PROPOSED

Species at Risk Act
Management Plan Series

Management Plan for the Magdalen Islands Grasshopper (*Melanoplus madeleineae*) in Canada

Magdalen Islands Grasshopper

2025

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[1] https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html

Preface

The federal, provincial and territorial government signatories under the Accord for the Protection of Species at Risk (1996)[2] agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada[3]. Under the *Species at Risk Act* (S.C. 2002, c. 29)[4] (SARA), the federal competent ministers are responsible for the preparation of management plans for listed species of special concern and are required to report on progress within five years after the publication of the final document on the Species at Risk Public Registry.

The Minister of Environment and Climate Change and Minister responsible for the Parks Canada Agency is the competent minister under SARA for the Magdalen Islands Grasshopper and has prepared this management plan, as per section 65 of SARA. To the extent possible, it has been prepared in cooperation with the Government of Quebec and local conservation organizations, as per section 66(1) of SARA.

Success in the conservation 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 plan and will not be achieved by Environment and Climate Change, the Parks Canada Agency, or any other jurisdiction alone. All members of the public are invited to join in supporting and implementing this plan for the benefit of the species and society as a whole.

Implementation of this management plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

[2] www.canada.ca/en/environment-climate-change/services/species-risk-act-accord-funding.html
[3] The Government of Quebec is not signatory to the Accord for the Protection of the Species at Risk (1996). However, the Government of Quebec does cooperate with the federal government in the conservation of species at risk of common interest.
[4] https://laws.justice.gc.ca/eng/acts/S-15.3/index.html

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Executive Summary

The Magdalen Islands Grasshopper (*Melanoplus madeleineae*) is a large (21 mm to 29 mm) species in the order Orthoptera. The main diagnostic feature of the adult stage is the hind femur, which is dark crimson on the lower surface and non-banded (solid black) on the outer surface. This species is globally endemic to the Magdalen Islands, an archipelago in the Gulf of St. Lawrence, and is a relic of the Wisconsinian glaciation. The Magdalen Islands Grasshopper is genetically derived from the Northern Spur-throat Grasshopper (*Melanoplus borealis*), a closely related and morphologically similar species. The Magdalen Islands Grasshopper was assessed as Special Concern by COSEWIC in November 2016 and listed as such on Schedule 1 of the *Species at Risk Act* (SARA) in August 2021. In Quebec, the Magdalen Islands Grasshopper has no protected status under the *Act Respecting Threatened or Vulnerable Species* (CQLR, c E-12.01).

The species' range is small and is globally restricted to the Magdalen Islands archipelago in Canada. It is known to be present on seven of the eight main islands in the archipelago. Six of these (Île du Havre Aubert, Île de la Grande Entrée, Île du Cap aux Meules, Grosse Île, Île du Havre aux Maisons and Île de la Pointe-aux-Loups) are connected by sandbars and smaller islands, whereas the seventh, Île d'Entrée, is separated from the main group of islands by about a 4 km stretch of water. At present, it is not possible to determine the species' distribution and abundance on the Magdalen Islands. The lack of data and information on the insect's habitat, life cycle and ecology limits our ability to develop conservation objectives to support its recovery.

The four main threats to the Magdalen Islands Grasshopper are direct mortality due to vehicle collisions along roads and railways, trampling due to recreational activities such as hiking and dog walking, habitat alteration caused by invasive and other problematic species and genes, and the increase in the frequency and severity of storms linked to climate change. The overall impact of the threats is considered to be low. The Magdalen Islands Grasshopper also faces certain limiting factors: its limited dispersal capacity, the short growing season, fluctuating weather patterns, and predators and parasites.

The management objective for the Magdalen Islands Grasshopper is to maintain the distribution of the species throughout its known range (Île du Havre Aubert, Île du Cap aux Meules, Île du Havre aux Maisons, Grosse Île, Île de l'Est, Île de la Grande Entrée and Île d'Entrée), including any new populations that may be discovered in the future.

Broad strategies to address the threats and attain the management objective include land management, awareness raising, research and monitoring, education and training, and institutional development. Conservation measures to implement these broad strategies are described in section 6 of this document. Among the conservation measures identified, promoting knowledge acquisition is the highest in priority, in order to implement conservation measures that target the right locations (recent and historical occurrences) and are suited to the species' needs (food and habitats).

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1. COSEWIC* Species Assessment Information

Date of Assessment: November 2016

Common Name (population): Magdalen Islands Grasshopper

Scientific Name: *Melanoplus madeleineae*

COSEWIC Status: Special Concern

Reason for Designation: This Canadian endemic is restricted to the Magdalen Islands in Quebec, where it is known to occur on seven of the eight main islands. Threats to the species are low, but recreational activities, road mortality and habitat loss through predicted coastal erosion may impact the species or its habitat.

Canadian Occurrence: Quebec

COSEWIC Status History: Designated Special Concern in November 2016.

* COSEWIC (Committee on the Status of Endangered Wildlife in Canada)

2. Species Status Information

According to NatureServe (2022), the global conservation status rank for the Magdalen Islands Grasshopper (*Melanoplus madeleineae*) is G3 (Vulnerable). In Canada, the species is ranked as N3 (vulnerable). The provincial conservation status rank for Quebec has not yet been determined (SNR; NatureServe 2022). In November 2016, the Magdalen Islands Grasshopper was assessed as Special Concern by COSEWIC and in August 2021, it was listed as such on Schedule 1 of the *Species at Risk Act* (SARA). In Quebec, the species has no protected status under the *Act Respecting Threatened or Vulnerable Species* (CQLR, c E-12.01).

3. Species Information

3.1. Species Description

The Magdalen Islands Grasshopper is an arthropod in the order Orthoptera (grasshoppers, crickets and locusts) and belongs to the family Acrididae (short-horned grasshoppers). The Magdalen Islands Grasshopper is part of the large subfamily Melanoplinae, or spur-throated grasshoppers, which feed mainly on herbaceous plants (COSEWIC 2016) and have a spur (or prosternal spine) located ventrally between the front legs (Johnson 2002).

The morphological description provided by Vickery and Kevan (1978) and the genetic analysis conducted by Chapco and Litzenberger in 2002 suggest that *Melanoplus madeleineae* is a sister taxon of the Northern Spur-throat Grasshopper (*Melanoplus*

borealis). More specifically, scientists believe that the Magdalen Islands Grasshopper is a unique taxon derived from the Northern Spur-throat Grasshopper during the Wisconsin glaciation period (Vickery and Kevan 1978; Chapco and Litzenberger 2002).

Life cycle – The Magdalen Islands Grasshopper has a life cycle consisting of three stages: egg, nymph (consisting of several immature stages) and adult (Criddle 1935). The species overwinters as an egg. Egg hatching within a subpopulation may be spread over a period of two weeks on average (Vickery and Kevan 1985), although the period may exceed two weeks. After hatching in late spring or early summer, the nymph undergoes gradual metamorphosis, eventually transforming into an adult. Each immature stage resembles a smaller version of the adult, and with each successive moult, the insect increases in size. Northern Spur-throat Grasshopper nymphs go through five nymphal stages, or instars (ECCC 2022a). The nymphs of the Magdalen Islands Grasshopper may go through the same number of instars, given the taxonomic and phylogenetic proximity of the two species. Two distinctive features—the size and shape of the wing buds—can be used to differentiate the developmental stages. The time it takes individuals to complete their development can vary depending on local weather conditions. In general, development from newly hatched nymph to adult takes about one month (COSEWIC 2016).

Eggs – There is no detailed information in the literature on the eggs of the Magdalen Islands Grasshopper. Nonetheless, the eggs of the Northern Spur-throat Grasshopper have been described as elongate and usually brown in colour; they are laid in oothecae[5] of 30 to 50 eggs at a depth of 1 to 3 cm in a substrate or against stones, plant structures such as roots, or similar microsites (COSEWIC 2016). The eggs of the Northern Spur-throat Grasshopper may undergo a two-year diapause[6] when environmental conditions are unfavourable (Fielding 2008). The oothecae of the Magdalen Islands Grasshopper may experience a temporary cessation of development for a similar period of time.

Nymphs (immature stages) – The Magdalen Islands Grasshopper undergoes gradual metamorphosis, developing and growing through several nymphal stages, or instars. In its sister taxon, the Northern Spur-throat Grasshopper, this occurs in five successive nymphal stages, each involving a moult (COSEWIC 2016). The first nymphal stage begins when the newly hatched larva leaves the soil and climbs up a nearby higher surface to moult. This stage lasts only a few days and marks the start of feeding and growth. The second stage is similar to the first; however, the second instar's body is longer and has two rudimentary wing buds, called flaps. A few days later, moulting occurs again, giving rise to the third instar, which has some venation on the developing wingbuds. The fourth instar is even larger than the previous instars because feeding is the main activity during this part of the life cycle. At this stage, the wingbuds have clearly defined veins and more closely resemble the fully developed wings of an adult.

[5] "A capsule containing the eggs of certain insects, such as those in the orders Orthoptera, Mantodea or Blattodea" *[Translation]* (Villemant and Blanchot 2004).

[6] "Temporary cessation of activity or development occurring in insects in winter or during the dry season, or in response to a shortage of food resources" *[Translation]* (Larousse 2023).

At the beginning of the fifth stage, the individual is nearly mature and its wingbuds resemble fully developed wings (Criddle 1935). This stage typically lasts about a week, after which the grasshopper moults and transforms into an adult with a functional reproductive system and developed but not fully functional wings. It takes a full day for the wings to harden and become functional (COSEWIC 2016).

