Species at Risk Act
Recovery Strategy Series

Recovery Strategy for the Gold-edged Gem (*Schinia avemensis*) in Canada

Gold-edged Gem

2014

Canada

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Cover illustration: Gold-edged Gem on Skeletonweed (Helen Trefry – Environment Canada, Canadian Wildlife Services)

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PREFACE

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996) agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of recovery strategies for listed Extirpated, Endangered, and Threatened species and are required to report on progress within five years.

The Minister of Environment is the competent minister for the recovery of the Gold-edged Gem and has prepared this strategy, as per section 37 of SARA. It has been prepared in cooperation with the Provinces of Alberta, Saskatchewan, and Manitoba, the Department of National Defence, Agriculture and Agri-Food Canada and Carry the Kettle Nakoda First Nation.

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 and will not be achieved by Environment Canada, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this strategy for the benefit of the Gold-edged Gem and Canadian society as a whole.

This recovery strategy will be followed by one or more action plans that will provide information on recovery measures to be taken by Environment Canada and other jurisdictions and/or organizations involved in the conservation of the species. Implementation of this strategy is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

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EXECUTIVE SUMMARY

- The Gold-edged Gem is a small inconspicuous day-flying flower moth endemic to North America. Globally, the species is considered rare and has a restricted distribution; only twelve element occurrences[1] (hereafter called "occurrences") are known to exist in Canada and the United States. The nine occurrences known to exist within Canada are small and fragmented with a limited range; the species was listed as Endangered under the *Species at Risk Act* in 2007.

- The Gold-edged Gem has specialized habitat requirements. The moth inhabits remnant patches of active sand dunes or blowouts where colonies of Prairie Sunflowers, its only known larval host plant, exist. The flight and mating period of the Gold-edged Gem is short and coincides with the blooming of Prairie Sunflowers. To date, efforts to survey Gold-edged Gem suitable habitat have been limited in Canada. Thus, little distribution and biological data are available.

- The primary threat to Gold-edged Gem recovery is habitat loss due to the progressive stabilization of active sand dunes across its range. Other threats to the species include elimination of host and nectar plants by invasive species, trampling of host and nectar plants, oil and gas development, ungulate herbivory, pest control, military activities and stochastic events.

- Recovery of the Gold-edged Gem is determined biologically and technically feasible. The population and distribution objectives for the Gold-edged Gem are to maintain or increase the distribution of all known occurrences in the Canadian range of the species, and any additional occurrence(s) discovered in Canada in the future. Recovery planning will be carried out through four broad strategies: inventory and monitoring, habitat management and stewardship, outreach and communication, and research.

- Critical habitat identified in this recovery strategy encompasses all nine occurrences known to exist in Canada and is considered sufficient to achieve the population and distributions objectives, at this time. Critical habitat for the Gold-edged Gem is identified within or adjacent to 23 quarter sections in Alberta, 18 quarter-sections in Saskatchewan, and 7 quarter-sections in Manitoba. Additional critical habitat may be identified across the range of the species as more information becomes available. Within these quarter-sections, critical habitat is identified as the active open sand dunes and/or blowouts, encompassing the area from the crest of the dune to the edge where native vegetation grows and the dune is stabilized.

- One or more action plans for the Gold-edged Gem will be completed by 2018.

[1] An area of land and/or water in which a species or natural community is, or was, present and has practical conservation value (NatureServe, 2011).

RECOVERY FEASIBILITY SUMMARY

Under the *Species at Risk Act* (Section 40), the competent minister is required to determine whether the recovery of the listed species is technically and biologically feasible. Based on the following criteria outlined by the Government of Canada (2009) for recovering species at risk, recovery of the Gold-edged Gem is considered biologically and technically feasible:

1. Individuals of the wildlife species that are capable of reproduction are available now or in the foreseeable future to sustain the population or improve its abundance.

Yes. Although the species abundance may fluctuate with populations of its only known larval host plant, adult Gold-edged Gems have been observed within 9 sand hills in Canada and have been observed mating in some occurrences. Under similar conditions, individuals are likely to continue to reproduce and persist at these occurrences. Further surveys of suitable habitat may result in the discovery of additional occurrences. Securing and enhancing additional nearby habitat may increase population abundance and growth rate.

2. Sufficient suitable habitat is available to support the species or could be made available through habitat management or restoration.

Yes. Although it appears to be small, fragmented, and progressively declining, suitable Gold-edged Gem habitat is presently available where the species has been observed as well as elsewhere in its Canadian range. Additional surveys may uncover more suitable habitat in sand hills that have not been surveyed yet. Several habitat management practices have the potential to maintain and enhance Gold-edged Gem habitat.

3. The primary threats to the species or its habitat (including threats outside Canada) can be avoided or mitigated.

Yes. The main threat to Gold-edged Gem recovery is habitat loss as a result of active sand dune stabilization. Other threats to the species include elimination of host and nectar plants by invasive species, trampling of host and nectar plants, oil and gas development, ungulate herbivory, pest control, military activities and stochastic events. Threats can be reduced or eliminated through stewardship, beneficial management practices, protection of critical habitat and raising awareness of the species requirements and threats among land users.

4. Recovery techniques exist to achieve the population and distribution objectives or can be expected to be developed within a reasonable timeframe.

Yes. Raising awareness of the species requirements and threats among the public and beneficial management practices such as prescribed burning, control of invasive species and vegetation encroachment, and suitable grazing should contribute to reduce or eliminate the most prevalent threats of sand dune stabilization, trampling of host and nectar plants, elimination of host and nectar plants by invasive species, and oil and gas development impacts in targeted occurrences. These techniques should aid in achieving the population and distributions objectives.

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1. COSEWIC SPECIES ASSESSEMENT INFORMATION

Date of Assessment: April 2006

Common Name (population): Gold-edged Gem

Scientific Name: *Schinia avemensis*

COSEWIC Status: Endangered

Reason for designation: This moth is a habitat specialist that needs active dunes or blow-outs with populations of its sole larval host plant. It is known from only two small populations in Canada and two in United States. Large-scale decline in active dune habitat over the past 100 years has likely resulted in a corresponding reduction in the moth. Only very small, scattered, isolated patches of suitable habitat, totaling approximately 6 km^2, remain. They are threatened by habitat loss in the form of stabilization of active dunes by both native and introduced vegetation and by overgrazing of its larval host plant, which severely impacts small isolated populations of the moth. The closest population of the moth in the United States is about 1,200 km to the south in Colorado, so immigration of individuals into the Canadian population is not possible.

Canadian Occurrence: AB, SK, MB

COSEWIC Status History: Designated Endangered in April 2006.

COSEWIC = Committee on the Status of Endangered Wildlife in Canada

2. SPECIES STATUS INFORMATION

The Gold-edged Gem (*Schinia avemensis*) is globally ranked as imperilled (G2) and nationally ranked as critically imperilled (N1) in Canada (NatureServe 2011). The species occurs in Alberta, Saskatchewan and Manitoba where it is also ranked as critically imperilled (S1). The percentage of the Gold-edged Gem's global distribution and abundance found in Canada is currently unknown. The Gold-edged Gem has been listed as Endangered under Schedule 1 of the federal *Species at Risk Act* since 2007 and was listed by the province of Manitoba under its *Endangered Species Act* as Endangered in 2012. In the United States, the moth is unranked nationally (NNR) and in Colorado (SNR), the only state where the species is known to occur (NatureServe 2011).

3. SPECIES INFORMATION

3.1 Species Description

The Gold-edged Gem is a member of the Order Lepidoptera (butterflies and moths) and Family Noctuidae (owlet or cutworm moths). The Gold-edged Gem is one of about 150 North American species belonging to the subfamily Heliothinae or flower moths, many of which are colorful in appearance and cryptic against the flowers on which they feed and rest (Hardwick 1996).

Figure 1. Adult Gold-edged Gem resting on a sunflower © J. Dombroskie.

Adult Gold-edged Gems are relatively small with stout body and a 16-20 mm wingspan (Figure 1; Hardwick 1996, COSEWIC 2006). The forewings are maroon and each is crossed with two yellow bands. The species' common name refers to the distinctive pale yellow fringe along the forewings. The head is pale yellow while the hindwings and thorax are predominantly black. Both sexes are similar in appearance, but females tend to be larger and darker than the males (COSEWIC 2006).

The Gold-edged Gem is a diurnal moth typically observed resting or nectaring on flowers of its larval host plant, or rapidly flying among blossoms of other composite plants. The moth is univoltine (one generation per year) and the average lifespan of an adult is less than a week (Hardwick 1996). The flight period in Canada can range from July 10 to August 20 (COSEWIC 2006). The early life-stages (i.e., egg, larva, and pupa) of the Gold-edged Gem have not yet been described.

3.2 Population and Distribution

The Gold-edged Gem is native to North America and its known range extends across the southern Prairie Provinces of Canada south into central Colorado, United States (Figure 2). Within this range, the species is confined to a few isolated pockets of open sand dunes[2] and blowouts[3]. The Canadian population is separated by over 1000 km from the American population (COSEWIC 2006). However, additional undocumented occurrences are speculated to exist throughout its range (G. Anweiler, pers. comm. 2008; NatureServe 2011,).

[2] A sand dune is a "mound, hill or ridge of windblown sand, either bare or variously covered by vegetation, capable of movement from place to place through the development of a slip face, but always retaining its own characteristic shape for an extended period of time" (David 1977).

[3] A blowout "refers to a small, typically less than 1 hectare in size, area of wind blown sand, which is commonly bowl shaped and somewhat elongated in the direction of transporting winds. Thus, road tracks, all-terrain vehicle trails, cattle trails, oil/gas well pads, dugouts, cattle-disturbed areas around water wells sites and ranches, and sand pits" are not considered to be natural wind blown blowouts (Wolfe 2010).

In the United States, Gold-edged Gems are known only from three occurrences, all within south-central Colorado (C. Harp, pers. comm. 2008). As of 2008, information on population abundance and trends in the United States was not available (NatureServe 2011). However, the population at the Great Sand Dunes National Park, Colorado, was thought to be stable (C. Harp, pers. comm. 2008).

