Species at Risk Act
Recovery Strategy Series

Recovery Strategy for the Dusky Dune Moth (*Copablepharon longipenne*) in Canada

Dusky Dune Moth



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Canada

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For copies of the recovery strategy, or for additional information on species at risk, including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Status Reports, residence descriptions, action plans, and other related recovery documents, please visit the Species at Risk (SAR) Public Registry[1].

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[1] http://www.registrelep-sararegistry.gc.ca

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. 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 five years after the publication of the final document on the SAR Public Registry.

The Minister of the Environment is the competent minister under SARA for the Dusky Dune Moth and has prepared this strategy, as per section 37 of SARA. To the extent possible, 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 Dusky Dune Moth 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.

The recovery strategy sets the strategic direction to arrest or reverse the decline of the species, including identification of critical habitat to the extent possible. It provides all Canadians with information to help take action on species conservation. When the recovery strategy identifies critical habitat, there may be future regulatory implications, depending on where the critical habitat is identified. SARA requires that critical habitat identified within federal protected areas be described in the *Canada Gazette*, after which prohibitions against its destruction will apply. For critical habitat located on federal lands outside of federal protected areas, the Minister of the Environment must either make a statement on existing legal protection or make an order so that the prohibition against destruction of critical habitat applies. For critical habitat located on non-federal lands, if the Minister of the Environment forms the opinion that any portion of critical habitat is not protected by provisions in or measures under SARA or other Acts of Parliament, and not effectively protected by the laws of the province or territory, SARA requires that the Minister recommend that the Governor in Council make an order to extend the prohibition against destruction of critical habitat to that portion. The discretion to protect critical habitat on non-federal lands that is not otherwise protected rests with the Governor in Council.

[2] http://registrelep-sararegistry.gc.ca/default.asp?lang=en&n=6B319869-1#2

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EXECUTIVE SUMMARY

The Dusky Dune Moth is a small inconspicuous sand dune specialist moth endemic to North America. Globally, the species is considered rare and has a restricted distribution. Only 25 localities are known to exist in North America, 13 of which occur in Canada. Canadian populations are small and fragmented, with a limited range. The species was listed as Endangered under the *Species at Risk Act* in 2020.

The Dusky Dune Moth has specialized habitat requirements, inhabiting remnant patches of active sand dunes or blowouts. Data on distribution, population dynamics, and ecology is very limited. Since the completion of the 2007 COSEWIC status report, Dusky Dune Moths have been discovered at 3 additional sand hills, indicating that the species is more widely distributed than previously thought.

Additional loss of habitat quantity or quality among the known Dusky Dune Moth populations could adversely affect the species' survival in Canada. Future loss of habitat will most likely ensue from threats that lead to dune stabilization and habitat succession. Examples of such threats include alteration to, or suppression of, natural grazing and/or fire regimes, invasive alien species or through direct habitat loss, fragmentation or degradation from threats like cultivation, oil and gas activities, sand extraction, recreational activities, military activities, and again, invasive alien species.

Recovery of the Dusky Dune Moth is determined to be biologically and technically feasible. The population and distribution objectives for the Dusky Dune Moth are to maintain or increase the current distribution of the species at all confirmed and natural (i.e., non-anthropogenic) locations, as well as at any additional natural locations discovered in the future. Recovery planning will be carried out through four broad strategies: inventory and monitoring; habitat assessment, management and conservation; communication, collaboration and engagement; and research.

Critical habitat identified in this recovery strategy encompasses 10 sand hill locations known to exist in Canada, translating into 21 individual active sand dunes or blowouts including 1 sand dune in Manitoba, 14 sand dunes in Saskatchewan and 6 sand dunes in Alberta. 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. This is considered sufficient to achieve the population and distribution objectives at this time. Additional critical habitat may be identified across the range of the species as more information becomes available.

One or more Action Plans for the Dusky Dune Moth will be posted on the Species at Risk Public Registry by 2020.

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 established by the Government of Canada (2009) for recovering species at risk, recovery of the Dusky Dune Moth 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. Currently, Dusky Dune Moth populations occur at a minimum of 21 locations (active sand dunes and blow outs) in Canada. The species has been documented to occur in several sand hills for more than 100 years, although the size and condition of some sand hills appear to have significantly changed over the past several decades. Once threats have been controlled, individuals are likely to continue to reproduce and persist at these sites. Furthermore, it is likely that the species occurs at other sand hills that have not been surveyed yet.

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

Yes. Sufficient suitable Dusky Dune Moth habitat is presently available, although remaining habitat patches are extremely small, fragmented and progressively declining due to stabilization of active sand dunes across the species' range. The specific habitat requirements for Dusky Dune Moth survival and recovery are not yet well understood. More information regarding the specific habitat requirements during the different life stages will be needed before reliable habitat management and restoration activities can be implemented. In the meantime, techniques are being developed to destabilize sand dunes, thus reducing the threat of dune stabilization.