Adults – The Magdalen Islands Grasshopper is considered to be a large grasshopper (COSEWIC 2016). Females range from 24 mm to 29 mm in length, and males, from 21 mm to 25.5 mm. Sexual dimorphism in the species is limited to this difference in body size (Vickery and Kevan 1985). The degree of facial slope in the Magdalen Islands Grasshopper differs from that in most other members of the family Acrididae in that its head is vertically oriented and not strongly slanted posteriorly. The species has a pair of filiform antennae. Unlike other grasshoppers, it has a head that is not especially large in relation to the rest of its body, and its sclerotized exoskeleton is not very hard (COSEWIC 2016). The Magdalen Islands Grasshopper has a prosternal spine (spur) on its ventral side. As in the other members of the subfamily Melanoplinae, the spur is located between the front legs (Johnson 2002). According to the morphological description provided by Vickery and Kevan in 1978, the forewings of adults are slightly pigmented but lack transverse bands. The hindwings are not pigmented (Vickery and Kevan 1978).

Several characteristics can be used to distinguish the Magdalen Islands Grasshopper from other members of the family Acrididae, including the dark crimson colour on the lower edge of the hind femur (Figures 1 and 2). In addition, the outer surface of the hind femur is uniformly black, with no bands. This insect can also be identified by the presence of golden-brown markings near the eyes (COSEWIC 2016). From a morphological standpoint, the Magdalen Islands Grasshopper is very similar to its sister taxon, the Northern Spur-throat Grasshopper. There are nonetheless differences between the two species: the Northern Spur-throat Grasshopper is slightly larger and the male genitalia have a different shape (Vickery and Kevan 1978).

Figure 1. Male Magdalen Islands Grasshopper. Specimen collected by Paul Catling on Île du Havre aux Maisons in the Magdalen Islands (Quebec), on August 11, 2010, and deposited at the Canadian National Collection of Insects, Arachnids and Nematodes in Ottawa, Ontario. Photo: Cory Sheffield (taken from COSEWIC 2016).

Figure 2. Male Magdalen Islands Grasshopper. Specimen observed in the Dune-du-Sud area of Île du Havre aux Maisons, in the Magdalen Islands (Quebec), on July 21, 2023, by the organization Attention FragÎles (Sara Desharnais Richard, Mélanie Bourgeois and Lucie d'Amours).

3.2. Species Population and Distribution

This orthopteran is a Magdalen Islands endemic, meaning that its distribution is restricted to the Magdalen Islands, which are located in the eastern part of the province of Quebec (Figure 3). In all, the archipelago is composed of 14 islands and islets, which have an area of 205 km^2. The species has been recorded from seven of the main islands in the archipelago: Île du Havre Aubert, Île du Cap aux Meules, Île du Havre aux Maisons, Grosse Île, Île de l'Est, Île de la Grande Entrée and Île d'Entrée. Most of the large islands are connected by dunes and sandbars, but two of the main islands are

separated from the main island chain by an expanse of ocean. Île d'Entrée is located 4.8 km from the southeastern tip of six of the main islands but, despite this distance, supports a Magdalen Islands Grasshopper subpopulation (Catling *et al*. 2013). Île Brion is also separated from the other islands; it lies about 16 km north of Grosse Île but, unlike Île d'Entrée, is uninhabited, and the species was not found there. In addition, a number of small, uninhabited islands, including Île aux Loups Marins and Île Paquet, have not been surveyed for the species at the appropriate time of year (COSEWIC 2016).

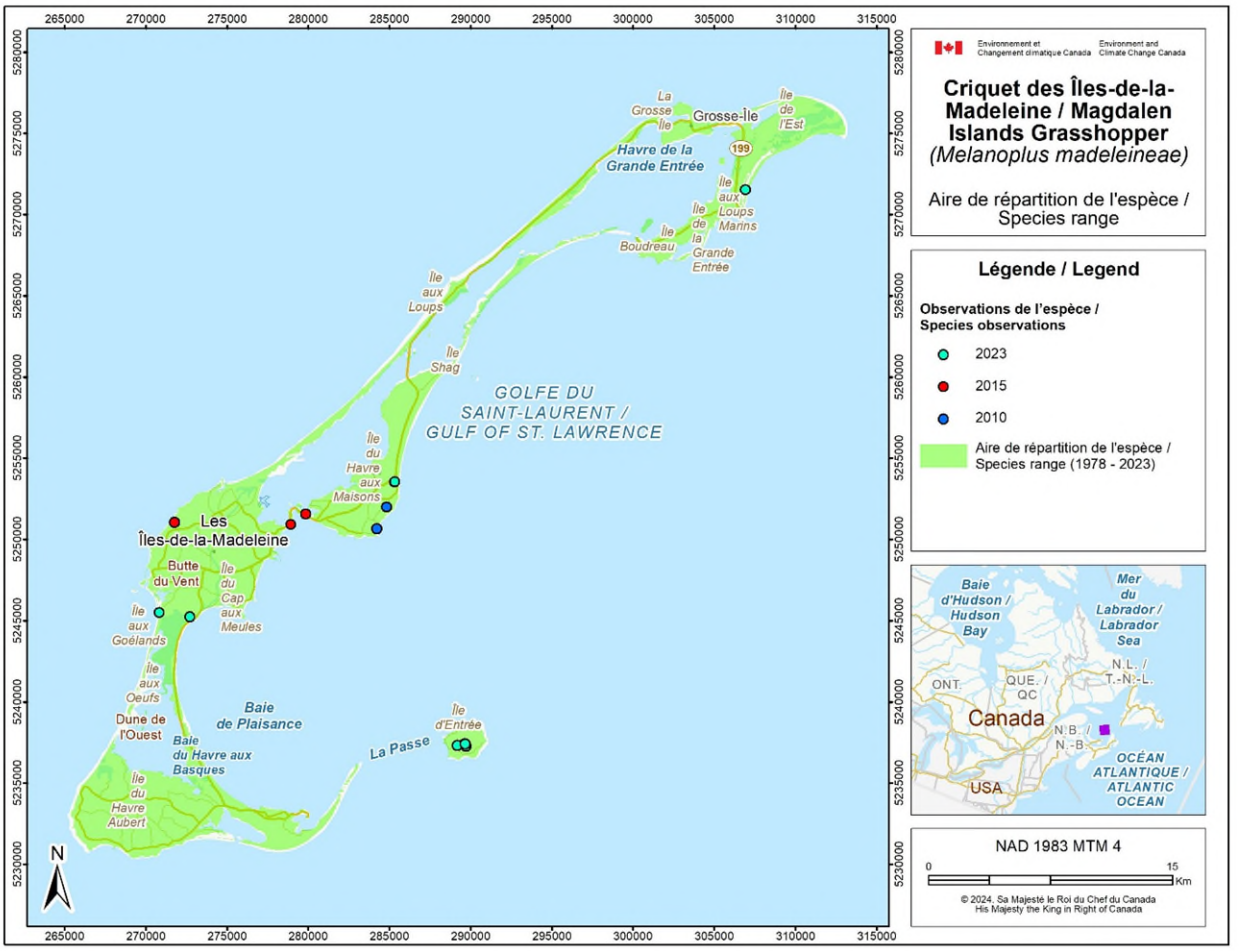

Figure 3. Canadian range of the Magdalen Islands Grasshopper and locations of recent observations (from the past 20 years).

Previous molecular analyses have demonstrated a close link between the Magdalen Islands Grasshopper and the Northern Spur-throat Grasshopper. However, the latter species is likely not present on the Magdalen Islands based on the current information (Vickery and Kevan 1985). According to Chapco and Litzengerger (2002), the Magdalen Islands Grasshopper can be differentiated from its sister taxon on the basis of distinctive genetic characteristics.

Although efforts have been devoted to finding new subpopulations, little is known about the spatial structure of the extant subpopulations. Since the Magdalen Islands

Grasshopper is probably not a strong flier (Vickery and Kevan 1985), dispersal of individuals between the different islands is likely limited.

In general, entomological surveys on the Magdalen Islands have been limited (COSEWIC 2016). Approximately 80 voucher specimens of the Magdalen Islands Grasshopper can be found in museum collections. Surveys, inventories and collection activities took place between 1912 and 2023 inclusive (Vickery and Kevan 1978; Chapco and Litzenberger 2002; Catling *et al*. 2013). Only the surveys from 2010, 2015 and 2023 include precise GPS coordinates (Catling *et al*. 2013; COSEWIC 2016; Figure 3).

COSEWIC (2016) estimated the maximum extent of occurrence[7] for this grasshopper species to be 1,021 km^2. The index of area of occupancy (IAO), based on a 2 km x 2 km grid, is approximately 568 km^2 (COSEWIC 2016). The habitat used to calculate the IAO includes areas where the species is not present, such as dense woodlands, sandy beaches and open ocean, which do not constitute suitable habitat for the Magdalen Islands Grasshopper but are nevertheless included in the spatial calculations. Therefore, the biological area of occupancy is expected to be much smaller than 568 km^2 (COSEWIC 2016). Since, in a given subpopulation, egg hatching does not occur simultaneously and may be spread over a period of more than two weeks, it is difficult to estimate the peak adult activity period for the species. For this reason, it is also challenging for researchers to time their collection activities to coincide with peak adult emergence (COSEWIC 2016). This indicates that the detection rate and perceptions of the rarity of the Magdalen Islands Grasshopper could vary significantly depending on the timing of surveys. The lack of data on the species' phenology is also an impediment to efforts to assess the species' abundance and distribution.