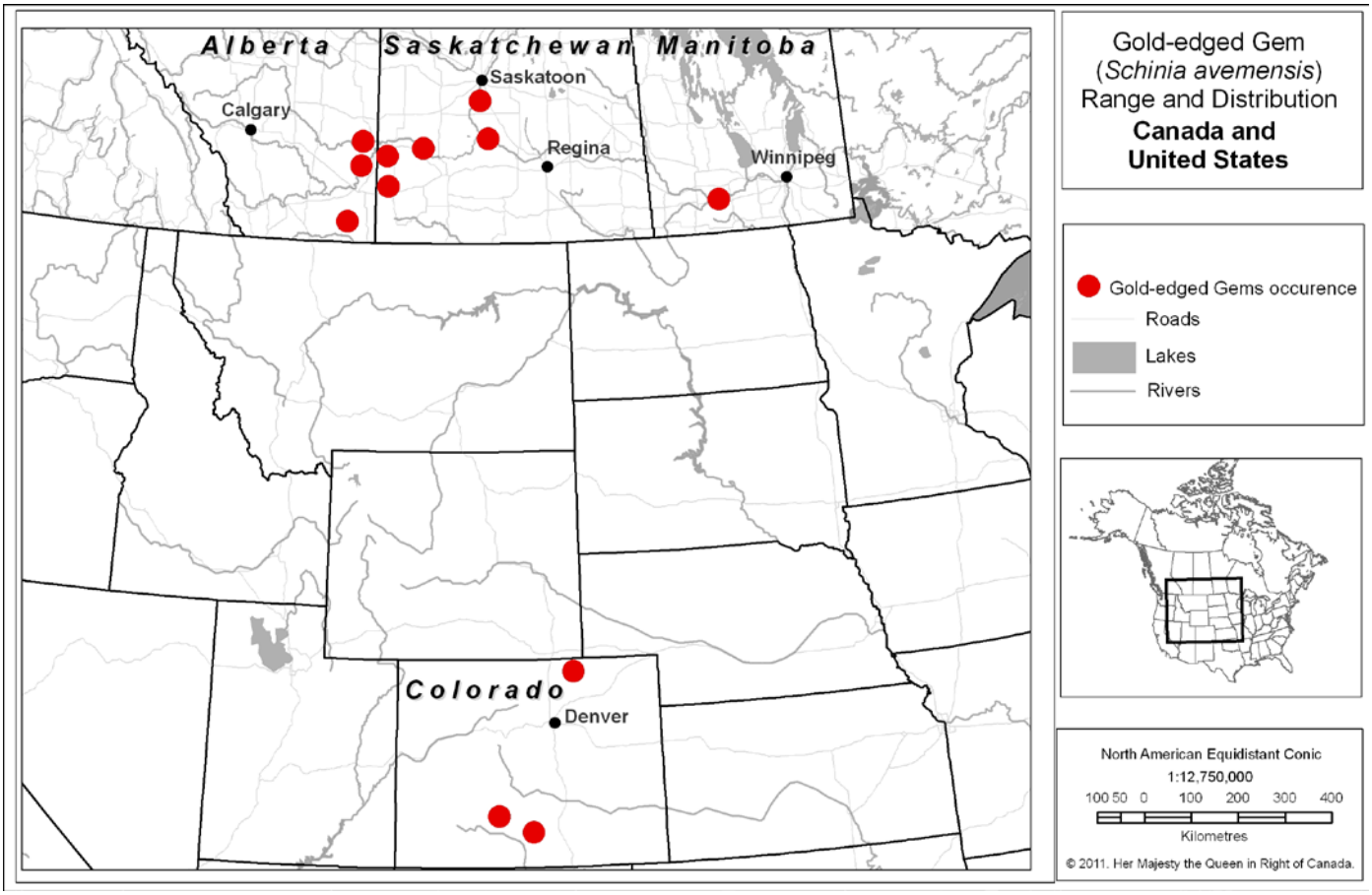

Figure 2. Known distribution of the Gold-edged Gem.

Canadian distribution and population

The known Canadian Gold-edged Gem range extends from southeastern Alberta through Saskatchewan and into southwestern Manitoba, south of the 52nd parallel (Figure 2). The species was not found during surveys of active dunes in sand hills[4] north of this parallel (i.e., North Battleford sand hills, Saskatchewan and Wainwright sand hills, Alberta) (M. Curteanu 2011, M-C. Bélair, unpubl. data).

[4] The term "sand hills" refers to a well-defined region where several sand dune occurrences exist (David 1977).

Since the COSEWIC status report was prepared in 2006, several new occurrences have been discovered in Saskatchewan and as of 2011 the Gold-edged Gem was known to occur in nine sand hills in Canada, including three occurrences in southeastern Alberta, five occurrences in Saskatchewan, and one occurrence in southwestern Manitoba (Table 1). Further investigation in unsurveyed sand hills in Saskatchewan (e.g., Pelican Lake, Westham, Great, Bigstick, Piapot and Seward sand hills) and Manitoba (e.g., Lauder sand hills) may uncover additional occurrences.

Generally, occupied habitat patches cover less than 50 hectares and Gold-edged Gem abundance is relatively low (10-50 moths per hectare) (COSEWIC 2006). COSEWIC (2006) roughly estimated the Canadian Gold-edged Gem population to be between 700 and 6,000 individuals. However, this is likely an underestimate. There is a high degree of uncertainty associated with the COSEWIC estimate, given the scant amount of survey work that has been done. New occurrences have been discovered since this estimate was made. The timing of surveys is critical as the presence of Gold-edged Gems is difficult to detect in occupied habitat patches. Adult moths of the Heliothinae subfamily are short lived (i.e., live less than a week) (Hardwick 1996), adult emergence period is variable on an annual basis (COSEWIC 2006) and hourly basis within the same sand dune (M-C. Bélair, unpubl. data). In addition, none of the field surveys conducted to detect this species' presence were designed to estimate population size.

For the reasons mentioned above, the size of the Canadian Gold-edged Gem population is currently unknown. There are also no data available with which to monitor changes in population and distribution for Gold-edged Gem. In Canada, open sand dunes and associated habitats have been stabilizing at a rate of 10% to 40% per decade (Wolfe et al. 2000). The progressive stabilization and loss of active dune complexes across the Great Plains in the past 100 years (Wolfe et al. 2000), suggest long-term population declines and a decrease in the ability to recolonize isolated remnant dunes.

Alberta Populations

Gold-edged Gems have been found in the Pakowki Lake, Middle and Empress Meander (Dune Point) sand hills in Alberta (Table 1). Frequent surveys of the Pakowki Lake sand hills have established that individuals at this location are thriving (Jensen et al. 2009, Curteanu 2011). The Middle sand hills occurrence, found within the Suffield National Wildlife Area (NWA), Alberta, was discovered in 1939 (Table1). Within the Suffield NWA, Gold-edged Gems have been found at a dozen small sand dunes and blowouts (Jensen et al. 2009, Curteanu 2011). The remaining occurrence is found in the Empress Meander (Dune Point) sand hills near Bindloss, Alberta.

Saskatchewan Populations

In Saskatchewan, the species has been observed in the Burstall, Tunstall, Cramersberg, Elbow and Dundurn sand hills (Table 1). Gold-edged Gems were recently found in two different sand dunes in the Cramersberg sand hills on Carry the Kettle Nakoda First Nation Indian Reserve (G. Anweiler, unpubl. data, M-C. Bélair, unpubl. data), one sand dune in the Dundurn sand hills, five sand dunes in Elbow sand hills within Douglas Provincial Park (DPP) and Elbow Community Pasture, and three sand dunes in the Tunstall sand hills on Bitter Lake Community

Pasture (Curteanu 2011, M-C. Bélair, unpubl. data,). The remaining occurrence is found in the Burstall sand hills.

Manitoba Population

In Manitoba, Gold-edged Gem occurs at one location within the Spirit Sands. The Spirit Sands is a 4 km^2 active sand dune located partly in Spruce Woods Provincial Park and partly in the adjacent Canadian Forces Base Shilo. The sand dune is part of the Brandon sand hills (Schykulski and Moore 1996). Gold-edged Gems were first reported in the Brandon sand hills in 1903 (Table 1) where they likely had a broader historical distribution. The species has not been observed in the past 80 years in some sand dunes (e.g., Aweme, MB) (COSEWIC 2006).

Table 1. Summary of known Gold-edged Gem occurrences in Canada[1].

Sand Hill[2]	Province	First Observation	Sum of individuals observed over time[3]	Most recent Observation
Brandon sand hills	MB	1903	37	2009
Tunstall sand hills	SK	2005	21	2010
Burstall sand hills	SK	2004	1	2004
Cramersberg sand hills	SK	2009	10	2011
Elbow sand hills	SK	2011	9	2011
Dundurn sand hills	SK	2010	1	2010
Empress Meander (Dune Point) sand hills	AB	2004	4	2004
Middle sand hills	AB	1939	27	2010
Pakowki Lake sand hills	AB	2005	163	2011

[1] The information in this table represents the best information available to Environment Canada at the time this recovery strategy was written. The sources for this table are: M-C. Bélair, unpubl. data, M. Curteanu, unpubl. data,COSEWIC 2006, Jensen et al. 2009, Curteanu 2011.

[2] Sand hill names according to Wolfe 2010.

[3] Minimum counts.

3.3 Needs of the Gold-edged Gem

General habitat requirements

The Gold-edged Gem is a sand dune prairie obligate moth; it is restricted to naturally occurring active (wind-moving) sand dunes or blowouts where colonies of Prairie Sunflower (*Helianthus petiolaris*) occur (Hardwick 1996, COSEWIC 2006). Anthropogenic roadside areas of open sand where Prairie Sunflowers were abundant have been found to be devoid of Gold-edged Gems during the adult emergence period (M-C. Bélair, unpubl. data, M. Curteanu, unpubl. data), suggesting that the species does indeed require the natural active sand dune areas where it has been found. Based on sampling records and field observations, Gold-edged Gem habitat consists of open, barren or sparsely vegetated sand dunes, sand flats, or sandy hill areas that are actively eroding and being moved by wind. Active sand dunes and blowouts currently occur as isolated patches on the crests of partially or fully stabilized sand hills (Wolfe 1997) that are scattered within a vast landscape of established grassland.