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

Yes. The main threats to Dusky Dune Moth recovery are those contributing to loss of habitat quality and quantity by increasing dune stabilization The main threats that promote dune stabilization include an alteration to, or suppression of, natural grazing or fire regimes, invasive alien species, and prolonged wet, climatic periods. Those threats can be reduced or mitigated primarily through site management and protection, stewardship, research, and education.

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

Yes. The main recovery techniques will be protection and habitat management at known occupied sites. The possibility of securing and/or managing sites presently located on private lands or on lands under Provincial jurisdiction can also be explored.

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1. COSEWIC* SPECIES ASSESSMENT INFORMATION

Date of Assessment: November 2007

Common Name (population): Dusky Dune Moth

Scientific Name: *Copablepharon longipenne*

COSEWIC Status: Endangered

Reason for Designation: The species is restricted to open, active sand areas that are both fragmented and declining. Although it may be common where found, it occurs in a small proportion of the total seemingly suitable sites and has been lost from historical localities. Dispersal between dune systems is considered to be extremely unlikely. Since the 1940's, the area of suitable habitat has declined by an estimated 10-20% per decade.

Canadian Occurrence: Alberta, Saskatchewan, Manitoba

COSEWIC Status History: Designated Endangered in November 2007.

*COSEWIC: Committee on the Status of Endangered Wildlife in Canada

2. SPECIES STATUS INFORMATION

The Dusky Dune Moth (*Copablepharon longipenne*) (Grote 1882) has a global conservation status of apparently secure (G4) (NatureServe 2013). The moth was assessed critically imperiled in Canada (N1N2), Alberta (S1), and Manitoba (S1) but remains unranked in Saskatchewan (SNR) and the United States (NNR) (NatureServe 2013).

The species is listed as endangered under the *Species at Risk Act*. It is listed as Endangered in Manitoba under the provincial Endangered Species and Ecosystems Act. It is not listed under provincial legislation in Saskatchewan and Alberta.

Populations outside of Canada are poorly and only partially documented, thus it is currently unknown what percentage of the Dusky Dune Moth global population occurs in Canada. However, approximately half of all known localities are located in Canada.

Two subspecies of Dusky Dune Moth are recognized within North America. The nominate subspecies, *C. longipenne* ssp. *longipenne* occurs in Canada with a range extending south to Colorado. Subspecies *C. longipenne* ssp. *serraticonis* (A. Blanchard) occurs from Colorado to Texas; the two subspecies apparently intergrade in Colorado (Lafontaine 2004).

3. SPECIES INFORMATION

3.1 Species Description

The Dusky Dune Moth is a member of the Order Lepidoptera (butterflies and moths), Family Noctuidae (owlet or cutworm moths), and Subfamily Noctuinae (dagger moths). The Dusky Dune Moth was first reported in Canada during the early 1900s from the Brandon Sand Hills, Manitoba by N.Criddle who raised an adult from collected larvae (Strickland 1920).

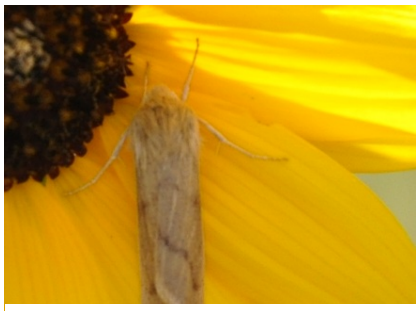


Figure 1. Adult Dusky Dune Moth © M.Curteanu

Adult Dusky Dune Moths are medium-sized (3.5-3.9 cm wingspan) moths with light yellow-brown or yellow-grey forewings crossed by a distinctive line of black dots (COSEWIC 2007). The hindwings are dark grey-brown. Adults of both sexes are similar in appearance, but females are larger than males (Lafontaine 2004). The moth has one generation per year with the flight period lasting approximately 10 weeks (COSEWIC 2007), from early July until late August, with the peak flight period in Canada likely from mid-July to early August (COSEWIC 2007). Like the majority of Noctuids, Dusky Dune Moths are considered nocturnal (COSEWIC 2007) as they fly at night and are strongly attracted to light; however, adults have been observed during the day resting on Prairie Sunflowers (*Helianthus petiolaris*) (M. Curteanu unpubl. data).

Eggs are translucent white spheres, approximately 0.3 mm in diameter, and are deposited in clusters of 15-35 eggs in the sand (COSEWIC 2007). The larva is grey with brownish-red stripes, and with a bluish white underside. The pupa of *Copablepharon* species can be recognized by the extremely long proboscis sheath, extending to the 6th abdominal segment (Strickland 1920; Lafontaine 2004).