3.3. Needs of the Species

The survey and inventory effort associated with the Magdalen Islands Grasshopper has been infrequent and poorly adapted to the species' phenology. Consequently, it is challenging to characterize this insect's habitat accurately and in detail. The first description of collection sites dates back to 2013 (Catling *et al*. 2013). Catling *et al.* described these sites as open meadow habitats with native vegetation. Based on the authors' brief description, the most abundant plant species at these sites belong to the genera *Carex*, *Juncus* and *Eupatorium* (Catling *et al*. 2013). However, these species were not present at all the sites where the grasshopper has been observed in the past and in this study.

Foraging and cover habitat – Surveys conducted in 2015 in preparation for the status report on the Magdalen Islands Grasshopper allowed new characteristics to be included in the description of the species' habitat. Immature specimens were collected in two grassy areas different from those described by Catling *et al.* in 2013. The first collection site, at Cap-aux-Meules, was an expansive grassy meadow with well-drained sandy soil

[7] The extent of occurrence is the area included in a polygon without concave angles that encompasses the geographic distribution of all known populations of a wildlife species (COSEWIC 2016).

adjacent to a steep sandy cliffside. The presence of short forb-type plants including Queen Anne's Lace (*Daucus carota*), Red Clover (*Trifolium pratense*) and hawkweeds (*Hieracium* spp.) was noted. Besides these species, flowering plants in the family Asteraceae (composites), including goat's-beard (*Trapopogon* spp.), and an exotic species, Tufted Vetch (*Vicia cracca*), were also observed (COSEWIC 2016).

The second collection site visited during the 2015 surveys was on Île du Havre aux Maisons, specifically on the beach less than 5 m above sea level, adjacent to dune habitats. This site contained suitable habitat for various forb species. The presence of a number of the same plants observed at the Cap-aux-Meules site was noted; however, the second site was dominated by tall herbaceous vegetation such as Beach Pea (*Lathyrus japonicus*) and American Beachgrass (*Ammophila breviligulata*) (COSEWIC 2016).

The inventories conducted in the summer of 2023 by the organization Attention FragÎles also provided more details on the foraging and cover habitats of the Magdalen Islands Grasshopper. Among the individuals observed and/or captured, two were collected in open habitat in Havre-aux-Maisons, specifically meadows with shrubs less than 30 cm tall. The main plant species observed in this type of habitat were Northern Bayberry (*Myrica pensylvanica*), American Green Alder (*Alnus viridis* subsp. *crispa*), Rugosa Rose (*Rosa rugosa*), Common Juniper (*Juniperus communis*), Sheep Laurel (*Kalmia angustifolia*), spiraea (*Spiraea*) and Black Crowberry (*Empetrum nigrum*) (Attention FragÎles 2023). Various species of grasses and goldenrods were also observed. In the same surveys in 2023, three individuals were spotted on Île d'Entrée along unmaintained or partially maintained roadsides. One individual was also collected at Grosse-Île in a wetland of mainly rushes, asters and grasses. Finally, the last two Magdalen Islands Grasshoppers found during these activities were photographed at Cap-aux-Meules but, since these observations were incidental, they were not accompanied by habitat descriptions.

In light of this information, the habitats used by the Magdalen Islands Grasshopper seem to consist of herbaceous meadows, some of which are affected by anthropogenic disturbances, as well as wetlands and early successional shrubland (Catling *et al*. 2013; COSEWIC 2016 and Attention FragÎles 2023).

Oviposition sites and overwintering habitat – Gravid females lay their eggs in soil composed mainly of sand with gravel and sandstone sediments (COSEWIC 2016). Like its sister taxon, the Magdalen Islands Grasshopper likely overwinters as an egg in soft sandy substrate. Open densely vegetated and grassy areas appear to be suitable oviposition sites, judging from the preferences of the Northern Spur-throat Grasshopper (Vickery and Kevin 1985). Since no accurate information is available on the oviposition and overwintering sites used by Magdalen Islands Grasshoppers, these are assumptions based on the behaviour and preferences of similar species.

Fielding (2011) reported that gravid female grasshoppers can likely influence the fitness of their offspring through their selection of oviposition sites. A lack of sites with suitable

substrate has been found to inhibit oviposition in the Migratory Grasshopper (*Melanoplus sanguinipes*), a species that is widely distributed in North America. In other words, if the substrate is unsuitable, gravid females will have difficulty finding optimal sites and this will affect hatching success (Fielding 2011). In a study on a different *Melanoplus* species, Beckerman (2002) found that that grass cover and litter accumulation can reduce the availability of oviposition sites. Fields with abundant tall grasses were found to harbour smaller populations of the Red-legged Grasshopper (*Melanoplus femurrubrum*), even though these types of grasses make up the bulk of the species' diet (Beckerman 2002). The thick litter layer and the shade created by tall grasses appears to reduce the soil temperature, making the soil cooler and unfavourable for egg laying. As a result, fewer optimal microsites were available (Beckerman 2002). More in-depth research is needed to determine the effects of soil composition and canopy cover on soil temperatures and oviposition activities.

Unlikely habitat – During the most recent surveys, conducted by COSEWIC in 2015 as part of the preparation of the status assessment for the Magdalen Islands Grasshopper (2016), the species was not found in three types of habitat: open foredune plant communities, sparsely vegetated dune plant communities, and dense woodlands. With regard to dense woodlands, none of the studies conducted to date on the Magdalen Islands Grasshopper have specifically examined this type of habitat. Furthermore, the Magdalen Islands Grasshopper has not been recorded in densely wooded habitat in any of the surveys targeting the species.

3.4. Limiting factors[8]

Limited dispersal capacity – At present, there is little information on the movement and dispersal capacity of the Magdalen Islands Grasshopper in the literature. According to Vickery and Kevan (1985), the adults of this species are likely not strong fliers, which means that their dispersal capacity may be limited. Past surveys reported the presence of the Magdalen Islands Grasshopper on six of the main islands in the archipelago (COSEWIC 2016). These six islands are connected by dunes, which may provide a terrestrial route allowing individuals of the species to disperse. Nonetheless, it is not known whether the adults and immature stages would be able to use this route to move between the islands. The insect was recently observed on Île d'Entrée, which is located more than 4 km from the main islands. Outside the Magdalen Islands, the landmass closest to Île d'Entrée (105 km south of it) is Prince Edward Island; dispersal to this landmass is considered unlikely, according to the status report for the species (COSEWIC 2016).

Short growing season – The growing season in the Magdalen Islands is fairly short, with maximum temperatures of 29 °C and 31 °C and minimum temperatures of 7.5 °C and 6.6 °C in July and August, respectively (COSEWIC 2016). Since grasshoppers are herbivores, plant productivity has an effect on their abundance. During years with a

[8] It is important to distinguish between limiting factors and threats. Limiting factors are generally not human induced and include characteristics that make the species or ecosystem less likely to respond to recovery or conservation efforts (ECCC 2022a).

shorter growing season, the Magdalen Islands Grasshopper has less time to complete its life cycle (COSEWIC 2016).

It has been projected that, by the end of the 21st century, the length of the growing season will increase significantly across Canada and will be 20 to 40 days longer than during the reference period (1981 to 2010) (Natural Resources Canada [NRCan] n.d.; Ouranos 2023). According to Ouranos (2023), the number of growing degree-days will increase over the coming decades in the Magdalen Islands. A longer growing season will enable grasshoppers to complete their life cycle and will facilitate their dispersal to new habitats (COSEWIC 2016). A longer growing season in the archipelago could indeed be beneficial to the species.

Fluctuating weather patterns – Grasshoppers are poikilothermic organisms: their body temperature is not stable and fluctuates with that of the surrounding environment (Bligh and Johnson 1973). This makes them dependent on the ambient temperature for movement and to warm their bodies (COSEWIC 2016). Cool summer temperatures and fog appear to be suboptimal for grasshopper movement (COSEWIC 2016). In subpopulations of this insect, year-to-year variations in weather patterns could reduce the number of individuals by diminishing foraging activities (COSEWIC 2016). The wind can also have a significant influence on the grasshopper's movement, foraging and mating behaviour. Strong winds can lead to increased erosion at sites with exposed soil (COSEWIC 2016). In such a case, eggs hidden in the first few centimetres of soil would be exposed to factors that are not normally present (e.g. large temperature variations, predators).

Predators – Predators and parasitoids exert pressure on grasshopper populations and limit their ability to recover (Branson 2005; Laws and Joern 2012). A wide range of vertebrates and invertebrates prey on grasshoppers (Preston-Mafham 1990). The proportion of predation associated with each taxon varies with the habitat and geographic location. Vertebrate predators are considered to have been a driving force in the development of chemical defences in Orthoptera (Preston-Mafham 1990). Thus, it can be assumed that vertebrates play a key role in regulating grasshopper populations in terrestrial habitats (COSEWIC 2016).