Reasons why Gold-edged Gems rely on active sand dunes or blowouts are poorly understood and require further investigation. Avoiding predation and/or parasitism or coping with subfreezing winter conditions is a common adaptation exhibited by a wide range of desert invertebrates (Crawford 1981). The sand substrate offers burrowing insects a humid and stable microclimate important during the resting stage (Crawford 1981). Although there are no data specific to Gold-edged Gem, it is probable that the sand provides a secure environment during the pupal stage and facilitates the burrowing activity during the larval and adult emergence stage.

Oviposition and larval resources

Female Gold-edged Gems deposit eggs within the blossoms of the Prairie Sunflower, the only plant known to be utilized by the larva for its development. Female Gold-edged Gems insert their eggs into the florets and the eggs hatch within a few days. The larvae (caterpillars) feed inside the flower heads of the host plant specifically consuming its floral parts and developing seeds (Hardwick 1996). The last larval instar ceases to feed and pupates at or below soil surface. The pupa remains in a state of diapause throughout the winter and spring although diapause can last up to several years (Hardwick 1996).

The Prairie Sunflower is an annual and is recognized by its bright yellow blossoms and alternate lance-shaped leaves; the plant can reach up to 2 m in height and blossoms from June to September (Heiser 1969, Moss 1994). The plant is native to North America and is widely distributed throughout Canada and United States (Heiser 1969). Prairie Sunflowers inhabit sand dunes, sandy river banks, eroded slopes, coulees, roadsides, and fallow fields; the plant is considered an early colonizer of disturbed areas (Moss 1994).

Monophagous moths and butterflies (i.e., species that feed on a single plant species) have to be selective in choosing plants for oviposition as the timing of larval development must coincide with that of the host plant (Dempster 1997, Peterson 1997). Starvation caused by the larvae's inability to consume the hard coated seed pods due to late oviposition and development has been reported as a cause of mortality in some butterfly species (Dempster 1997). Gold-edged Gem may suffer higher mortality rates and lower reproductive success if adult emergence, oviposition, and larval hatching do not coincide with larval host plant blossoming and seed development. Currently, very little is known about the ecology of the Prairie Sunflower or how environmental and climatic conditions influence this plant's distribution and germination. For example, the number of Prairie Sunflowers at some occurrences has been observed to vary greatly from year to year (G. Anweiler, pers. comm. 2008), in turn affecting Gold-edged Gem abundance at these occurrences.

Adult food resources

Similar to other moths and butterflies, adult Gold-edged Gems depend on an adequate supply of nectar as a source of energy for metabolic functions, flying, and reproduction (Heinrich and Raven 1972). The Prairie Sunflower and Common Skeletonweed (*Lygodesmia juncea*) are the primary nectar sources for Gold-edged Gems (COSEWIC 2006, C. Harp, pers. comm. 2008). Common Skeletonweed is a perennial and is widely distributed throughout the Great Plains. In

Colorado Gold-edged Gems have been observed perched on Common Skeletonweed blossoms when Prairie Sunflowers were still in bud. Gold-edged Gems have been observed resting on Rhombic-leaved Sunflowers (*Helianthus pauciflorus subsp. subrhomboideus*) in the Middle sand hills which suggests that this plant may be an additional nectar source or larval host plant (S. Westworth, pers. comm. 2011). However, further investigation is required to confirm this because Gold-edged Gems have never been observed mating or feeding on Rhombic-leaved Sunflowers.

Limiting Factors

Gold-edged Gem distribution and abundance is inherently limited by the scarcity of open active sand dunes or blowouts where colonies of Prairie Sunflower exist. Thorpe et al. (2001) identified 125 sand hills throughout the Canadian Prairie Provinces but these comprise only a small fraction of the total land-cover. Within sand hills, Gold-edged Gems also show microhabitat preferences based on sand dune topography, moisture, sand particle size and plant community (COSEWIC 2006, Jensen et al. 2009). Given Gold-edged Gem's habitat and host plant specificity and the scarcity of current active dunes in Canada, availability of suitable habitat is the primary biological factor limiting this species' recovery.

Additionally, Gold-edged Gem distribution might be limited by dispersal and colonization ability. Although the species' dispersal has not yet been assessed, monophagous moths generally display strong host plant fidelity, thus they are generally not found outside of the immediate vicinity of host plant colonies (Hardwick 1996, COSEWIC 2005). While at a local scale, adults may disperse along a ridge, or among open sandy patches, or among sand dunes or blowouts in close proximity to one another, it is highly unlikely that Gold-edged Gems are able to disperse at the landscape level given the lengthy distances of unsuitable habitat separating major sand hills. Furthermore, the short life span of Gold-edged Gems suggests that its dispersal and colonization potential may be limited or non-existent. The home range for the genus *Schinia* is estimated at 1 km^2 (NatureServe 2011). Consequently, if the Canadian populations were extirpated, natural recolonization from the American populations is presumed impossible (COSEWIC 2006).

4. THREATS

4.1 Threat Assessment

Table 2. Threat Assessment Table.

Threat	Level of Concern[1]	Extent	Occurrence	Frequency	Severity[2]	Causal Certainty[3]
Habitat Loss or Degradation						
Dune stabilization	High	Widespread	Historical/ Current	Continuous	High	High
Oil and gas development	Low	Localized	Current	Continuous	Unknown	Low
Exotic, Invasive, or Introduced Species						
Invasion and establishment of exotic plants	High	Widespread	Current	Continuous	Medium	Medium/ High
Disturbance or Harm to Populations						
Trampling of host and nectar plants	Medium	Localized	Current	Continuous	Low/ Medium	Medium
Accidental Mortality						
Ungulate herbivory	Low	Localized	Current	Continuous	Low/Medium	Low
Pest control	Low	Unknown	Current	Seasonal	Unknown	Low
Military activities	Low	Localized	Current	Unknown	Unknown	Low
Climate and Natural Disasters						
Stochastic events	Low	Widespread	Anticipated	Unknown	Unknown	Unknown

[1] *Level of Concern: signifies that managing the threat is of (high, medium or low) concern for the recovery of the species, consistent with the population and distribution objectives. This criterion considers the assessment of all the information in the table.*

[2] *Severity: reflects the population-level effect (High: very large population-level effect, Medium, Low, Unknown).*

[3] *Causal certainty: reflects the degree of evidence that is known for the threat (High: available evidence strongly links the threat to stresses on population viability; Medium: there is a correlation between the threat and population viability e.g. expert opinion; Low: the threat is assumed or plausible).*

4.2 Description of Threats

The progressive stabilization of active sand dunes and blowouts is the most prevalent threat to the Canadian Gold-edged Gem populations (COSEWIC 2006, Jensen et al. 2009). Other factors such as elimination of host and nectar plants by exotic, invasive or introduced species, trampling of host and nectar plants, oil and gas development ungulate herbivory, pest control, military activities and stochastic events also have the potential to negatively impact Gold-edged Gem populations. Threats are listed in order of decreasing level of concern.

Dune stabilization

In the last century, the North American Great Plains land-cover has changed dramatically in response to climatic variations and land use regimes resulting in several active sand hills being nearly or completely stabilized by vegetation (Wolfe et al. 1995, Geological Survey of Canada 2001, Mangan et al. 2004). An increase in precipitation in the prairies during the last century has been a major factor contributing to sand dune stabilization (Wolfe et al. 1995, Hugenholtz and Wolfe 2005). Dune stabilization occurs during moist warm periods when the rate of vegetation growth is faster than the rate of dune migration (Wolfe et al. 1995, Hugenholtz and Wolfe 2005). Established vegetation prevents the wind from moving the dune and eventually stabilizes it; drier conditions such as droughts and significant disruptions to vegetation growth can cause dunes to reactivate and migrate.

Natural disturbances such as extreme weather patterns, large ungulate grazing, flooding, animal burrowing activities, pest outbreaks, and fires, have played significant roles in the evolution of North America's prairies (White 1979, Sousa 1984, Axelrod 1985). Historically, these disturbances occurred frequently, randomly, and at different scales and magnitudes across the landscape, and have contributed to plant community composition and structure, and the overall ecological integrity of the prairie (Garren 1943, Daubenmire 1968, White 1979, Leisica and Cooper 1999). Grazing of sand dunes by Plains Bison (*Bison bison*) combined with the periodic burning of the prairies contributed to disturbance and the overall maintenance of active sand dunes; the absence of bison grazing and reduction in prairie fires since European settlement may have accelerated the rate of sand dune stabilization across the Prairie Provinces. Finally, intensive seeding or re-vegetation of active sand dunes in order to decrease soil erosion and improve land use productivity was historically encouraged and practiced up to the early 1990s. Species of grass that thrive in dry nutrient-poor soils have been planted at the Burstall sand hills, Saskatchewan to accelerate dune stabilization (David 1977), while flax bales were used at the Middle sand hills, Alberta, to prevent soil erosion.

Potential habitat available for Gold-edged Gem has been decreasing at a rapid rate. Several open dunes in the Brandon sand hills, Manitoba, were active during the late 1920s but are now mostly stabilized by parkland type vegetation including Aspen (*Populus* spp.), Spruce (*Picea* spp.), Tamarack (*Larix* spp.), Dwarf Oak (*Quercus* spp.) and native grasses and shrubs (David 1977, Schykulski and Moore 1996). It was estimated from aerial photographs that dune stabilization of the Brandon sand hills has occurred at a rate of 10-20% per decade since the early to mid 1900s despite periods of drought (Wolfe et al. 2000, Hugenholtz and Wolfe 2005). At Pakowki Lake sand hills, Alberta, the amount of bare sand has declined by almost 75% since the 1950s (Wallis and Wersher 1998).