3.2 Population and Distribution

The global range of the Dusky Dune Moth lies almost entirely within the Great Plains region of North America (Figure 2). The range extends across the southern Prairie Provinces from southeastern Alberta to southwestern Manitoba and south into northern Texas, United States (Lafontaine 2004; COSEWIC 2007). Within this global range, populations are fragmented, occurring only at several open active sand dunes[3] and

[3] 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).

dune blow-outs[4] which exist within larger stabilized or semi-stabilized sand hills[5]. The Canadian population is 270 km from the nearest population in Montana, United States and dispersal between these populations is thought to be highly unlikely (COSEWIC 2007).

Additional survey efforts are likely to discover previously undocumented populations (COSEWIC 2007).

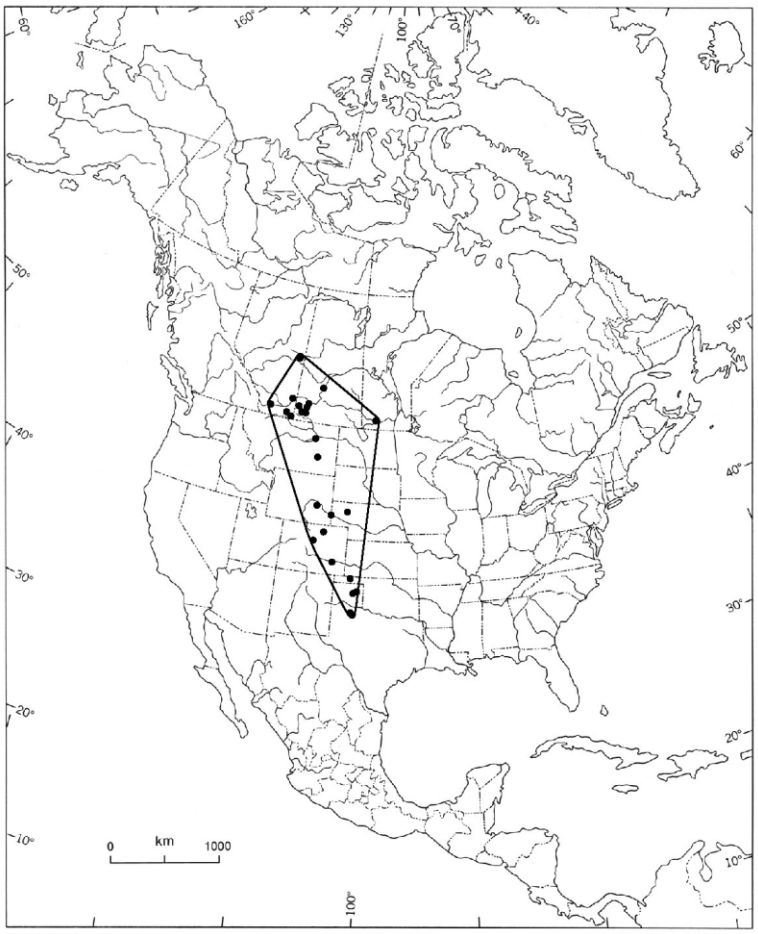


Figure 2. North American distribution of Dusky Dune Moth (COSEWIC 2007). This figure includes historic locations.

[4] 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).

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

Canadian Range

The current known Canadian Dusky Dune Moth range extends from southeastern Alberta, across southern Saskatchewan and into Manitoba's Spruce Woods Provincial Park and as far north as Canadian Force Base (CFB) Dundurn, Saskatchewan (Figure 3) (Lafontaine 2004; COSEWIC 2007; M. Curteanu unpubl. data; M.C. Belair unpubl. data). The Saskatchewan Dusky Dune Moth population is separated from the Manitoba population by approximately 500 km of agricultural and developed land; gene flow between these populations is thought to be highly unlikely.

The entire Canadian Dusky Dune Moth range lies within the Prairie Ecozone (Ecological Stratification Working Group 1995). The total extent of occurrence of all known Dusky Dune Moth populations is estimated to be 164,480 km² (COSEWIC 2007); however, this is likely an overestimate since several populations are believed to no longer exist (i.e., "historic" populations where suitable habitat no longer exists and likely no longer supports Dusky Dune Moths; COSEWIC 2007). The area of occupancy for known populations (i.e., excluding historic records) is estimated to be less than 50 km^2 (COSEWIC 2007).