Terrestrial vertebrate diversity on the Magdalen Islands is low, and no studies have been conducted to analyze the effects of vertebrate predation on the Magdalen Islands Grasshopper. However, researchers recognize that predation by birds contributes to the regulation of grasshopper populations, although the effects can be complex and may vary with the availability of food resources and with the local grasshopper community (Bock *et al.* 1992; Branson 2005). Approximately 320 bird species have been recorded on the Magdalen Islands, contributing to the large number of potential vertebrate predators (Preston-Mafham 1990). Among these, the Piping Plover is likely to have the capacity to prey on immature and adult grasshoppers if present in large numbers in its habitat (COSEWIC 2016). The Magdalen Islands Grasshopper has been found in regurgitated pellets from Whimbrel (*Numenius phaeopus*) on Grosse Île (Skeel and Mallory 1996). The data suggest that the grasshoppers are an important ephemeral

food source for Whimbrels, even though these birds tend to be generalist insect predators (Skeel and Mallory 1996).

Predator-prey relations between native mammals and the Magdalen Islands Grasshopper have not been studied in depth. Only a few native terrestrial mammals prey on the insect, including micromammals such as the Meadow Vole (*Microtus pennsylvanicus*) and Deer Mouse (*Peromyscus maniculatus*) (COSEWIC 2016). The Red Fox is a known predator of grasshoppers, but is not considered to be native to the islands (Catling 1988; Read and Bowen 2001).

There are numerous generalist arthropod predators of orthopterans, including spiders, beetles, robber flies, ants, and several wasp species (Preston-Mafham 1990). Some of them, such as beetle species in the genus *Epicauta* (Diptera), feed on grasshopper eggs (Joern and Gaines 1990; Pinto 1991). No specimens of *Epicauta* have been found on the Magdalen Islands (COSEWIC 2016).

An indirect explanation for the low abundance of this grasshopper species in coastal habitats is provided by a study on the diet of the Piping Plover (*Charadrius melodus*) in the Magdalen Islands (Shaffer and Laporte 1994). The researchers noted the presence of fast-flying insects such as tiger beetles in the droppings of some individuals of the Piping Plover, a bird species that occupies coastal habitats in the Magdalen Islands (COSEWIC 2016). This suggests that the Piping Plover likely preys on grasshoppers as well, since they are slower moving, although their presence was not detected in the species' droppings in 1994 (Shaffer and Laporte 1994; Majka and Shaffer 2008). Given their slow movement, gravid females are especially likely to be predated by the Piping Plover.

The effects of these biotic interactions vary depending on multiple factors such as the availability of habitats and resources for the different taxa. Most of these factors have not been examined in depth for the Magdalen Islands Grasshopper (ECCC 2022a). As a result, both the biotic interactions and the effects on the dynamics of Magdalen Islands Grasshopper populations are poorly understood (COSEWIC 2016).

Parasites – Several families in the orders Diptera (e.g. Sacrophagidae) and Hymenoptera (e.g. Scelionidae) are parasitoids of grasshoppers (Smith 1940; Smith and Finlayson 1950; York and Prescott 1952; Rees 1985; Przybyszewski and Capinera 1991; Laws and Joern 2012). A study conducted by Branson in 2003 showed that mites are also major parasites of grasshoppers (Branson 2003).

A large number of nematode species are known parasites or parasitoids of orthopterans (Baker and Capinera 1997). For example, a juvenile hairworm indirectly causes the death of mature Drumming Katydid (*Meconema thalassinum*) individuals (Biron *et al*. 2005). Some fungal and bacterial pathogens also have adverse effects on grasshopper populations (Bucher and Stephens 1957; Streett and McGuire 1990). *Entomopthora grylli* and *Nosema locustae* are two fungal pathogens that attack grasshoppers (COSEWIC 2016). *Entomopthora grylli* has been characterized as a potential specialist

pathogen of grasshoppers and crickets (Pickford and Riegert 1964; Erlandson *et al*. 1988). Like most pathogens of orthopterans, the status of fungal and bacterial pathogens in subpopulations of the Magdalen Islands Grasshopper has not yet been analyzed by scientists (COSEWIC 2016).

4. Threats

4.1. Threat Assessment

The Magdalen Islands Grasshopper threat assessment is based on the IUCN-CMP (International Union for Conservation of Nature–Conservation Measures Partnership) unified threats classification system (Salafsky et al. 2008). Threats are defined as the proximate activities or processes that have caused, are causing, or may cause in the future the destruction, degradation, and/or impairment of the entity being assessed (population, species, community, or ecosystem) in the area of interest (global, national, or subnational). Limiting factors are not considered during this assessment process. For purposes of threat assessment, only present and future threats are considered. Historical threats, indirect or cumulative effects of the threats, or any other relevant information that would help understand the nature of the threats are presented in the Description of Threats section.

Table 1. COSEWIC threat assessment for the Magdalen Islands Grasshopper (2016)

Threat[a]	Threat Description	Impact[b]	Scope[c]	Severity[d]	Timing[e]	Detailed Threat
1	Residential & Commercial Development	Negligible	Negligible	Moderate	High	
1.1	Housing & Urban Areas	Negligible	Negligible	Moderate	High	Because of the isolated island setting, the Magdalen Islands are not particularly affected by real-estate development, which remains minimal due to the difficulty of accessing the islands.
2	Agriculture & Aquaculture	Unknown	Small	Unknown	High	
2.1	Annual & Perennial Non-Timber Crops	Unknown	Small	Unknown	High	The species' use of hayfields (a perennial crop) is unknown. Mowing hay to meet livestock needs may have an adverse effect on the Magdalen Islands Grasshopper.
2.3	Livestock Farming & Ranching	Unknown	Small	Unknown	High	Livestock farming is known to increase grazing in the pastures on the islands. However, the impacts of grazing on the species are still unknown.

Threat[a]	Threat Description	Impact[b]	Scope[c]	Severity[d]	Timing[e]	Detailed Threat
3	Energy Production & Mining	Negligible	Negligible	Extreme	Moderate	
3.3	Renewable Energy	Negligible	Negligible	Extreme	Moderate	In December 2020, the Dune-du-Nord wind farm was commissioned. A second wind project (four wind turbines) on the Magdalen Islands is in the planning and consultation phase (Hydro-Québec 2020).
4	Transportation & Service Corridors	Low	Small	Serious	High	See Description of Threats section
4.1	Roads & Railroads	Low	Small	Serious	High	The mortality risk to grasshoppers is greater on dirt roads, where grasshoppers rest. Females are at greater risk since this type of road provides a suitable substrate for egg laying (COSEWIC 2016).
6	Human Intrusions & Disturbance	Low	Small	Moderate	High	See Description of Threats section
6.1	Recreational Activities	Low	Small	Moderate	High	In recent years, tourism has become more popular on the Magdalen Islands. The islands are a prime destination for outdoor recreation enthusiasts. A significant increase in visitor numbers has been observed, and visitors tend not to use the established trails and parking lots (Tourismes Île de la Madeleine n.d.).
7	Natural System Modifications		Not a Threat	Slight	Neutral or Potential Benefit	
7.3	Other Ecosystem Modifications		Not a Threat	Slight	Neutral or Potential Benefit	Effects vary depending on the modifications made and can be neutral or beneficial. For example, the construction of dikes and planting of Sea Lyme Grass to prevent erosion would stabilize some eroded areas, thus reducing habitat loss (COSEWIC 2016).

Threat[a]	Threat Description	Impact[b]	Scope[c]	Severity[d]	Timing[e]	Detailed Threat
8	Invasive & Other Problematic Species, Genes & Diseases	Low	Pervasive	Slight	High	See Description of Threats section
8.1	Invasive Non-Native/Alien Species/Diseases	Low	Pervasive	Slight	High	The Magdalen Islands Grasshopper is at risk of being predated by various non-native predators. Invasive alien plants present on the islands could alter the composition of vegetation communities and the abundance of species that use open habitats. The impacts of invasive alien species on endemic species are greater in an island environment than in mainland environments.
10	Geological Events	Not Calculated	Small	Extreme	Unknown	
10.2	Earthquakes/Tsuna-mis	Not Calculated	Small	Extreme	Unknown	This threat may be present, but was not calculated. Currently, the six main islands are linked by sandbars. Earthquakes and tsunamis could potentially damage the connecting habitat and reduce connectivity between the islands.
11	Climate Change & Severe Weather	Unknown	Pervasive	Unknown	Moderate	See Description of Threats section
11.1	Habitat Shifting & Alteration	Not Calculated	Small	Unknown	Low	
11.2	Droughts	Not Calculated	Pervasive	Unknown	Low	According to Ouranos (2023), the total precipitation in the Magdalen Islands is expected to increase in the next two decades.
11.3	Temperature Extremes	Unknown	Pervasive	Unknown	Moderate	The estimated mean annual temperature should increase in future years, but an increase in heat waves is not expected (Ouranos 2023; MAMH n.d.). Total annual precipitation, in either liquid or frozen form,

Threat[a]	Threat Description	Impact[b]	Scope[c]	Severity[d]	Timing[e]	Detailed Threat
						should also follow this trend. Extreme temperature variations will put pressure on the physiological tolerances of grasshoppers on the islands. The actual impacts that this threat is expected to have on the species are not known. The decrease in frozen precipitation in the winter and increase in freeze-thaw events within a 24-hour period could also have an impact on the species' survival (Ouranos 2023).
11.4	Storms & Flooding	Not Calculated	Unknown	Unknown	Low	The frequency of Atlantic hurricanes is increasing (Vecchi *et al*. 2021). The islands naturally experience the strong winds and storms associated with hurricanes (e.g. Juan 2003, Dorian 2019, Fiona 2022), which cause flooding and erosion (COSEWIC 2016). With ongoing sea-level rise and the gradual disappearance of coastal ice, submergence will be more likely during fall and winter storms, and will be more damaging (Ouranos 2019). Researchers predict that the average annual rate of coastal retreat on the Magdalen Islands due to erosion will increase from 0.24 m to 0.66 m by 2060 (Serret 2021; Bernatchez *et al*. 2008). Climate change could increase the frequency and duration of these phenomena.