Dune stabilization alters the physical and functioning structure of active dunes and ultimately renders the habitat unsuitable for sustaining Gold-edged Gems; dune stabilization is a serious threat to the recovery of the species in Canada.

Invasion and Establishment of Exotic Plants

Exotic species that escape cultivated areas have the potential to invade and out-compete native vegetation, and over time, dominate and alter ecosystem properties and functions (Gordon 1998, Henderson and Naeth 2005). Specifically, invasive species exclude native flowering plants, conceivably limiting both nectar and larval food resources which are critical for Gold-edged Gem reproduction and survival. Invasive species also render Gold-edged Gem habitat unsuitable by accelerating the process of dune stabilization. At Pakowki Lake sand hills, Crested Wheatgrass (*Agropyron cristatum*) and Tall Baby's-breath (*Gypsophila paniculata*) were observed growing in dense stands near Gold-edged Gem habitat (Jensen et al. 2009). Within Spruce Woods Provincial Park, Manitoba, sweet clover (*Melilotus* sp.), Smooth Brome (*Bromus inermis*), and particularly Leafy Spurge (*Euphorbia esula*) are considered major problems for the long-term integrity and sustainability of the native prairie (Schykulski and Moore 1996). Owing to their invasive nature and habitat-altering qualities, invasive species are considered a prominent threat to Gold-edged Gem recovery and survival.

Trampling of host and nectar plants

Activities such as off-highway vehicle (OHV) use, livestock movement, horseback riding, and hiking can contribute to dune destabilization and potentially benefit Gold-edged Gem habitat. According to Lemauviel and Roze (2003), active and semi-stabilized dune vegetation showed higher resilience over a short term to tourist pressure than stabilized dunes. However, consistent, heavy use of an area without periods of recovery may lead to extensive trampling and eventual eradication of Gold-edged Gem larval host and nectar plants. Specifically, OHV recreational activities can cause significant lasting damage to the landscape including dispersal of invasive species and destruction of native and establishing vegetation (Ouren et al. 2007) leading to changes in the plant community. Currently, OHV recreational activities have been observed at the Burstall (Saskatchewan) and Pakowki Lake (Alberta) sand hills (G. Anweiler, pers. comm. 2008). The Manitoba Gold-edged Gem occurrence is not threatened from OHV recreational activities or trampling as a result of livestock movement since OHV and livestock are not permitted in the area occupied by the species (Schykulski and Moore 1996). Gold-edged Gems within the Elbow sand hills within Douglas Provincial Park, Saskatchewan and Spirit Sands of Spruce Woods Provincial Park, Manitoba may be subject to disturbance from tourists. More than 40,000 visitors can visit Douglas Provincial Park within a summer (Lake Diefenbaker Tourism Destination Area Planning Committee 2008). Grazing by livestock occurs in the immediate vicinity of several sand dunes and blowouts in the Pakowki Lake and Empress Meander (Dune Point) sand hills in Alberta, and the Burstall, Tunstall, Cramersberg, Elbow and Dundurn sand hills in Saskatchewan. Host and nectar plants at these occurrences could be threatened by trampling if overgrazing occurs within dune and blowout critical habitat. Some active sand dunes in the Elbow sand hills appeared to be heavily used by cattle and were devoid of Prairie Sunflowers (M-C. Bélair, pers. obs.). However, whether this relationship was one of cause-and-effect or merely circumstantial was not determined.

Other Threats

Activities associated with petroleum development such as exploration and extraction may threaten suitable Gold-edged Gem habitat. Roads divide landscapes leading to habitat fragmentation and alteration, population isolation and facilitation of the introduction and spread of exotic species (Clifford 1959, Forman et al. 2003). Several studies (e.g. Rao and Girish 2007) have shown that increases in traffic and speed inadvertently kill butterflies and moths. In the Middle sand hills, Alberta, and Cramersberg sand hills, Saskatchewan, oil and gas activities are ongoing and there is potential for further development which may contribute to Gold-edged Gem mortality and habitat loss. Based on analysis of historical aerial photographs and satellite imagery of the northeast corner of Middle sand hills in Suffield NWA, the density of oil and gas wells increased from 0 well sites/km^2 to 2 well sites/km^2 between 1949 and 1998 (Bender et al. 2005). By 2007, a density of 6.25 well sites/ km^2 occurred in some areas of Suffield NWA (EnCana 2007). Additionally, Rowland (2008) has shown that diversity and cover of introduced plant species, which may accelerate sand dune stabilization and outcompete host plant (see Table 4), was greater at pipelines and well sites than in native prairie at Suffield NWA. The relative significance of petroleum development as a threat to Gold-edged Gem recovery is difficult to quantify at this time, especially since the extent to which the open, active sand dunes themselves have been damaged by oil and gas development remains unknown. Moreover, modern techniques such as horizontal drilling, which would preclude the need for directly disturbing the surfaces of open, active sand dunes, and restricting exploration and drilling activities to wintertime should limit the threat that petroleum development poses to Gold-edged Gems.

Ungulate herbivory likely represents a continuum of possible effects on Gold-edged Gem ranging from beneficial to potentially deleterious depending on the intensity and timing. On the one hand, grazing by domestic and wild ungulates may benefit Gold-edged Gem habitat by destabilizing sand dunes and initiating sand movement (Lesica and Cooper 1999, Hugenholtz and Wolfe 2005). On the other hand, grazing during critical periods of growth and flowering could result in the removal of host and/or nectar plants, which may in turn be detrimental to Gold-edged Gems particularly during periods of drought (COSEWIC 2006). Although it has been shown that different ungulate species will select different plant species when grazing (Lloyd et al. 2010) and may not prefer the Gold-edged Gem's host and/or nectar plants, ungulates may not be selective during periods of drought when their preferred forage is unavailable or is in short supply which could result in the grazing of the moth's host and/or nectar plants. Gold-edged Gem eggs and larvae are concentrated within the blossoms and developing seeds of the host plant, and as such, intensive long-term grazing by both domestic and wild ungulates can lead to direct mortality of individuals. The effect of grazing on the most important host and nectar plant for Gold-edged Gems, the Prairie Sunflower, is unclear. One study reported a reduction in density and cover of the Prairie Sunflower in grazed short-grass prairie compared to ungrazed sites (Ruthven et al. 2000). Another study reported that grazing by bison had no effect on forbs, among which the Prairie Sunflower was included, in sand hill prairie habitat (Pfeiffer and Steuter 1994). Dempster (1997) reported that grazing of Orange-tip Butterfly (*Anthocharis cardamines*) host flowers accounted for up to 19% of larval mortality. Evidence of grazing by native ungulates on Prairie Sunflowers was observed at the Middle and Pakowki Lake sand hills, Alberta (M. Curteanu, pers. obs., M-C. Bélair, pers. obs).

Pest control through the indiscriminate or careless application of chemicals to control agricultural pests and mosquitoes has played a significant role in the decline of pollinators in industrialized regions (Kevan 1999). Pesticide drift, particularly though not exclusively from aerial applications, could be a potential threat to Gold-edged Gem recovery through the direct mortality as well as the removal of adult nectar and larval host plants (Longley and Sotherton 1997). Studies have shown that effects of herbicides on non-target plants in field margins dissipate rapidly with distance from the target. While adverse effects have routinely been documented within 10 m of a field's edge, few such effects have been documented at much greater distances (Wolfe and Cessna 2004). In contrast, even relatively small amounts of off-field drifting insecticides were predicted to pose a significant mortality risk to larval butterflies living in field margins (Davis et al. 1991, Cilgi and Jepson 1995). In Canada, the pesticide regulatory and labelling processes are intended to take into consideration and minimize the potential for environmental impacts due to spray drift (Felsot et al. 2011). While it is unlikely that sand dunes where the Gold-edged Gem is known to occur would be directly targeted for pesticide application, it remains unknown whether the same is true of farmland that lies adjacent to those dunes and from which pesticides could drift into Gold-edged Gem habitat. In summary, while chemical pest control may be a threat to Gold-edged Gem, its magnitude remains unknown.

The Gold-edged Gem is known to occur in certain sand dunes located within three military bases: CFB Suffield in Alberta, CFB Dundurn in Saskatchewan and CFB Shilo in Manitoba. The Department of National Defence does not use sand dunes at CFB Shilo and Suffield for military training. Access to these areas is limited to periodic inspections, and forest fire response. The impact of these activities on the Gold-edged Gem should be minimal. However, some sand dunes at CFB Dundurn are located within the military training area. It is unknown whether the species occurs at those dunes.

Stochastic events can threaten specialist species. Specialized species with a short flight period and fluctuating populations are more prone to local extinctions from random (stochastic) events (i.e., severe storms, winter conditions, or fires), than generalist species with stabilized populations (Tscharntke et al. 2002, Nilsson et al. 2008). Gold-edged Gems have a narrow habitat breadth. Known Canadian occurrences are small and localized which make them vulnerable to extirpation due to environmental stochasticity. Additionally, genetic effects attributed to habitat fragmentation, isolation, and stochastic events have been suggested to play a significant role in local extinction of Lepidoptera (Packer and Owen 2001). Natural recolonization is unlikely given that the nearest known Gold-edged Gem population in the United States is approximately 1,200 km away (COSEWIC 2006).

5. POPULATION AND DISTRIBUTION OBJECTIVES

The population and distribution objectives for the Gold-edged Gem are to maintain or increase the distribution of all known occurrences in the Canadian range of the species, and any additional occurrence(s) discovered in Canada in the future.

At this time, it is not feasible to establish quantitative population objectives because the size of the Canadian population has not been accurately estimated due to the difficulty associated with detecting the presence of the species and the limited data available on the species (see section 3.2).

Gold-edged Gems are specialists and their distribution in Canada is restricted to active open sand dunes and/or blowouts that contain larval host plants and/or adult nectar sources. Suitable habitat for the species is limited as it exists only in small isolated occurrences separated by large areas of unsuitable habitat and is declining as sand dunes are stabilizing. Even if the species is eventually down-listed to a lesser category as knowledge gaps are filled and new occurrences are discovered it is reasonable to assume that it will probably always remain at risk in Canada.