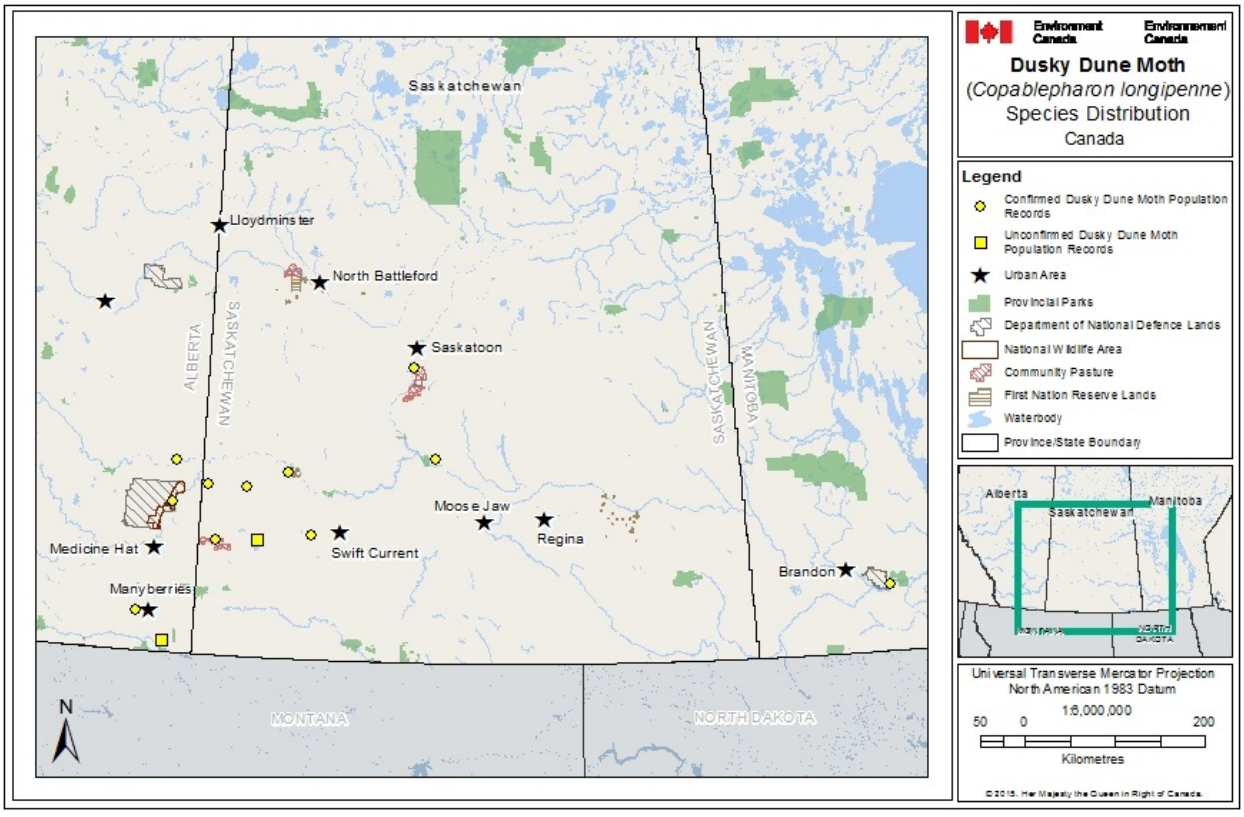


Figure 3: Dusky Dune Moth Canadian distribution. Yellow circles represent populations at sand hills where the species has been confirmed since 1999. Yellow squares represent unconfirmed populations, where the species was last observed >45 years ago but suitable habitat still exists.

Since 1951, Dusky Dune Moths have been recorded within 13 sand hills in Canada: 4 in Alberta, 8 in Saskatchewan and 1 in Manitoba (Table 1; Figure 3). The exact location and current status of two of these populations (Dominion Sand Hills Alberta, and Big Stick-Crane Lake Sand Hills, Saskatchewan) have not been confirmed since their discoveries in 1951 and 1969 respectively (Table 1); however, suitable habitat still exists in the area thus they are included in the species' general distribution. All but one population are from natural sand dune habitats. The single population in anthropogenic habitat was from a sandy fireguard within the Dundurn Sand Hills in Saskatchewan.

Three populations (Middle Sand Hills, Alberta and Elbow and Tunstall Sand Hills, Saskatchewan; Figure 3, Table 1) were discovered since the completion of the 2007 COSEWIC status report (M. Curteanu unpubl. data; M.C. Belair unpubl. data). With continued survey effort, it is likely that additional Dusky Dune Moth populations will be discovered in Canada. Several surveys were conducted in sand dunes north of the 52nd parallel (e.g., Buffalo Park, Edgerton, Sounding Lake, and North Battleford Sand Hills); however, Dusky Dune Moths were not found at any of these sites (N. A. Page unpubl. data; M. Curteanu unpubl. data; M.C. Belair unpubl. data), suggesting that the species might not occur that far north. Currently CFB Dundurn, Saskatchewan, remains the most northerly population for Dusky Dune Moths. Further investigation of unsurveyed sand hills in Saskatchewan (e.g., Pelican Lake, Westham, Carmicheal and Piapot Sand Hills) may uncover additional populations.