[a] **Threats** are numbered using the IUCN Classification System. Only those threats that are relevant to the species are presented in this table and in Section 4.2 Description of Threats.

[b] **Impact** – The degree to which a species is observed, inferred, or suspected to be directly or indirectly threatened in the area of interest. The impact of each threat is based on Severity and Scope rating and considers only present and future threats. Threat impact reflects a reduction of a species population or decline/degradation of the area of an ecosystem. The median rate of population reduction or area decline for each combination of scope and severity corresponds to the following classes of threat impact: Very High

(75% declines), High (40%), Medium (15%), and Low (3%). Unknown: used when impact cannot be determined (e.g. if values for either scope or severity are unknown); Not Calculated: impact not calculated as threat is outside the assessment timeframe (e.g. timing is insignificant/negligible or low as threat is only considered to be in the past); Negligible: when scope or severity is negligible; Not a Threat: when severity is scored as neutral or potential benefit.

[c] **Scope** – Proportion of the species that can reasonably be expected to be affected by the threat within 10 years. Usually measured as a proportion of the species' population in the area of interest. (Pervasive = 71–100%; Large = 31–70%; Restricted = 11–30%; Small = 1–10%; Negligible < 1%).

[d] **Severity** – Within the scope, the level of damage to the species that can reasonably be expected to be affected by the threat within a 10-year or three-generation timeframe. Usually measured as the degree of reduction of the species' population. (Extreme = 71–100%; Serious = 31–70%; Moderate = 11–30%; Slight = 1–10%; Negligible < 1%; Neutral or Potential Benefit ≥ 0%).

[e] **Timing** – High = continuing; Moderate = only in the future (could happen in the short term [< 10 years or 3 generations]) or now suspended (could come back in the short term); Low = only in the future (could happen in the long term [> 10 years or 3 generations]) or now suspended (could come back in the long term); Insignificant/Negligible = only in the past and unlikely to return, or no direct effect but limiting.

4.2. Description of Threats

According to the threat assessment, the overall impact of the threats to the Magdalen Islands Grasshopper is low (COSEWIC 2016). The table in the previous section (Table 1) shows that the species likely faces three low-impact threats: (1) Roads & Railroads; (2) Recreational Activities; and (3) Invasive & Other Problematic Species, Genes & Diseases. Each of these low-impact threats is described in detail below according to the type of impact, beginning with the threats with the greatest impact (i.e. low, negligible, and unknown). Threats whose impacts were not calculated for various reasons (e.g. occur outside the 10-year study period, or scope or severity unknown) are not described.

Although the impacts of climate change and severe weather were assessed as unknown when the status report for the species was published (COSEWIC 2016), since 2016, several negative impacts of these changes on insects have been highlighted in the literature. Consequently, Threat 11 in the IUCN-CMP's unified threats classification system will be briefly described in this section.

Threats with Low Impacts

IUCN-CMP Threat 4: Transportation & Service Corridors

4.1 Roads & Railroads

Road construction and use can lead to mortality in the Magdalen Islands Grasshopper, particularly during the summer tourist season, when there is more traffic on the roads. In 2022, around 73,600 people visited the Magdalen Islands (Bérubé 2022), which is roughly 10,000 more than in 2019, the previous record year (Bérubé 2022). The number of vehicles on the islands' road network is bound to increase if the tourism trend continues in the next few years.

Vehicles on the roads are likely to run over grasshoppers, influencing population dynamics in the subpopulations that live in the adjacent habitats (Catling *et al.* 2013). Increased tourism could encourage the expansion of the islands' road network.

Individuals that move at a slower-than-average pace are at greater risk of being run over by vehicles. This includes gravid females, which pause frequently when hopping from place to place (COSEWIC 2016). Infrequently used roads, which have a high sand and gravel content and are less compacted, generally have a substrate favourable to egg laying. Therefore, females face a greater risk of being crushed during the egg-laying period.

Furthermore, road construction contributes in general to the phenomenon of habitat fragmentation. Given the fact that adults of the species are not strong fliers, the question arises whether habitat fragmentation by roads could isolate local subpopulations (Rutledge 2003). Extreme weather events affecting the islands, such as

large storms and flooding, worsen the condition of roads. As a result, regular maintenance and repairs are required (COSEWIC 2016). These activities probably increase mortality in road rights-of-way (see Threat 11, Climate Change & Severe Weather).

IUCN-CMP Threat 6: Human Intrusions & Disturbance

6.1 Recreational Activities

The Magdalen Islands are a popular tourist destination in summer for recreational activities. Tourists and local residents alike frequently engage in hiking, mountain biking, and all-terrain vehicle (ATV) use. These activities contribute directly to the compaction of substrates, reducing the number of potential egg-laying sites. Water sports such as kitesurfing and windsurfing are also very popular. Foot traffic on and off the trails leading to the islands' beaches results in the grasshoppers being exposed to trampling risks (Catling *et al.* 2013). Camping and parking in non-designated areas also contribute to the disturbance of Magdalen Islands Grasshopper habitat (Rosenthal *et al.* 2022; Pierre Aquin pers. comm.). Berry picking, a popular activity throughout the archipelago, frequently takes place in coastal meadows and can increase trampling in the grasshopper's habitat.

Most visitors prefer to use the official network of open meadow parks, lookouts and cliffsides on the islands (Tourisme Îles de la Madeleine n.d.). However, other activities such as mountain biking are more difficult to control, since they usually occur in unprotected areas (COSEWIC 2016). Even though most activities take place in beach ecosystems along the coastline, sometimes users must travel through open meadow habitat to reach these areas (COSEWIC 2016). The habitat descriptions in earlier studies indicate that the Magdalen Islands Grasshopper likely uses open meadows.

Statistics on recreation and tourism show a marked increase in the number of tourists visiting the Magdalen Islands in recent years, except for the first year of the COVID-19 pandemic (2020). Michel Bonato, the general manager of Tourisme Îles de la Madeleine, has also observed an increase in off-season tourism (Bérubé 2022). Recreational activities not only cause substrate compaction and trampling, but also require the creation of new cycling networks and improvements to the ATV trail network on the islands (Larose 2022; Économie, Innovation et Énergie 2022). The severity and frequency of these disturbances and their proximity to the foraging or breeding habitat component in question determine the extent to which the species is affected (ECCC 2022a).

The results of this assessment are in line with those from a recent study by Rosenthal *et al.* (2022). When threat intensity is taken into account, recreational activities pose the third greatest threat to species at risk in Canada after invasive non-native/alien species and roads and railroads (Rosenthal *et al*. 2022).

IUCN-CMP Threat 8: Invasive & Other Problematic Species, Genes & Diseases (Low)

8.1 Invasive Non-Native/Alien Species/Diseases

The European Starling (*Sturnus vulgaris*), a resident bird species in the Magdalen Islands (Attention FragÎles 2010), likely poses a threat to the Magdalen Islands Grasshopper (Catling *et al*. 2013). An analysis of the species' fecal contents confirmed that it feeds on grasshoppers and other insects (Wood 1973). According to the most recent COSEWIC assessment and status report on the Magdalen Islands Grasshopper (COSEWIC 2016), the European Starling occurs in large numbers on the islands and is quickly multiplying. Other species of starlings are also considered to be predators of grasshoppers (Ji *et al*. 2008) and, in general, birds are known to be major predators of these insects (Preston-Mafham 1990). However, the predator-prey relationship between the European Starling and the Magdalen Islands Grasshopper has not been described in detail.

Domesticated and feral cats could also represent a threat to these grasshoppers (Errington 1936; McMurry and Sperry 1941; Konecny 1987; Catling 1988; Read and Bowen 2001). A study on the diet of feral cats in island environments has revealed that insects, particularly orthopterans, are among the organisms most frequently hunted by these generalist felines (Bonnaud *et al*. 2010). Increased rates of grasshopper predation by cats have been observed in summer, probably because grasshoppers are larger and more abundant then (Molsher *et al.* 1999).

Like invasive alien animal species, invasive alien plants also represent a potential threat to the Magdalen Islands Grasshopper. These plants' gradual invasion of and spread in open habitats and roadside edges could influence the composition and abundance of flowering plants, which serve as food sources for the Magdalen Islands Grasshopper (COSEWIC 2016). Sentinelle, a tool for detecting invasive alien species, identified various species of knotweeds (*Reynoutria* spp.), Reed Canarygrass (*Phalaris arundinacea*), Goutweed (*Aegopodium podagraria*) and buckthorns (*Rhamnus* spp.) on the Magdalen Islands (Ministère de l'Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs [MELCCFP] 2020). These species could displace existing plant communities and reduce the quantity and quality of suitable habitat for the Magdalen Islands Grasshopper.

Threats with Negligible Impacts

IUCN-CMP Threat 1.1: Housing & Urban Areas

The Magdalen Islands have not been greatly affected by real-estate development in recent decades. The isolated island setting, difficulty of accessing the islands (which occurs mainly by boat) and existing municipal bylaws have prevented a massive population influx, and have therefore limited the need for housing on the archipelago. Most lots are large, with houses only occupying a very small footprint. Rural areas on

the islands are protected under various municipal bylaws which limit real-estate development (COSEWIC 2016).