6. BROAD STRATEGIES AND GENERAL APPROACHES TO MEET OBJECTIVES

6.1 Actions Already Completed or Currently Underway

Very little work has been done on Gold-edged Gems in Canada to this date. Nevertheless, activities that that have been undertaken and are relevant to this species and its habitat are as follows:

- Environment Canada has conducted Gold-edged Gem surveys in Alberta, Saskatchewan and Manitoba from 2008 to 2011 during the adult emergence period confirming the species' presence in new locations.
- Lepidopterists associated with the Edgar Harold Strickland Entomological Museum collected specimens during field trips from 2003-2009 extending the species' distribution.
- Environment Canada co-published with Fisheries and Oceans and Agriculture and Agri-Food Canada a booklet on species at risk in 2009 in which the Gold-edged Gem is a featured species. The booklet has been distributed to landowners opportunistically and during various public meetings.
- Since 2007, DND in collaboration with the University of Calgary has applied various treatments such as hand-digging, prescribed burning and placing grazing attractants in an attempt to restore a number of sand dunes to an active state at Suffield NWA. Their actions have been met with varying degrees of success (A. Taylor, pers. comm. 2011). For instance, twelve sand dunes at Suffield NWA were restored using habitat improvements that resulted in conversion to high quality habitat lasting up to four years (Sustainable Resource Development 2012).
- The Government of Saskatchewan created the Dune Nature Centre and set up signage along hiking trails within Douglas Provincial Park in Saskatchewan to educate visitors on sand dune ecosystems. The park also monitors the emergence of Leafy Spurge and sprays to eliminate the invasive species when needed (J. Perry, pers. comm. 2011).
- Spruce Woods Provincial Park in Manitoba has adopted several management approaches to maintain a balance of successional stages of the vegetation communities in the park including prescribed spring burning, aspen mowing along prairie margins, and goat grazing. Several management activities have also been initiated by Manitoba Conservation to deal with Leafy Spurge within Spruce Woods Provincial Park including herbicide applications, spring burning, shrub mowing and release of spurge beetles (Schykulski and Moore 1996).

6.2 Strategic Direction for Recovery

Table 3. Recovery Planning Table.

Threat or Limitation	Priority	General Description of Research and Management Approaches
Broad Strategy: Inventory and Monitoring		
All threats and knowledge gaps related to distribution	High	• Develop and implement a long-term standardized monitoring program throughout the species' range in Canada to ensure known occurrences are maintained and threats are monitored. • Conduct surveys for the species in suitable habitat at new sites in an effort to increase knowledge of the species' distribution in Canada. • Coordinate Gold-edged Gem monitoring programs with those for other dune specialist Lepidoterans in the Canadian Prairies.
Broad Strategy: Habitat Management and Stewardship		
All threats except stochastic events	High	• Determine and implement best management practices to achieve conservation of suitable habitat, and reduction or elimination of threats. • Collaborate with land owners, land managers, government agencies and other relevant parties to promote, coordinate and implement habitat management and conservation efforts. • Integrate Gold-edged Gem habitat management and stewardship efforts with those for other dune specialist species in the Canadian Prairies.
Broad Strategy: Outreach and Communication		
All threats except stochastic events	Medium	• Increase public awareness of Gold-edged Gems, other sand dune Lepidopteran specialist species and their habitat requirements in the Canadian Prairies. • Educate land users to reduce habitat degradation caused by their activities.
Broad Strategy: Research		
All threats and knowledge gaps related to the species' biology	Medium	• Fill in key knowledge gaps with respect to the species' life history, ecology, and microhabitat requirements.

6.3 Narrative to support Recovery Planning Table

Inventory and Monitoring

To determine whether the population and distribution objectives (see section 5) are being achieved, a standardized Lepidopteran survey and monitoring protocol should be developed and implemented across the species' Canadian range. Regular systematic surveys over several consecutive years of known occupied sites and additional sites that have yet to be surveyed are highly recommended. The dataset created by Wolfe (2010) identifying all active sand dunes and blowouts within Canadian Prairie Provinces should be used to facilitate the planning of surveys.

It is estimated that as much as two thirds of potential Gold-edged Gem habitat has not yet been surveyed (COSEWIC 2006, NatureServe 2011, G. Anweiler, pers. comm. 2008). In the future, surveys should be done at key, previously unsurveyed sand hills. Furthermore, Gold-edged Gem monitoring efforts should be coordinated with those of other Lepidopteran dune specialist species at risk found in the Canadian Prairies to maximize effectiveness of efforts and costs.

Habitat Management and Stewardship

Habitat management and stewardship are key elements in the recovery strategy. Beneficial management practices (e.g., prescribed burning, suitable grazing, and control of invasive species and vegetation encroachment) should be developed to reduce or eliminate threats and maintain suitable habitat for the species. Collaboration among individuals, organizations and government departments that own, lease, use or manage land where the species occurs will be essential to reduce or eliminate threats and achieve optimal management of the species habitat. Management activities for the Gold-edged Gem should consider the requirements of other species occurring within sand dune ecosystems and be carried out accordingly (see Appendix C).

Ungulate grazing is a necessary natural process in maintaining healthy and diverse grassland ecosystems (SK PCAP, 2008). Grazing management that prevents the landscape from becoming unhealthy or improves the ecological health status benefits numerous species on the landscape (Adams et al. 2005). In order to effectively manage livestock grazing, it is necessary to operate and maintain infrastructure such as fencing, water sources, and salting locations to achieve the goal of rangeland health. Livestock do not graze in a uniform manner resulting in areas of low, high and moderate utilization that provide a patchy bio-diverse rangeland which meets habitat requirements of wildlife and species at risk. As such, grazing and the maintenance of the infrastructure supporting it may be a beneficial management practice within the critical habitat of the Gold-edged Gem.

Outreach and Communication

Gold-edged Gems and other sand dune specialist Lepidopteran species found in the Canadian Prairie are cryptic and land users are often unaware of their existence and activities that negatively affect them.

Featuring Gold-edged Gem and other sand dune specialist Lepidopteran species on signs or within information pamphlets of protected areas where the species are found would increase awareness of their existence among the public. Also, land users conducting activities that negatively affect such species or their habitat could be advised on how they can attenuate their impacts.

Research

Effective recovery and management of Gold-edged Gem will depend on scientific research into this species' biology and ecology as well as habitat associations and the relative importance of various human-related threats. Some key areas for future research include investigating life history attributes and mortality factors especially in relation to habitat selection. Likewise, data is needed for host plant requirements, micro-habitat characteristics and if possible the effects of annual climatic variables and disturbances on host plant distribution and abundance. Several rare and at risk species occur in the active and semi-stabilized sand dune ecosystem (see Appendix C). When possible, collaborative research with recovery teams working on these sand dune specialists would be both practical and appropriate.

7. CRITICAL HABITAT IDENTIFICATION

7.1 Identification of the species' critical habitat

Critical habitat is defined in SARA (Subsection 2(1)) as *"the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species"*.

Critical habitat identified in this recovery strategy encompasses all nine occurrences known to exist in Canada, and is considered sufficient to achieve the population and distributions objectives, at this time.

Critical habitat is identified at each Gold-edged Gem location as the active open sand dunes and/or blowouts, encompassing the area from the crest of the dune to the edge where native vegetation grows and the dune is stabilized.

Data collected during field surveys conducted between 2004 and 2011, and occurrence information obtained from literature searches were used to identify Gold-edged Gem critical habitat locations.

Critical habitat locations were identified based on the following three criteria:

1) The presence of one or more Gold-edged Gem has been confirmed by a trained observer at a location prior to December 2011. The rationale for this criterion is as follows:

    a. Counts of Gold-edged Gem likely underestimate the true abundance of the species at any given location. Gold-edged Gem adults have a patchy distribution, are small, fly rapidly and have a short adult life span (Hardwick 1996, COSEWIC

2006). Furthermore, their detectability may vary with time of day (M.-C. Bélair, unpubl. data). The adult emergence period varies from one year to another (COSEWIC 2006) and the population peaks for only a few days each year (G.Anweiler, pers. comm. 2008). Therefore, the presence of Gold-edged Gems in occupied sand dunes or blowouts could easily go undetected.

b. The species is a habitat specialist and has only one known host plant, the Prairie Sunflower (COSEWIC 2006). The abundance of Prairie Sunflower varies annually (G. Anweiler, pers. comm. 2008), thus influencing Gold-edged Gem abundance on a yearly basis.

c. Gold-edged Gems are not known to disperse or migrate (COSEWIC 2006) and the extent of their habitat use is estimated at 1 km^2 (NatureServe 2011). Similar moth species have displayed host plant fidelity and are therefore observed only in the immediate vicinity of host plant colonies (Hardwick 1996, COSEWIC 2005). It is unlikely that the Gold-edged Gem is able to disperse at the landscape level given the lengthy distances of unsuitable habitat separating major sand dune or blowout areas. Thus, it is likely that all individuals observed at a particular dune are resident, reproducing individuals capable of contributing to population persistence at that particular dune. It is unlikely they are vagrants that are simply transitioning from one site to another.

2) Locations of Gold-edged Gem observations were determined with reasonable accuracy (i.e. where the species' occurrence had precise geographical coordinates or where the sand dune on which the species had been observed could be precisely located on a map).

3) Locations are characterized by the following biophysical attributes:

(a) active open sand dunes and/or blowouts, encompassing the area from the crest of the dune to the edge where native vegetation grows and the dune is stabilized, as inventoried by Wolfe (2010) or confirmed by ground truthing by a trained individual.
(b) The presence of one or more larval host plants (i.e., Prairie Sunflower) and/or one or more adult nectar sources (e.g., Prairie Sunflower, Common Skeletonweed and Lemon Scurfpea).

Critical habitat for the Gold-edged Gem, as identified above, is located within or adjacent to 23 quarter-sections[5] in Alberta, 18 quarter-sections in Saskatchewan, and 7 quarter-sections in Manitoba (Appendix A and B). Additional critical habitat may be identified across the range of the species as more information becomes available.