While it is not known if any populations of Dusky Dune Moths have been extirpated, it is likely that the Dusky Dune Moth Canadian range has decreased in the last decade (COSEWIC 2007). Dusky Dune Moth museum records, extending back more than 50 years, exist from several locations north and west of the current known range. Historic locations, including Lethbridge and Sunnydale[6] Alberta, are likely incapable of supporting Dusky Dune Moth populations due to loss of suitable active sand dune habitats (COSEWIC 2007).

Canadian Abundance

There is no reliable information on population size and trends for the Dusky Dune Moth. The inherent difficulty in assessing population sizes, variability, and trends in rare insects greatly reduces the potential for detailed population information.

However, based on well-studied stabilization trends of active sand dunes in the southern Canadian prairies, Dusky Dune Moth populations in Canada are believed to be declining at a rate of 10–20% per decade; a rate of decline that is expected to continue (COSEWIC 2007; Wolfe and Nickling 1997).

[6] The Sunnydale location is mis-plotted to near Oyen in Lafontaine (2004).

The Dusky Dune Moth has likely been a rare and local species since European settlement of the prairies, as there were very few collection sites recorded prior to the recent survey work initiated by COSEWIC. Populations are limited by the amount of suitable, highly specialized habitat, which is fragmented and has been steadily declining due to natural succession.

Table 1. Summary of Canadian Dusky Dune Moth Populations.

Sand Hill[1]	First Observation	Most Recent Observation	Sum of Individuals Observed Over Time[2]	Number of Occupied Locations[3]
ALBERTA				
1. Dominion Sand Hills	1951	1951	2	unknown
2. Dune Point Sand Hills	2004	2004	1	1
3. Middle Sand Hills	2008	2010	7	2
4. Pakowki Lake Sand Hills	1925	2010	23	3
SASKATCHEWAN				
5. Big Stick- Crane Lake Sand Hills	1969	1969	1	unknown
6. Burstall Sand Hills	1997	2004	>187	1
7. Cramersberg Sand Hills	2005	2011	>48	4
8. Dundurn Sand Hill	2004	2004	78	1 (fire guard)
9. Elbow Sand Hills	2011	2011	2	1
10. Great Sand Hills	1999	2005	47	3
11. Seward Sand Hills	2004	2004	286	2
12. Tunstall Sand Hills	2010	2010	80	3
MANITOBA				
13. Brandon Sand Hills	1910	2012	> 96	1

[1] *Sand Hill names adopted from Wolfe (2010).*
[2] *Minimum counts.*
[3] *Locations refer to active open sand dunes or blowouts*

3.3 Needs of the Dusky Dune Moth

Habitat Requirements

Dusky Dune Moth is considered a habitat specialist because it inhabits sparsely vegetated active sand dunes and dune blowouts (COSEWIC 2007). In Canada, active sand dunes and blowouts currently occur as isolated patches, often on the crests of stabilized or semi-stabilized sand hills (Wolfe 1997). During the 2001 and 2010 surveys, the smallest sand dune known to be occupied by the Dusky Dune Moth was 0.08 ha while the largest sand dune, and the one with the highest abundance of captured adults, was approximately 10 ha (M. Curteanu unpubl. data). Plants such as Prairie Sunflower, Common Skeletonweed (*Lygodesmia juncea*), Lance-leaved Scurf-pea (*Ladeania lanceolata*), and Sand Dock (*Rumex venosus*) were all found on the active sand dunes and blow outs that are occupied by the Dusky Dune Moth (M. Curteanu unpubl. data).

Occasionally, Dusky Dune Moths have been found in stable or semi-stable dunes or dune ridges as well as anthropogenic features such as sandy fireguards; but only when these occurred immediately (50-75 m) adjacent to an active sand dune. Additionally, the number of individuals captured in such habitats were generally much less than the number of individuals captured within the adjacent active dune, suggesting that stabilized dunes and anthropogenic features are sub-par habitats (N.A. Page unpubl. data).

Anthropogenic habitat such as sandy roads and fireguards may act as corridors connecting suitable sand dune habitat thus contributing to gene flow, or they may act as habitat sinks, thereby undermining long term recovery. Because fireguards are human made, and suitable habitat exists adjacent to it, these habitats are not assumed to be necessary for the survival and recovery of the species.

Adult Oviposition and Food Resources

Each Dusky Dune Moth life stage (e.g., adult, egg, larva and pupa) requires different and specific habitat resources; however, limited data exists on the species' ecology and microhabitat requirements (COSEWIC 2007).

Adult Dusky Dune Moths obtain energy from nectar in plants that grow in or adjacent to the dunes and that are in bloom during the period when adults are alive. Information on the exact adult food sources is largely lacking. Adults have been observed nectaring on Lance-leaved Scurf-pea in the evening (COSEWIC 2007) and resting on Prairie Sunflowers during the day (M. Curteanu pers. obs.); however it is unknown if Prairie Sunflowers are also a nectaring source.