At the time the COSEWIC assessment and status report was being prepared (2015–2016), the impact of these threats was assessed as negligible. However, when the COVID-19 pandemic hit, many people began to work from home, and eventually an exodus from urban centres resulted (Jenny Heron pers. comm. 2023) The movement of large numbers of people from urban areas to more rural communities, including the Magdalen Islands, continues. In 2020, roughly 70 new houses were built on the archipelago (Larose 2021). In addition, development is spreading to the islands' agricultural areas (Larose 2021). Since the vast majority of farmland on the islands is not covered under the *Act Respecting the Preservation of Agricultural Land and Agricultural Activities* (enacted in 1978), land currently used for agriculture could be converted to residential use (Larose 2021). This factor, combined with increasing housing costs in urban centres across eastern Canada and the demand for larger properties with a significant amount of land, suggests that the influx of people moving to the Magdalen Islands will grow in the coming decades (Jenny Heron pers. comm. 2023).

IUCN-CMP Threat 3.3: Renewable Energy

The Dune-du-Nord wind farm was commissioned in December 2020. Less than two years later, the zoning amendment process began for a second wind farm project (Radio-Canada 2022). At the present time, the project, which involves four wind turbines in the archipelago, is in the planning and consultation phase. As was the case for the earlier project, the turbines and rights-of-way are expected to be located on Grosse Île (Radio-Canada 2022; Hydro-Québec 2022). The Magdalen Islands' 2020–2023 energy strategy recommends subsidies for solar energy and dynamic electricity rates to promote renewable energy, among others (La communauté maritime des Îles-de-la-Madeleine 2020). It is not known whether Magdalen Islands Grasshoppers use these rights-of-way and whether they are adversely affected by the construction of wind turbines and solar energy infrastructure; however, the area affected (scope) by the four new wind turbines is negligible.

Threats with Unknown Impacts

IUCN-CMP Threat 11: Climate Change & Severe Weather (Unknown)

In the Magdalen Islands, average temperatures and precipitation are expected to increase and extreme weather events, to intensify, according to the Ouranos climate change models (UDEMNouvelles 2022; Ouranos 2023). The Magdalen Islands Grasshopper is sensitive to significant climate fluctuations, primarily due to its small size and its inability to regulate its internal body temperature (COSEWIC 2016). Substantial variations in the temperature and moisture regimes in the surrounding environment have adverse effects on insects' metabolism and ultimately, their population dynamics (Harvey *et al.* 2022).

The Northern Spur-throat Grasshopper, the sister species of the Magdalen Islands Grasshopper, is already strongly affected by these types of changes. According to Brodeur *et al.* (2022), the Northern Spur-throat Grasshopper is a prime example of an insect threatened by climate change. The Northern Spur-throat Grasshopper has migratory tendencies and is currently moving northward and colonizing the tundra on the summits of a number of mountains on the Gaspé Peninsula. The species now occupies the Chic-Chocs (UDEMNouvelles 2022; Harvey *et al.* 2022). Although its sister species is able to migrate substantial distances to seek out a colder climate and other benefits, the Magdalen Islands Grasshopper does not seem to be a strong flier itself. In addition to its island environment and the long distances separating the Magdalen Islands from other terrestrial environments, the species may have physiological limitations that prevent it from migrating. In short, the migration possibilities for the Magdalen Islands Grasshopper are slim.

Some habitats in the region are greatly threatened by rising sea levels attributable to climate change (Bernatchez *et al.* 2008). Scientists estimate that, on the Magdalen Islands, the average annual rate of coastal retreat due to erosion could increase from 0.24 m to 0.66 m by 2060 (Serret 2021). The strong winds on the islands also play a role in this increased erosion. These winds could even expose the species' eggs buried in the soil, and reduce its movements and foraging and mating behaviours (COSEWIC 2016).

The Magdalen Islands Grasshopper's isolated island location, poor flying abilities and sensitivity to large climatic fluctuations, along with the loss of its habitat, put the species at particular risk from climate change impacts.

However, despite the potential adverse impacts described above, climate change could also have a positive effect on grasshopper population dynamics. As mentioned in the Limiting Factors section, the increase in average temperatures could significantly lengthen the growing season (NRCan n.d.; Ouranos 2023; COSEWIC 2016).

IUCN-CMP Threat 2.1: Annual & Perennial Non-Timber Crops

The Magdalen Islands Grasshopper was not identified in agricultural areas on the islands in recent surveys and it is not known whether the species uses hayfields. However, its closest phylogenetic relative, the Northern Spur-throat Grasshopper, tolerates haying fairly well. The creation of open habitats could even have positive effects on the species' population dynamics (COSEWIC 2016).

In 2019, around 15 Magdalen Island farmers were growing or using hay, thus contributing to the 475 ha (4.75 km^2) of land planted in forage crops on the islands (Larose 2021). This land represents 2.31% of the total area of the archipelago (205.5 km^2).

5. Management Objective

The management objective for the Magdalen Islands Grasshopper is to maintain the distribution of the species throughout its known range (Île du Havre Aubert, Île du Cap aux Meules, Île du Havre aux Maisons, Grosse Île, Île de l'Est and Île de la Grande Entrée), including any new populations that may be discovered in the future.

At present, the data are insufficient to support a quantitative objective for population abundance and distribution. The information on the distribution and abundance of local populations is incomplete. Consequently, an objective focusing on the distribution of the Magdalen Islands Grasshopper seems to be the approach best suited to managing the species.

As more knowledge is acquired, it will be possible to define the management objective more precisely. However, the recovery of the Magdalen Islands Grasshopper must not be postponed until more knowledge can be obtained. Reducing the threats to the species now can help contribute to its recovery, even though the progress made cannot be evaluated by using quantitative data.

6. Broad Strategies and Conservation Measures

6.1. Actions Already Completed or Currently Underway

Actions completed – Relatively few insect surveys have been conducted on the Magdalen Islands in order to improve our understanding of the biology and ecology of the Magdalen Islands Grasshopper. The species was first collected in 1912, and additional surveys were carried out in 1999, 2000, 2010, 2015 and 2023. Roughly 80 voucher specimens of the species can be found in museum collections.

When the COSEWIC status report was being prepared, targeted surveys for the species were carried out along transects in suitable habitats, from July 6 to 12, 2015. During this period, most grasshopper species were at various nymphal stages, since the adult activity period occurs between late July and mid-September. Immature grasshoppers were identified using the DNA barcoding technique, which is lethal. According to the results, the Magdalen Islands Grasshopper is likely fairly rare in comparison to the other grasshopper species on the islands (COSEWIC 2016). Figure 4 shows the location of the search efforts targeting the Magdalen Islands Grasshopper in 2015.

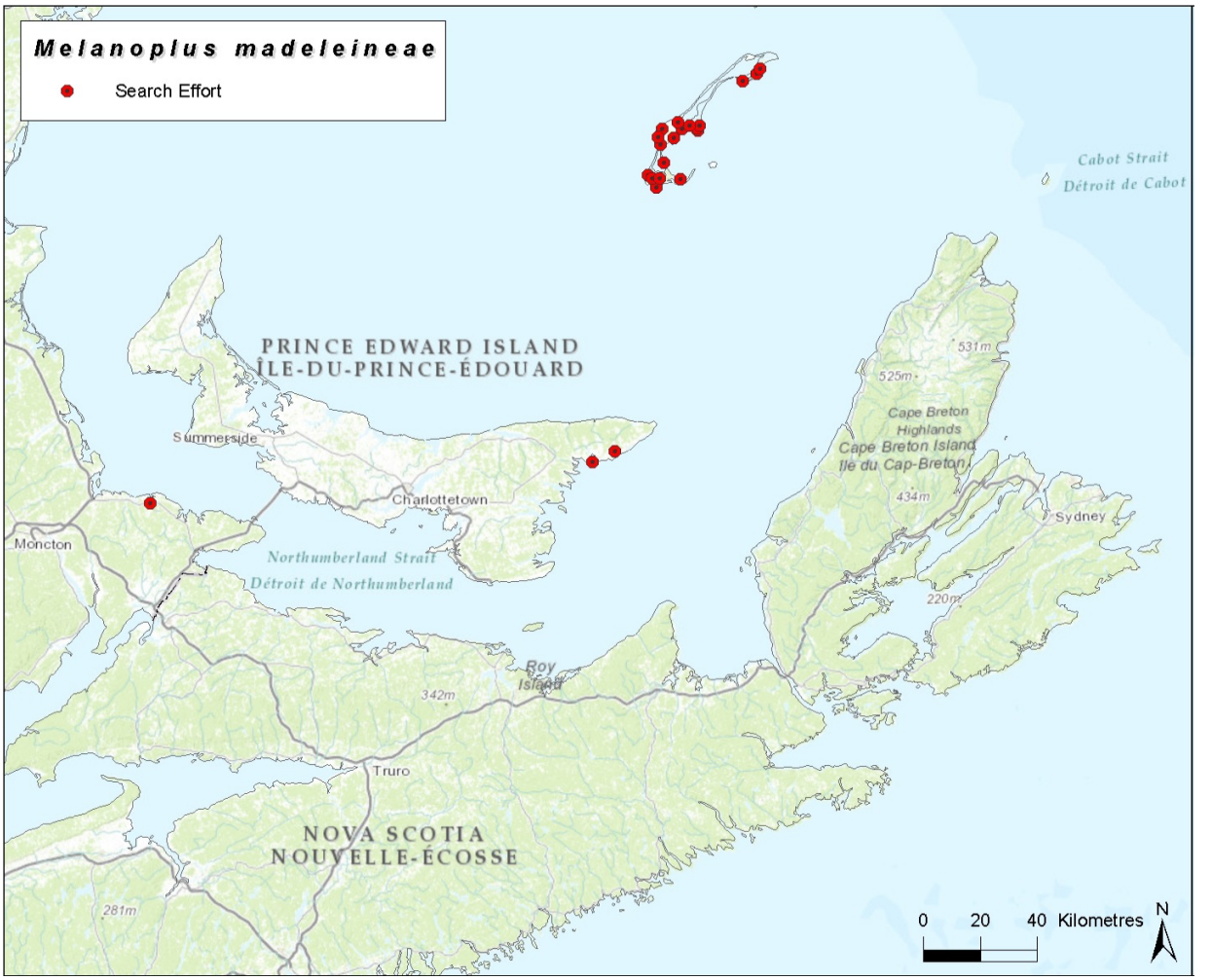

Figure 4. Search efforts for the Magdalen Islands Grasshopper in 2015 (taken from COSEWIC 2016).