[5] The Dominion Land Survey system (McKercher and Wolfe 1986) is the grid system used in the Prairie Provinces to describe land locations. One unit of this system, the quarter-section (65 ha), is particularly useful for mapping critical habitat as it is used for ownership and management purposes. The quarter-section level is used in this strategy to aid in describing the location of Gold edged Gem critical habitat.

7.2 Activities likely to result in destruction of critical habitat

Destruction is determined on a case by case basis. Destruction would result if part of the critical habitat was degraded, either permanently or temporarily, such that it would not serve its function when needed by the species. Destruction may result from a single activity or multiple activities at one point in time or from the cumulative effects of one or more activities over time (Government of Canada 2009).

Examples of activities that may result in destruction of critical habitat include, but are not limited to:

1) **Stabilization of active sand dune habitat.** Seeding, re-vegetation, the use of flax bales, straw crimping, drift fences, and landscape fabrics, or any other actions that actively stabilize sand dunes or blowouts as a means of decreasing soil erosion, reclaiming disturbed locations, or improving land use productivity would constitute destruction of Gold-edged Gem critical habitat. Sand dune or blowout stabilization changes the plant diversity and structure and directly contributes to the loss of open active sand area.

2) **Alteration of sand dune or blowout habitat and surrounding area**. Activities that cause disturbance to soil and/or native vegetation of sand dunes that exceed natural ranges of variability in disturbance dynamics will likely result in destruction of critical habitat. Changes in the frequency, severity, seasonality and extent of natural disturbance events caused by new oil and gas exploration and development, sand extraction, expansion of existing or creation of new anthropogenic structures in or adjacent[6] to sand dune or blowout habitats are activities that would result in destruction of Gold-edged Gem critical habitat. These activities are associated with new access road development, motorized traffic, new pipeline installation, and new construction or expansion of infrastructure that may cause mortality of larval host plants and adult nectar sources, as well as habitat loss, degradation, and fragmentation. Although sand and gravel extraction is not known to occur within the identified critical habitat at present, future demand for sand for road building and urban development may increase. Sand extraction results in the direct removal of soil and elimination of the existing seed bank of larval and adult host and/or nectar plants. The listed activities also have the potential to introduce exotic species which in turn contribute to dune stabilization and competition with host and/or nectar plants (*see* Section 4.2 for species' threats). They may also alter the local hydrology with possible consequences for the sand dune habitat. Because Gold-edged Gems require active sand dune or blowout habitats within a native prairie matrix and host and/or nectar plants, the species cannot survive in modified landscapes.

3) **Indiscriminant application of harmful chemicals.** Non-targeted application of certain pesticides may destroy critical habitat by reducing or eliminating pollinators upon which host plants and/or nectar plants rely or by reducing or eliminating the host and nectar

[6] Adjacent is defined as "not distant, having a common endpoint or border, and immediately preceding or following" (Merriam-Webster 2012).

plants themselves. Direct application of pesticides at frequencies, intensities and spatial extents that expose pollinators or host and nectar plants to lethal concentrations would destroy the critical habitat. The likelihood of such activities affecting critical habitat may vary by the season of application. In addition, pesticide drift or runoff from nearby croplands or roadsides may also have the potential to destroy the critical habitat, provided that concentrations reaching non-target insects or plants are high enough to be lethal. Fertilizer runoff can alter soil nutrient status, creating new conditions that may be unsuitable for Gold-edged Gem host and/or nectar plants. Changes to soil nutrient status may also influence the outcome of interspecific competition for nutrients for Gold-edged Gem host and/or nectar plants.

4) **Improper management of grasslands or sand dune/blowout areas.** Reduction or elimination of host and nectar plants due to grazing, trampling, vehicular and recreational traffic, waste application, or deliberate introduction or promotion of invasive exotic species would constitute destruction of critical habitat[7]. The listed activities may result in the mortality or reduction in abundance and productivity of host and/or nectar plants. The introduction or promotion of invasive species may contribute to the stabilization of dune habitat and may result in displacement of host and nectar plants by the exotic species.

8. MEASURING PROGRESS

The performance indicator presented below provides a way to define and measure progress toward achieving the population and distribution objectives. Progress towards meeting the population and distribution objectives must be reported within five years after this recovery strategy is finalized.

- The distribution of all known occurrences in the Canadian range of the species, and any additional occurrence discovered in Canada in the future are maintained or increased by 2019.

9. STATEMENT ON ACTION PLANS

One or more action plans for the Gold-edged Gem will be completed by 2018. A multi-species action plan(s) for various species inhabiting the active dune ecosystem would be beneficial and cost-effective.

[7] Properly managed grazing systems and the maintenance of existing infrastructure supporting it, may be a beneficial management practice within the critical habitat of the Gold-edged Gem because grazing by cattle simulates the role of native ungulate grazing in maintaining open, active sand dunes. Activities or infrastructure in Gold-edged Gem critical habitat related to maintaining proper grazing systems may include: maintenance of existing trails (mowing or grading), existing fence lines, existing prairie tracks for vehicles including two-track trails, and existing fire guards.

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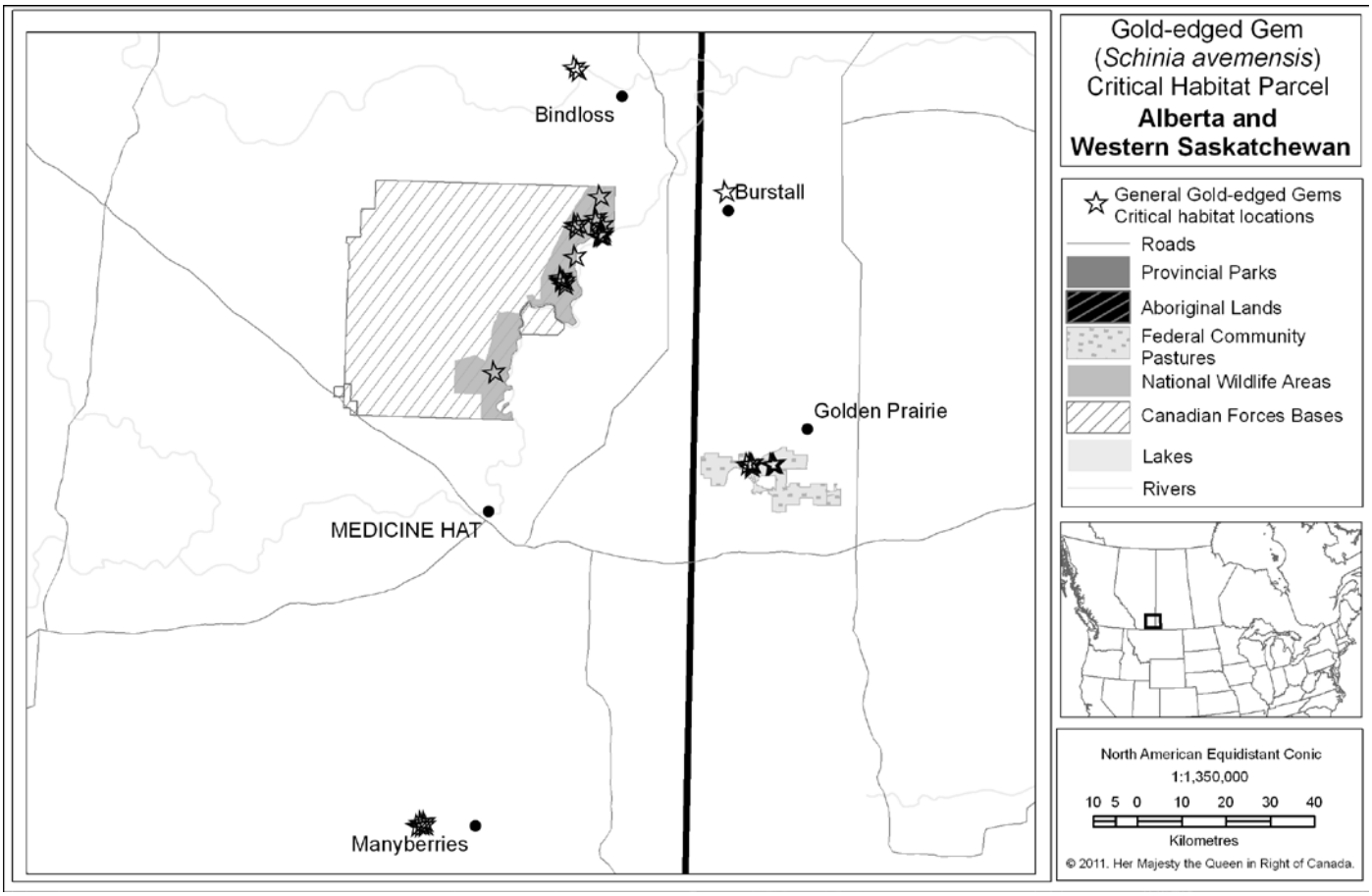
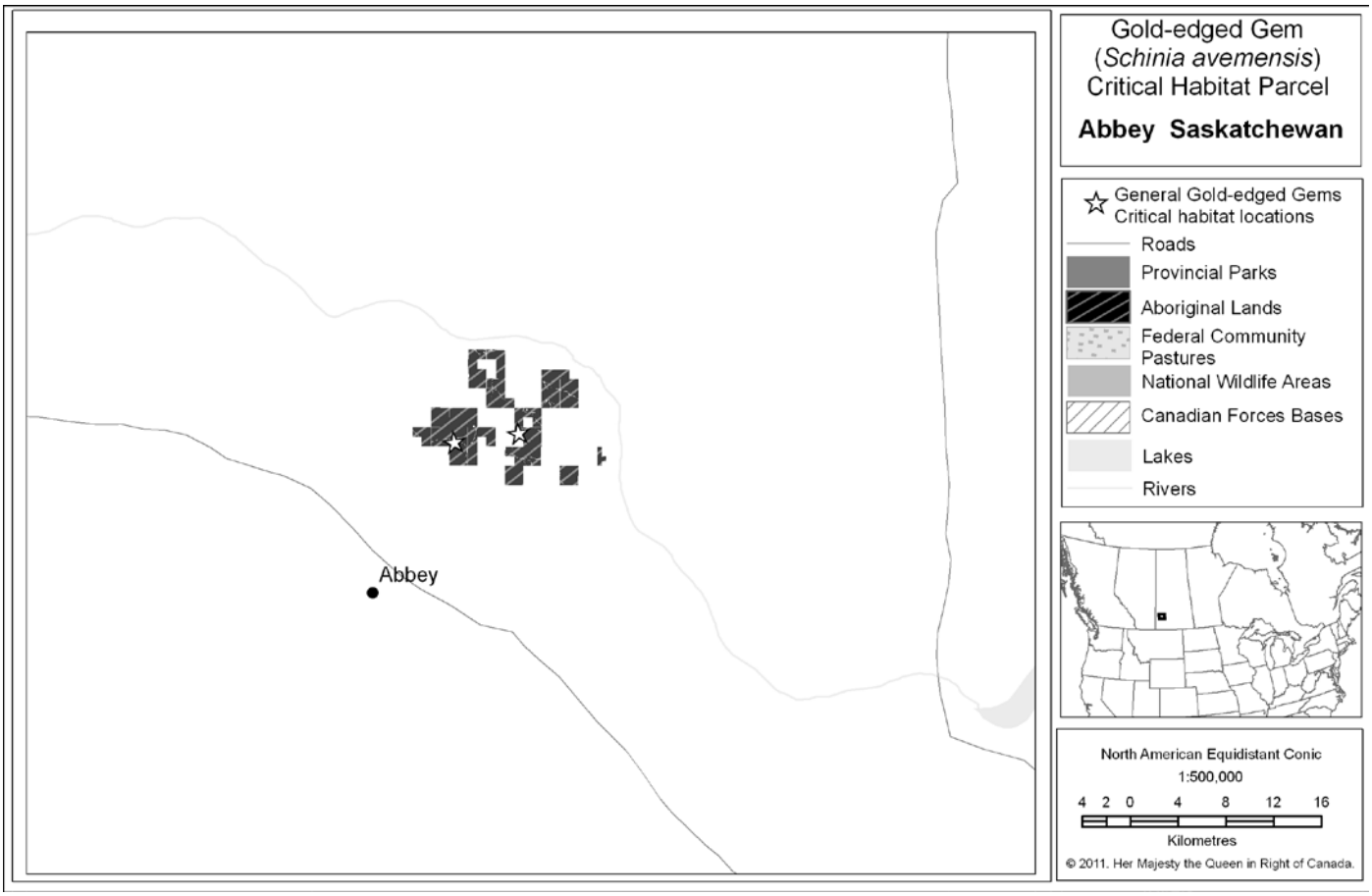
Personal Communications