Adult female moths require loose, open sand for egg deposition. Dusky Dune Moths were observed ovipositing on the leeward edge (slip face) of active dunes or other depositional areas where sand accretion prevents subsequent exposure and predation of eggs (COSEWIC 2007). The larvae pupate in the soil, emerging about two and a half weeks later (COSEWIC 2007).

Larval Resources

Dusky Dune Moth larvae are subterranean cutworms that live buried about 2.5 cm deep in the soil near the host plant (Seamans 1925). The larvae require a substrate that they can navigate through, and that supports an adequate supply of suitable plants for them to feed on. Specific larval food sources are currently unknown. The single larval host plant reported in the literature is a native rose species (*Rosa* sp.) (Lafontaine 2004), which is rare or absent at some of the occupied sites. As such it is unlikely that this is the only and/or primary host plant used by Dusky Dune Moth larvae. Sand Dock and Lance-leaved Scurf-pea are two native plants that occur at most sites, the latter often being the only plant occurring in apparently sufficient quantities to support a large

population of moths. However, Lance-leaved Scurf-pea is also absent from some occupied sites (G. Anweiler pers. obs.), suggesting that Dusky Dune Moths are not dependant upon a single host plant throughout their range.

4. THREATS

4.1 Threat Assessment

Table 2. Threat Assessment Table

Threat	Level of Concern[1]	Extent	Occurrence	Frequency	Severity[2]	Causal Certainty[3]
Changes to Ecological Dynamics or Natural Processes						
Alteration of natural fire and grazing regimes	High	Widespread	Current	Seasonal	Moderate	Medium
Exotic, Invasive, or Introduced Species						
Invasion and establishment of exotic plants	High	Widespread	Current	Continuous	Medium	Medium/ High
Climate and Natural Disasters						
Prolonged wet climatic periods	Low-Medium	Widespread	Historic/ Current	Unknown	Unknown	Medium
Stochastic events	Low	Widespread	Current/ Anticipated	Continuous/ Unknown	Unknown	Unknown
Habitat Loss and Degradation						
Energy development and infrastructure	Low	Localized	Current	Seasonal	Unknown	Low
High-intensity prolonged grazing	Low	Widespread	Current	Seasonal	Unknown	Low
Sand extraction	Low	Localized	Current/ Anticipated	Seasonal	High	Low
Accidental Mortality						
Military activities	Low	Localized	Current	Seasonal	Low	Medium
Ungulate herbivory	Low	Localized	Current	Continuous	Low/ Medium	Low

Application of pesticides and other chemicals	Low	Localized	Historic/ Current	Seasonal	Unknown	Low
Disturbance or Harm						
Trampling of host and nectar plants	Low	Localized	Current	Seasonal	Low	High

[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, Moderate, 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

Threats are listed in order of decreasing level of concern. The primary threats to Dusky Dune Moths at all Canadian localities are those which contribute to loss of open active sand dune habitat, which is required to support Dusky Dune Moths. This loss is occurring via, anthropogenic factors such as the alteration to natural fire and grazing regimes coupled with natural progressive succession due to changes in climatic conditions (COSEWIC 2007). Other secondary threat factors identified include invasion and establishment of exotic plants, prolonged wet climatic periods, stochastic events, energy development and infrastructure, high-intensity prolonged grazing, sand extraction, military activities, ungulate herbivory, application of pesticides and other chemicals, and trampling of host and nectar plants.

Alteration to Natural Fire and Grazing Regimes

Dunes in the southern Canadian prairies have been stabilizing since at least the early 1900's through a combination of climate and changes in land-use practices since European settlement (Epp and Townley-Smith 1980; Wallis 1988, Wallis and Wershler 1988; Geological Survey of Canada 2001). Changes in land-use practices contributing to dune stabilization primarily include eradication of Bison (*Bison bison*), a reduction in the frequency and extent of prairie fires, as well as a more homogenous pattern of grazing (Higgins et al. 1989; Frank et al. 1998; Brockway et al. 2002; Samson et al. 2004; Hugenholtz and Wolfe 2005). In sand dunes, the absence of natural disturbances like grazing, burrowing and fire interacting with cycles of drought can lead to vegetation growth at the edges of open dunes. Natural succession by grasses and forbs, then shrubs, and eventually trees, can stabilize and eventually cover sand dunes with vegetation (Hulett et al. 1966; Potvin and Harrison 1984; Lesica and Cooper 1999; Hugenholtz et al. 2010), thereby reducing or eliminating suitable habitat for Dusky Dune Moths, a habitat specialist requiring sparsely vegetated active sand dunes.

Historically, it is possible that fires in the summer or fall created lush vegetation the following spring which attracted large herds of grazing animals like bison (Vinton et al.