To assist organizations in acquiring knowledge on the species before the publication of this management plan, the team of biologists at ECCC developed an internal protocol for grasshopper inventories based on expert advice. The protocol was also given to Attention FragÎles, a non-profit organization working in the Magdalen Islands.

This organization conducted inventories and searches for the species (2023), concentrating on the period in which the adult form is found, i.e. from the end of July to the end of September. A total of eight individuals were observed and/or collected during these efforts, including two at Havre-aux-Maisons, three on Île d'Entrée, two at Cap-aux-Meules and one on Grosse Île. Most grasshoppers were photographed between 10 am and 3:30 pm. However, two individuals were spotted in dusk searches (3:30 to 9:00 pm) at Havre-aux-Maisons.

Actions underway – To the knowledge of ECCC, no actions have been undertaken—aside from the inventories carried out by Attention FragÎles in 2023—since the release of the COSEWIC status report in 2016 (COSEWIC 2016). The publication of the management plan should help to raise the awareness of partners in the Magdalen

Islands on the importance of conserving the species, and thus facilitate the implementation of conservation measures.

The Magdalen Islands ecosystem is an area of interest for ECCC owing to the number of species at risk that occur there. The Canadian Wildlife Service (CWS) is responsible for the Pointe de l'Est National Wildlife Area (NWA) and, for a number of years, has been collaborating with local organizations such as Attention FragÎles (Aquin pers. comm. 2023). Although no actions contributing specifically to the species recovery have been implemented to date, altering the natural habitat in the NWA, which is located on the far northeastern end of the archipelago, is prohibited (Figure 5; ECCC 2022b). According to the most recent surveys, the species is present on Île de l'Est, and therefore part of its range is protected.

The Magdalen Islands have also been designated a Community-Nominated Priority Place (CNPP) (Aquin pers. comm. 2023). The priorities of the CNPP program are the following (ECCC 2022c):

- To contribute to the recovery of multiple species at risk;
- To advance partnerships and collaboration, including with Indigenous peoples;
- To contribute to priority co-benefits.

The Magdalen Islands Grasshopper will continue to benefit from the CNPP funding program that began in 2023. The plan is to acquire knowledge on the species' distribution in order to implement conservation measures adapted to the threats present.

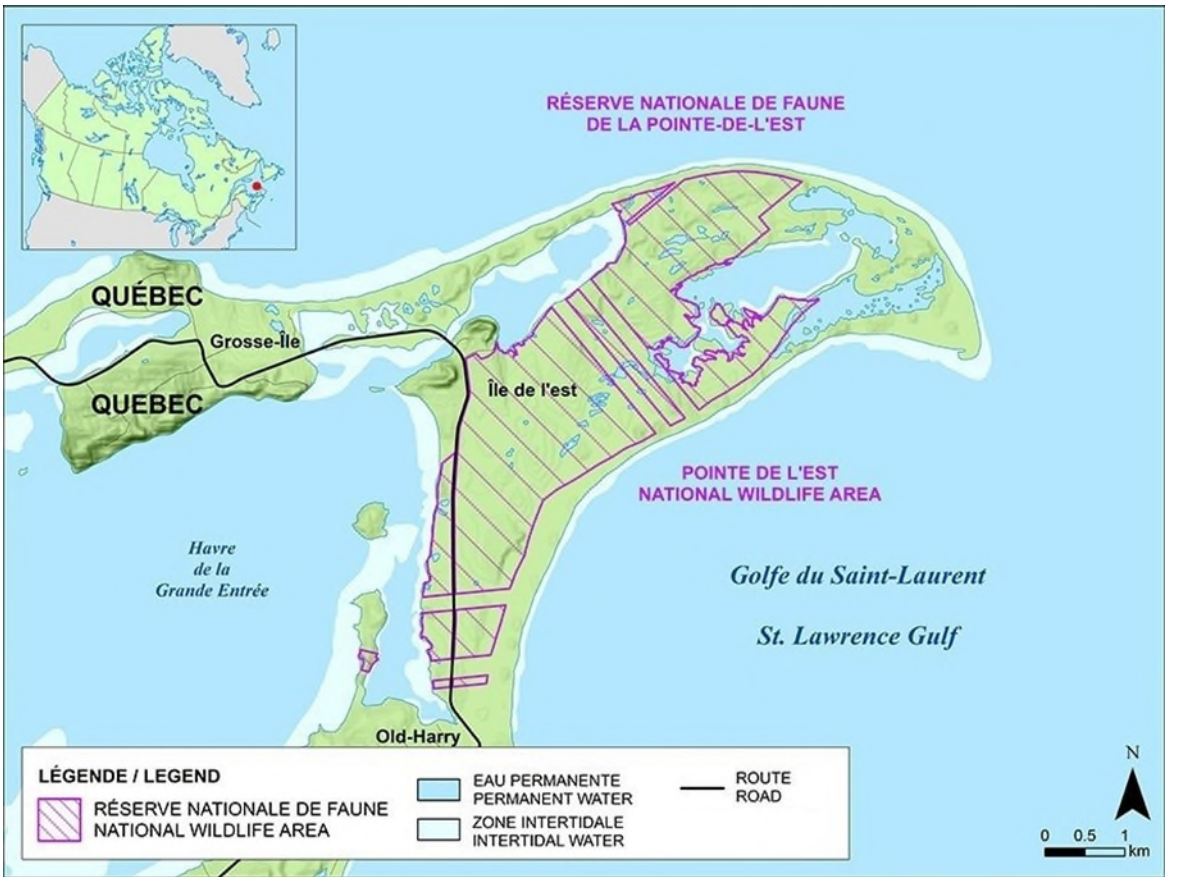

Figure 5. Map of the boundaries of the Pointe de l'Est NWA (724 ha) (Quebec) (taken from ECCC 2022b).

6.2. Broad Strategies

To achieve the management objective, the recommended conservation measures to be carried out are organized under five broad strategies:

- Land management (1)
- Awareness raising (3)
- Research and monitoring (8)
- Education and training (9)
- Institutional development (10)

These broad strategies were derived from version 2.0 of the CMP Conservation Actions Classification (Conservation Measures Partnership 2016).

6.3. Conservation Measures

The following table outlines conservation measures and an implementation schedule that, if undertaken, would support achieving the overall management objective.

Table 2. Recommended Conservation Measures and Implementation Schedule

Conservation Measure	Priority [e]	Threats or Concerns Addressed	Timeline
Broad Strategy			
1. Land management			
Avoid creating new hiking trails, unmarked ATV trails and access routes to beaches. Limit access to open grassy habitats (trampling and compaction) by encouraging the use of marked trails and parking lots. Install fencing and wooden footbridges and trails to channel visitor traffic. Develop good agricultural practices tailored to the species' needs and phenology (e.g. adapt haying periods).	Medium	Threats from agriculture (2) and recreational activities (6.1)	2025 – ongoing
3. Awareness raising			
Increase public awareness of best practices in outdoor recreation (e.g. staying on marked trails, accessing beaches at designated places, using designated parking lots). Install signage and publish articles in the local media and on social media. When the species' distribution and best practices in agricultural environments are known, raising the awareness of farmers could be envisaged.	High	Public support for conservation; threat from recreational activities (6.1)	2025 – ongoing

8. Research and monitoring			
Use standardized survey protocols to conduct surveys throughout the species' known range as well as in previously unsurveyed areas, in order to locate new populations and update information on historical populations (see Actions Already Completed or Currently Underway section).	High	Knowledge gap; measure progress towards attaining the management objective	2025–2028
Study the species' phenology to determine timing of adult emergence and to facilitate surveys. Investigate the life history of the Magdalen Islands Grasshopper by studying the species in captivity (e.g. development time, number of stages and duration of each stage; favourable conditions for nymphs, adults and overwintering eggs; fecundity and egg survival rate).	High	Knowledge gap	2025–2028
Conduct research to improve understanding of the species' ecology and needs (e.g. foraging, dispersal, recruitment and survival, microhabitat needs).	Medium	Knowledge gap	2025 – ongoing
Conduct research on the impacts of threats on the species (e.g. agriculture, urban development, roads and road maintenance, recreational activities, invasive species, climate change). Identify threats at known and newly discovered locations.	High	Roads & Railroads (threat 4.1), Recreational Activities (threat 6.1), Invasive Non-Native/Alien Species/Diseases (threat 8.1) and any other threat that can identified in the field	2025– ongoing
Conduct research on the anticipated impacts of climate change (storms and floods) on the species.	Low	Knowledge gaps and Climate Change & Severe Weather (threat 11)	2025 – ongoing