Andrew Taylor – Range Biologist, Canadian Forces Base Suffield, Alberta
Chuck Harp - Season Summary Coordinator, Rocky Mountain Region, Colorado
Gary Anweiler – Associate, University of Alberta, Strickland Entomology Museum, Alberta
Joel Perry – Park Supervisor -Douglas Provincial Park, Saskatchewan
Sharilyn Westworth – Wildlife Technician, Canadian Wildlife Service, Environment Canada, Alberta

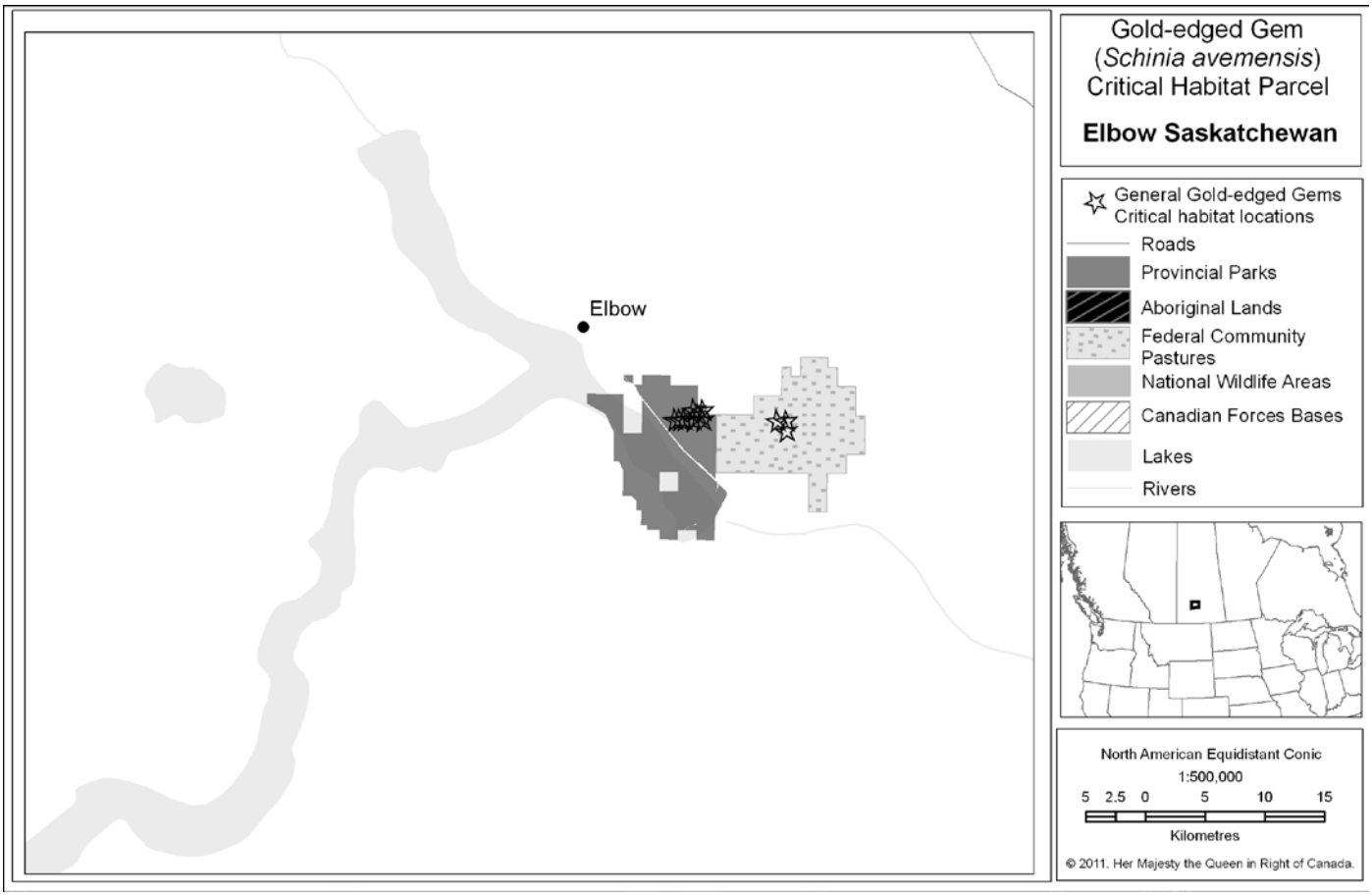
APPENDIX A – MAPS OF GOLD-EDGED GEM CRITICAL HABITAT IN CANADA.



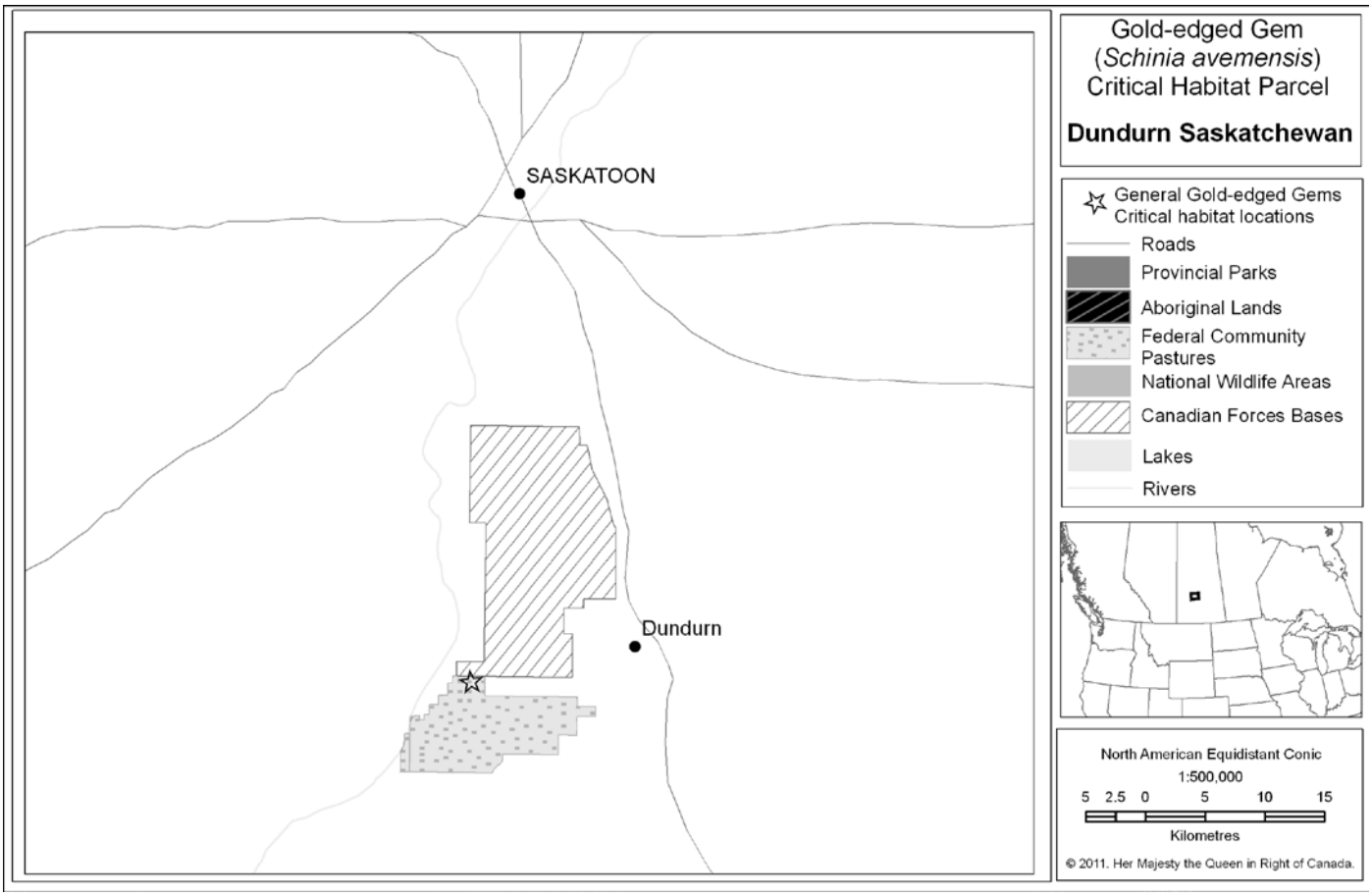
Critical habitat for the Gold-edged Gem in the Empress Meander (Dune Point) (near Bindloss), Pakowki Lake (near Manyberries) and Middle sand hills (in Suffield NWA) of Alberta, and the Burstall, and Tunstall (near Golden Prairie) sand hills of Saskatchewan.