1993) and resulted in reactivation of sand dunes. Fire can also increase wind erosion by removing the vegetative barrier which had prevented sand from being exposed to wind (Whicker et al. 2002; Vermeire et al. 2005). A combination of fire and grazing likely destabilizes sand dunes and disrupts vegetative succession more effectively than either disturbance independently (Lesica and Cooper 1999). Dunes have been stabilizing in some areas where there have been repeated fires but little grazing, while in other areas dunes have stabilized where there has been grazing but few fires (Wallis 1988). Historically, the stabilization of active dunes was thought to be good conservation practice and land managers attempted to stabilize dunes by extinguishing fires, actively reseeding, altering grazing patterns, and placing objects, such as tires or bales, on blowouts (David 1977; Wallis and Wershler 1988). It is only recently that people have realized the benefits of having active dunes for wildlife.

Invasion and Establishment of Exotic Plants

Exotic plant species, such as Baby's Breath (*Gypsophila paniculata)* and Leafy Spurge (*Euphorbia esula*), as well as escaped introduced forage species such as Crested Wheat Grass (*Agropyron cristatum*) and Sweet Clover (*Melilotus sp.*), have the potential to out-compete native vegetation in dunes, and with time dominate and alter ecosystem properties and functions (Gordon 1998; Henderson and Naeth 2005; G. Anweiler pers. obs.). Specifically, invasive species can rapidly colonize active dune areas, accelerating the establishment of other native and non-native vegetation, in essence accelerating the stabilization of the dune and rendering the habitat unfit for Dusky Dune Moths.

At the Pakowki Lake Sand Hills, Crested Wheatgrass and Baby's Breath were observed growing in dense stands near the active dunes (Jensen et al. 2009). Owing to their invasive nature and habitat-altering qualities, invasive plants are considered an important threat to Dusky Dune Moth habitat.

Intensive seeding or re-vegetation of active sand dunes as a means to decrease soil erosion and improve land use productivity was encouraged in the past. Exotic grasses that thrive in dry nutrient-poor soils were planted at the Burstall Sand Hills to accelerate dune stabilization (David 1977), while flax bales were used at the Middle Sand Hills to prevent soil erosion.

Prolonged Wet Climatic Periods

Progressive stabilization of sand dunes dating back as far as the 1700's and driven mainly by decreased periods of drought and decreased wind speed and erosion may have contributed to habitat loss and degradation, even in the absence of anthropogenic factors that are currently contributing to dune stabilization (Wallis 1988, Wolfe et al. 2001, Hugenholtz and Wolfe 2005, Hugenholtz et al. 2010). Prolonged wet climatic periods can increase vegetation growth, including woody vegetation, in the sand dunes, thereby suppressing wind erosion and sand movement leading to stabilization and vegetation succession (Thorpe et al. 2001, Wolfe et al. 2001). Stabilization rates in sand dunes in the Canadian prairies, are estimated to be as low as 0.4 ha/yr to as high as 17.7 ha/yr (Hugenholtz and Wolfe 2005). In some areas, as much as 90% of active

dunes have vegetated since the early 1900s (Wallis 1988; Hugenholtz and Wolfe 2005). However, projections of future climate warming and increased evapotranspiration may favour increased sand dune activity, reversing the current stabilization trend (Wolfe 2001, Wolfe and Thorpe 2005).

High-intensity Prolonged Grazing

High-intensity, prolonged livestock grazing may be detrimental to Dusky Dune Moth habitat at some sites. High-intensity prolonged grazing may result in the removal of larval host and nectaring plants or trampling of eggs as well as soil compaction and changes in the plant community.

Sand Extraction

In some areas sand deposits may be valued as a source of construction material, in particular for road construction and maintenance. While commercial scale removal of sand from active dune areas could be a threat to Dusky Dune Moth by destroying both dune moths and the habitat on which they depend, controlled commercial removal of sand from stabilized areas has the potential of creating new active dune areas suitable for colonization by Dusky Dune Moths.

Energy Development and Infrastructure

In addition to direct mechanical disturbance caused by oil and gas activities, these activities also provide vectors for introducing invasive plant seed, and can cause pollution due to spills of hydrocarbons, drilling fluids and other contaminants. Dusky Dune Moths at Seward, Cramersburg, and Tunstall Sand Hills, Saskatchewan, and Middle Sand Hills, Alberta, are subject to threats posed by energy development and infrastructure. Given the existence of energy development and infrastructure in close proximity to several Dusky Dune Moth populations, there remains uncertainty as to the effects this threat has on this species at a population-level.

