N-rank and S-rank, are not legal designations. Global and National ranks are determined by NatureServe. Subnational S-ranks are determined for Ontario by the Natural Heritage Information Centre. The conservation status of a species or ecosystem is ranked from 1 to 5, preceded by the letter G, N or S which shows the geographic scale of the assessment. The numbers mean the following:

- 1 = critically imperilled
- 2 = imperilled
- 3 = vulnerable
- 4 = apparently secure
- 5 = secure
- NR = not yet ranked

Crepitation: A crackling, snapping, or buzzing sound made in flight by expanding or contracting the hind wings.

Duff: The layer of dried, dead plant debris that builds up on the surface of the ground.

***Endangered Species Act, 2007* (ESA):** The provincial legislation that provides protection to species at risk in Ontario.

Extirpation: When a species has been completely eliminated from a defined area; a localized extinction.

Femur: The long, upper segment of a grasshopper's hind leg.

Foredune: Within the dune complex, the area closest to the water that consists of dry sand not being regularly swept with waves.

Instars: Phases in the development of an insect or other invertebrate animal.

Natural succession: The natural progression of the vegetation as it increases from a sparse cover of herbaceous plants, to a denser cover, to an increase in shrubs

and woody seedlings, to a growth of trees, and ultimately to a forest. Some types of open (non-forest) ecosystems require natural disturbance events such as fires or wind storms to prevent natural succession and the growth of trees.

Nymph: A juvenile stage of a developing grasshopper.

Protonum—see *Thorax*

Species at Risk Act (SARA): The federal legislation that provides protection to species at risk in Canada. This act establishes Schedule 1 as the legal list of wildlife species at risk. Schedules 2 and 3 contain lists of species that at the time the Act came into force needed to be reassessed. After species on Schedule 2 and 3 are reassessed and found to be at risk, they undergo the SARA listing process to be included in Schedule 1.

Species at Risk in Ontario (SARO) List: The regulation made under section 7 of the *Endangered Species Act, 2007* that provides the official status classification of species at risk in Ontario. This list was first published in 2004 as a policy and became a regulation in 2008.

Stridulation: Sound produced by rubbing one part of the body against another. Includes the familiar noise made by crickets. Band-winged Grasshoppers stridulate by rubbing the femur against the front wing (Bland 2003).

Tegmina (plural; singular tegmen): The front wing(s) of grasshoppers and the order Orthoptera (includes crickets, katydids, and others).

Thorax: The middle section of the insect body between the head and the abdomen.

Vegetation community: Recurring groups of plants found together on specific types of substrates and moisture requirements; examples may include Dry-Fresh Mineral Sugar Maple Forest or Willow Organic Thicket Swamp.

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Appendix A

Table 4. List of sites where the Lake Huron Grasshopper currently occurs (COSEWIC 2015), with ownership information. Most recent observation for all sites is 2014.

Site Name	Region	Private Ownership	Municipal Ownership*	Other Ownership
Nottawaga Beach	Georgian Bay; Simcoe County	Multiple owners	Tiny Township	
Giant's Tomb Island	Georgian Bay; Simcoe County	Multiple Owners	Tiny Township	Ontario Parks
Carter Bay	Manitoulin Island	Two owners	Central Manitoulin	
Providence Bay	Manitoulin Island	Multiple owners	Central Manitoulin	
Dean's Bay	Manitoulin Island	Multiple owners	Central Manitoulin	
Lonely Bay	Manitoulin Island	Multiple owners	Central Manitoulin	
Square Bay	Manitoulin Island	Multiple owners	Central Manitoulin	
Dominion Bay	Manitoulin Island	Multiple owners	Central Manitoulin	
Shrigley Bay	Manitoulin Island	Multiple owners	Burpee-Mills	
Portage Bay	Manitoulin Island	Multiple owners	Burpee-Mills	
Taskerville	Manitoulin Island	One owner	Burpee-Mills	Nature Conservancy Canada
Desert Point, Great Duck Is.	Northern Lake Huron	One owner	Northeastern Manitoulin and Islands	
Pancake Bay	Southern Lake Superior			Ontario Parks

*In the Manitoulin District, below the historical high water line, most shorelines are owned by the municipality. Above that line, the dunes may be in private ownership.

Table 5. List of some dune sites with suitable habitat (Jones 2001-2003, 2006; Bakowsky and Henson 2014) suggested for future surveys for the Lake Huron Grasshopper.

Site Name	Region
Big Sand Bay, Christian Island**	Georgian Bay
Little Sand Bay, Christian Island**	Georgian Bay
West Sand Bay, Christian Island	Georgian Bay
Hope Island	Georgian Bay
Beckwith Island	Georgian Bay
Cawaja Beach	Georgian Bay
Dorcas Bay	Bruce Peninsula
Black Creek Provincial Park	Bruce Peninsula
Oliphant	Bruce Peninsula
Chantry Dunes, Southampton	Bruce County
Inverhuron Provincial Park	Bruce County
Lurgen Beach	Bruce County
Timber Bay	Manitoulin Island

Recovery Strategy for the Lake Huron Grasshopper in Ontario

Site Name	Region
Hyndman Bay	Cockburn Island
Wagosh Bay	Cockburn Island
Western Duck Island	Northern Lake Huron
Horseshoe Bay, Great Duck Island	Northern Lake Huron
John Island	North Channel, Lake Huron
Aird Island	North Channel, Lake Huron
Klotz Island	North Channel, Lake Huron
Mississagi Island	North Channel, Lake Huron
North Sandy Island	Lake Superior
Ile Parisienne	Lake Superior
Goulais Bay	Lake Superior
Oiseau Bay*	Lake Superior

* Not shown on map in Figure 4. ** Proximal sites depicted by a single symbol.