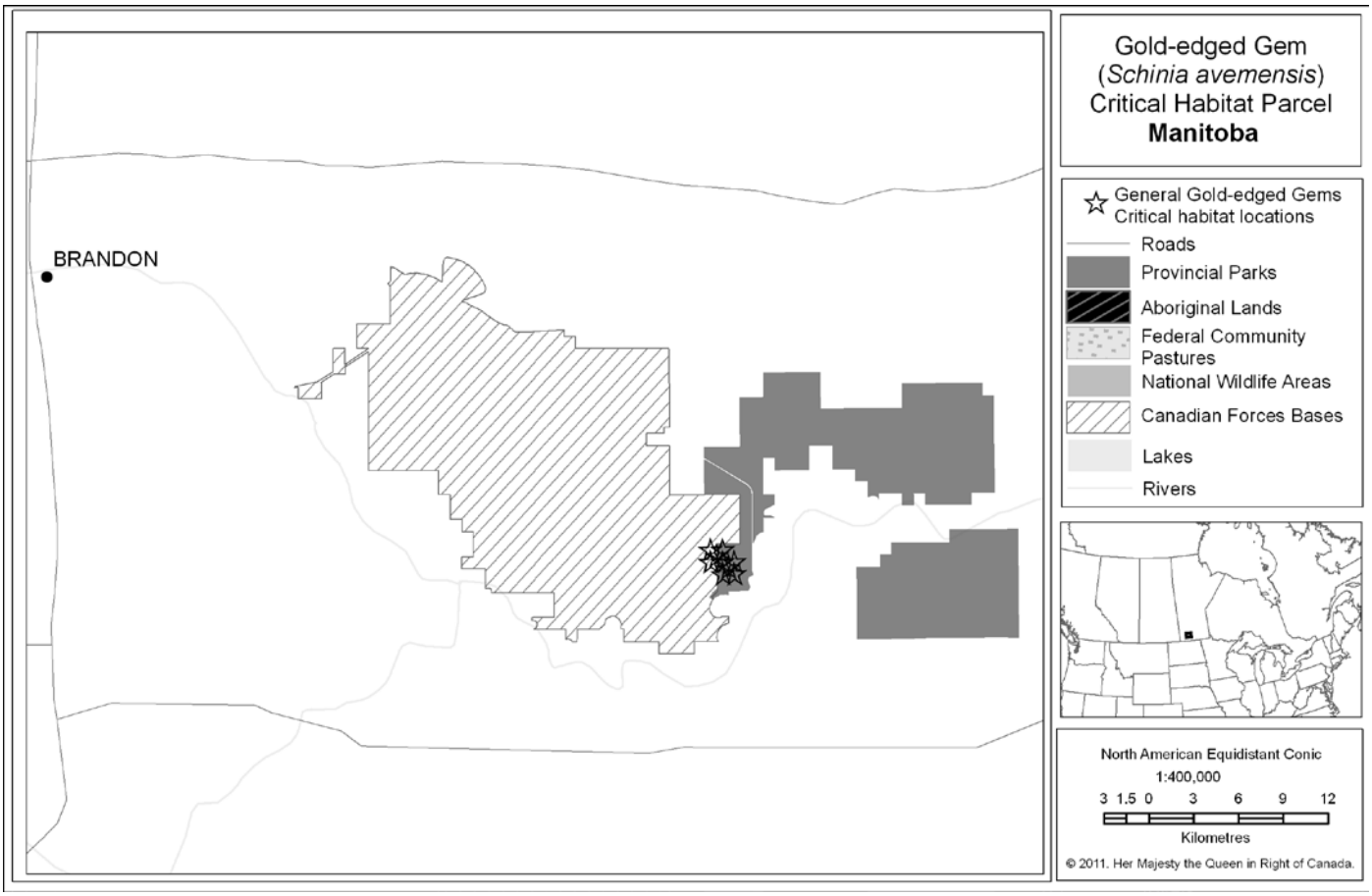
Critical habitat for the Gold-edged Gem in the Cramersburg (near Abbey) sand hills of Saskatchewan.



Critical habitat for the Gold-edged Gem in the Elbow sand hills, Saskatchewan.



Critical habitat for the Gold-edged Gem in the Dundurn sand hills, Saskatchewan.



Critical habitat for the Gold-edged Gem in the Brandon sand hills, Manitoba.

APPENDIX B – QUARTER SECTIONS CONTAINING GOLD-EDGED GEM CRITICAL HABITAT IN CANADA[8].

Quarter sections containing Gold-edged Gem critical habitat Canada.

Saskatchewan					
Dune field	**Quarter section**	**Section**	**Township**	**Range**	**Meridian**
Tunstall sand hills	NW	6	14	28	3
Tunstall sand hills	NE	6	14	28	3
Tunstall sand hills	SE	6	14	28	3
Tunstall sand hills	NE	3	14	28	3
Tunstall sand hills	NW	2	14	28	3
Burstall sand hills	NE	14	20	29	3
Cramersburg sand hills	NE	9	22	19	3
Cramersburg sand hills	SE	12	22	20	3
Elbow sand hills	SE	23	24	4	3
Elbow sand hills	SW	24	24	4	3
Elbow sand hills	NW	13	24	4	3
Elbow sand hills	NE	14	24	4	3
Elbow sand hills	NE	15	24	4	3
Elbow sand hills	NW	14	24	4	3
Elbow sand hills	NW	15	24	3	3
Elbow sand hills	NE	15	24	3	3
Elbow sand hills	SE	15	24	3	3
Dundurn sand hills	NW	30	32	5	3
Alberta					
Dune field	**Quarter section**	**Section**	**Township**	**Range**	**Meridian**
Pakowki Lake sand hills	SE	21	5	7	4
Pakowki Lake sand hills	SW	22	5	7	4
Pakowki Lake sand hills	NW	22	5	7	4
Pakowki Lake sand hills	NE	22	5	7	4
Pakowki Lake sand hills	SE	22	5	7	4
Middle sand hills	NE	6	16	5	4
Middle sand hills	NW	11	18	4	4
Middle sand hills	SW	14	18	4	4
Middle sand hills	NE	11	18	4	4
Middle sand hills	SE	11	18	4	4
Middle sand hills	SW	31	18	3	4
Middle sand hills	NW	27	19	3	4
Middle sand hills	SW	27	19	3	4
Middle sand hills	NE	10	20	3	4
Middle sand hills	SW	14	19	3	4
Middle sand hills	SE	15	19	3	4
Middle sand hills	NW	14	19	3	4
Middle sand hills	NW	23	19	3	4

[8] As described in Section 7.1, critical habitat is identified at each Gold-edged Gem location as the active open sand dunes and/or blowouts, encompassing the area from the crest of the dune to the edge where native vegetation grows and the dune is stabilized

Middle sand hills	NE	19	19	3	4
Middle sand hills	NW	19	19	3	4
Middle sand hills	SW	19	19	3	4
Empress Meander (Dune Point) sand hills	NE	12	23	4	4
Empress Meander (Dune Point) sand hills	SW	7	23	3	4
Manitoba					
Dune field	**Quarter section**	**Section**	**Township**	**Range**	**Meridian**
Brandon sand hills	NW	22	8	14	1
Brandon sand hills	NE	21	8	14	1
Brandon sand hills	SE	21	8	14	1
Brandon sand hills	SW	22	8	14	1
Brandon sand hills	SE	22	8	14	1
Brandon sand hills	NE	15	8	14	1
Brandon sand hills	NW	15	8	14	1

APPENDIX C - 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*. 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.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies 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 strategy itself, but are also summarized below in this statement.

Sand dune ecosystems support a wide range of rare and highly specialized plants and animals, many of which are at risk of extinction in Canada. As such, it is anticipated that the activities identified in this recovery strategy will benefit several species and the environment. In particular, the endangered Ord's Kangaroo Rat (*Dipodomys ordii*) that sometimes occurs in the same habitat as Gold-edged Gem, would benefit from management and research activities identified in this strategy. Several at risk plants occur in sand dunes including the endangered Small-flowered Sand-verbena (*Tripterocalyx micranthus*) and Tiny Cryptantha (*Cryptantha minima*), as well as the threatened Hairy Prairie-clover (*Dalea villosa var. villosa*), Smooth Goosefoot (*Chenopodium subglabrum*) and Western Spiderwort (*Tradescantia occidentalis*). Several rare moths are also found in association with Gold-edged Gem habitat including the endangered White Flower Moth (*Schinia bimatris*), Aweme Borer Moth (*Papaipema aweme*) and Dusky Dune Moth (*Copablepharon longipenne*), as well as the special concern Pale Yellow Dune Moth (*Copablepharon grandis*).

Accordingly, management and conservation measures aimed at Gold-edged Gem recovery will benefit many of these rare and sensitive species and overall, will contribute to the future conservation of active dune ecosystems.