9. Education and training			
Support citizen science projects and tools (e.g. iNaturalist) likely to produce relevant data. Encourage acquisition of knowledge on alien species (and submit data, e.g. Sentinelle). Develop information brochures on the Magdalen Islands Grasshopper.	Medium	Knowledge gaps; measure progress towards attaining the management objective; public support for knowledge acquisition	Ongoing
10. Institutional development			
Establish and maintain collaborations and partnerships focused on the implementation of conservation activities and knowledge generation and sharing, while building local expertise on the Magdalen Islands Grasshopper and its habitat.	High	Knowledge acquisition; knowledge gap and all threats	Ongoing

[e] *"Priority" reflects the degree to which the measure contributes directly to the conservation of the species or is an essential precursor to a measure that contributes to the conservation of the species. High priority (essential) measures are considered those most likely to have an immediate and/or direct influence on attaining the management objective for the species. Medium priority (necessary) measures may have a less immediate or less direct influence on reaching the management objective, but are still important for the management of the population. Low priority (beneficial) conservation measures will likely have an indirect or gradual influence on reaching the management objective, but are considered important contributions to the knowledge base and/or public involvement and acceptance of the species.*

6.4. Narrative to Support Conservation Measures and Implementation Schedule

High priority (essential)

CMP Strategy 3: Awareness Raising

The Magdalen Islands Grasshopper is difficult to observe and identify due to its small size compared to other wild organisms such as mammals and birds. Furthermore, in general, there is a lack of interest in entomological research, and gaps remain in our understanding of insect biology. Consequently, the public is often unaware of the existence of these cryptic and poorly understood species, or of the potential impacts of human activities on their habitats.

Installing signage at key locations—outlining some of the behaviours of the Magdalen Islands Grasshopper, among other things— would benefit the species. Educating the public about best practices in outdoor recreation (e.g. staying on marked trails, not picking plants, parking vehicles in designated areas) would reduce the destruction and trampling of suitable habitats and food resources.

CMP Strategy 8: Research and Monitoring

Currently, the life history, ecology and habitat requirements of the Magdalen Islands Grasshopper are poorly understood and have not been studied in detail. Few surveys targeting the Magdalen Islands Grasshopper have been conducted on the islands. The surveys carried out to date have allowed the species' occurrence on a few islands to be assessed but have not resulted in an estimate of population size. Most of the islands studied have only been visited once, with only a small area covered. It would be useful to determine the species' occurrence on all the islands in the archipelago to get a better idea of its range. Carrying out surveys at new sites and recording data on habitat parameters (e.g. vegetation communities) will improve our understanding of the species' distribution and its habitat requirements. In addition, these surveys will allow information to be gathered on the threats to the species.

The data obtained in the new surveys could be combined with those from previous ones to develop a habitat suitability model, which could be used to determine priority areas for searches and thus better target the survey effort (ECCC 2022a). A standardized protocol is required to ensure that sites can be compared with each other and changes over time can be tracked. The internal protocol developed by ECCC (see Section 6.1) would be a good start. The use of standardized methods for surveying and for compiling and aggregating data from different surveys will make it easier for different groups and organizations to participate in the survey efforts. Establishing standardized methods will also help in creating a monitoring program for estimating population size, tracking population dynamics, and studying the interactions between populations and habitat conditions over time (ECCC 2022a).

To limit mortality, surveying should preferably be done when adults outnumber the nymphs, since the adults can be reliably identified in the field using a taxonomic key based on the species' distinctive morphological characteristics. In contrast, the earlier developmental stages are generally placed in 70% ethanol and examined in the laboratory using DNA barcoding in order to identify them. Although DNA barcoding is lethal in most cases, it is an effective tool for identifying specimens when the peak of adult emergence is difficult to estimate (COSEWIC 2016). A non-lethal DNA barcoding method could also be developed for immature grasshoppers, which would involve cutting off the tip of an antenna and placing it in 95% alcohol (Jennifer De Almeida pers. comm.). The insect could then be released to continue its development and its antenna would fully regrow at the next moult.

If, due to a lack of financial and human resources, regular surveys cannot be performed over a long enough period (at least two years) or if DNA barcoding using antennae cannot be carried out, breeding a few individuals in captivity could be helpful. This inexpensive practice makes it possible to collect multiple types of data on all life stages (egg, nymph and adult). Ideally, both knowledge acquisition techniques—field surveys and rearing the species in a vivarium—could be used. This combination would allow biological data to be collected on the different life stages, as well as information on the species' habitat preferences (e.g. vegetation and soil composition, microhabitats).

CMP Strategy 10: Institutional Development

Very few conservation organizations are active on the Magdalen Islands. The availability of human resources and funding often determines the scope and number of projects that these organizations can undertake. In addition, local expertise on the grasshoppers is scarce. Owing to the isolated island context and the previously mentioned constraints, external expertise must sometimes be called on to ensure the recovery of species at risk.

To do this, establishing collaborations and partnerships with universities would be useful in order to support the creation of research projects focusing on the Magdalen Islands Grasshopper. This would allow knowledge to be generated on an ongoing basis without overwhelming local organizations, which are very busy already.

Medium priority (necessary)

CMP Strategy 1: Land Management

Proposing land management measures for the species is difficult because its precise distribution and the types of habitats that it uses at each stage in its life cycle are unknown. Furthermore, best practices in agricultural environments cannot be identified because the scientific community possesses very little information on the species' phenology.

Similarly, suggesting measures for managing invasive alien species to support the Magdalen Islands Grasshopper is currently impossible. Once more detailed information becomes available on the Magdalen Islands Grasshopper and the invasive alien species present in its habitat, appropriate management measures can be developed.

Although the negative effects of pesticide use on the species are poorly understood and pesticide use has not been identified as a threat to the species, adopting the precautionary principle and taking action to minimize pesticide use would be appropriate. Other ways to mitigate the negative impacts of pesticide use include the development and promotion of best practices in pesticide application**,** along with initiatives to encourage compliance with these practices.

CMP Strategy 9: Education and Training

Citizen science initiatives such as iNaturalist (www.inaturalist.org) have considerable potential to generate new occurrence data for the species, and should be supported (ECCC 2022a). As of March 2023, there was one record of the Magdalen Islands Grasshopper on this platform. Aside from its use as a platform for recording observations of the species, iNaturalist also allows data to be gathered on plant diversity in the species' habitat. This would allow links to be established between the plant species present at sites where the Magdalen Islands Grasshopper was captured, and the species' habitat and diet.

7. Measuring Progress

Before we outline how progress will be measured, it is important to remember that very few biological or biophysical data (e.g. life history, diet, habitat preferences) are available on the species. The species' range cannot be identified precisely, and providing an estimate of its abundance is even less possible at this time. The lack of information on the species limits the development of quantitative management objectives adapted to the species' current status and, in turn, the establishment of appropriate indicators.

The performance indicators presented below provide a way to measure the progress towards achieving the management objective and monitoring the implementation of the management plan.

Maintenance of species' range:

- Known Magdalen Islands Grasshopper populations and those discovered after the publication of the management plan are maintained or increased by 2035.

Implementation of conservation measures:

- Conservation measures are implemented by partners as knowledge on the species is improved.

- The Magdalen Islands Grasshopper is taken into account in the multi-species approach used in the Community-Nominated Priority Places (CNPP) program and other conservation projects.

- The size of the Magdalen Islands Grasshopper population is stable or increasing. To monitor population size, demographic trends need to be determined through repeated, time-limited surveys at representative sites.

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Appendix A: Effects on the Environment and Other Species

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*.[9] The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or any of the Federal Sustainable Development Strategy's[10] (FSDS) goals and targets.

Conservation planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that implementation of management plans may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the management plan itself, but are also summarized below in this statement.

This management plan will clearly benefit the environment by promoting the conservation of the Magdalen Islands Grasshopper. Conservation actions for the Magdalen Islands Grasshopper are expected to also benefit a number of other insect species that use open habitats.

The potential for the management plan to inadvertently lead to adverse effects on other species was considered during the development process. The SEA concluded that this plan will benefit the environment and will not entail any significant adverse effects. According to current knowledge of the Magdalen Islands Grasshopper's needs and phenology, the anticipated adverse effects of such measures would be extremely limited, if not totally absent. The reader should refer to the following sections of the document in particular: description of the species' habitat and biological needs, limiting factors, actions already completed or currently underway and conservation measures.

As noted in section 6.1 (Actions Already Completed or Currently Underway), the Magdalen Islands ecosystem is an area of interest for ECCC since it is home to a number of species at risk, including the Magdalen Islands Grasshopper. The Horned Grebe (*Podiceps auritus*), Gulf of St. Lawrence Aster (*Symphyotrichum laurentianum*) and Piping Plover (*Charadrius melodus melodus*) also occur there. The implementation of conservation measures in the Pointe de l'Est NWA will likely benefit a number of species at risk.

[9] www.canada.ca/en/environmental-assessment-agency/programs/strategic-environmental-assessment/cabinet-directive-environmental-assessment-policy-plan-program-proposals.html
[10] www.fsds-sfdd.ca/index.html#/en/goals/