Trampling of Host and Nectar Plants

Recreational activities such as off-highway vehicle (OHV) use, horseback riding, and/or hiking can contribute to dune destabilization and potentially benefit Dusky Dune Moth 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 Dusky Dune Moth larval host and adult nectaring plants. Specifically, OHV recreational activities can cause significant lasting damage to the landscape including soil compaction, dispersal of invasive species, and destruction of native and establishing vegetation (Ouren et al. 2007). Dunes and dune fields are frequently targeted by recreational users of OHV (i.e., The Burstall dunes colony site has been a favored site for local recreational all-terrain vehicles (ATV) users; G. Anweiler pers. obs.). Dusky Dune Moths at

Elbow Sand Hills within Douglas Provincial Park, Saskatchewan and Brandon Sand Hills within Spruce Woods Provincial Park, Manitoba may also be subject to disturbance from tourists.

Military Activities

Military operations and exercises have the potential to contribute to dune destabilization through physical soil disturbances and frequent fire occurrences. Moth and host plant mortality caused by military activities is possible, but highly unlikely. Military exercises could have negative impacts at the local level should heavy traffic or shelling take place in active dune areas with populations of Dusky Dune Moths. A Dusky Dune Moth population has been observed at a firebreak created on CFB Dundurn, and similar habitat at CFB Shilo (Brandon Sand Hill) may also be occupied by Dusky Dune Moths. The Dusky Dune Moth habitat at CFB Suffield (Middle Sand Hills) is located on the National Wildlife Area, which is out of bounds of Military activity, thus the colony at CFB Suffield is not in immediate danger.

Military activities may also have beneficial effects on Dusky Dune Moths, where certain activities may assist in reactivating sand dunes by removing the vegetation from stabilized sites (Bender et al. 2005).

Ungulate Herbivory

Ungulate herbivory likely represents a continuum of possible effects on Dusky Dune Moth ranging from beneficial to potentially deleterious depending on the intensity and timing. On the one hand, grazing by domestic and wild ungulates may benefit Dusky Dune Moth 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 Dusky Dune Moth particularly during periods of drought (COSEWIC 2007). 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 Dusky Dune Moth host and/or nectar plants, ungulates may not be selective during periods of drought when their preferred forage is unavailable or in short supply which could result in the grazing of the moth's host and/or nectar plants.

Application of Pesticides and Other Chemicals

Both deliberate and unintentional applications of pesticides used to control pest insects (i.e., grasshopper or cutworms) or invasive plant species in dune areas or in adjacent agricultural areas (via drift) can be detrimental to Dusky Dune Moth colonies. Pesticide drift, particularly though not exclusively from aerial applications, could be a potential threat to Dusky Dune Moth recovery through 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 labeling 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 Dusky Dune Moth 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 Dusky Dune Moth habitat. In summary, while chemical pest control may be a threat to Dusky Dune Moth, its magnitude remains unknown.

Stochastic events

The Dusky Dune Moth is a highly specialized species with a relatively short summer flight period. Therefore, it is likely more prone to local extinctions from random (stochastic) events (i.e., severe storms and winter conditions, droughts, or fires), than are generalist species with stabilized populations (Tscharntke et al. 2002; Nilsson et al. 2008). Dusky Dune Moths are confined to relatively small patches of a very specific habitat type, which leaves them vulnerable to extirpation due to stochastic events. Genetic effects attributed to habitat fragmentation, isolation, and stochastic events have been identified as possibly playing a significant role in local extinctions of Lepidoptera (Packer and Owen 2001). Natural re-colonization of the habitat is hampered by the distances between these "islands" of suitable Dusky Dune Moth habitat.

5. POPULATION AND DISTRIBUTION OBJECTIVES

The population and distribution objectives for the Dusky Dune Moth are to maintain or increase the current distribution of the species at all confirmed and natural (i.e., non-anthropogenic) locations, as well as at any additional natural locations discovered in the future. This translates into 21 sand dune and blowout locations within the 10 populations.

Owing to the limited number of population surveys done to date, the distribution and abundance of Dusky Dune Moths in Canada remain poorly understood; therefore it is not feasible at this time to set quantitative population objectives. Additional and more comprehensive surveys of suitable habitat within the current range will likely result in additional occupied sand hills being discovered in the near future. However, the species has likely always been relatively rare and localized in southern Canada at least since the advent of European settlement and perhaps earlier than that. Furthermore, suitable habitat for Dusky Dune Moth is now fragmented, of limited extent, and progressively declining in both quantity and quality. It is likely not feasible to reverse the natural stabilization of sand hills at a large scale to create more active sand dunes and significantly increase the distribution of the species in Canada. Thus, it is reasonable to

assume that the Dusky Dune Moth will probably always remain rare, localized and at risk in Canada.

6. BROAD STRATEGIES AND GENERAL APPROACHES TO MEET OBJECTIVE

6.1 Actions Already Completed or Currently Underway

Very little is known about the biology and ecology of the Dusky Dune Moth throughout its range (COSEWIC 2007). However, since the completion of the COSEWIC status report several surveys have been undertaken extending the species' distribution in Alberta and Saskatchewan.

Monitoring and Assessment

- From 2008 to 2011 Environment Canada conducted Dusky Dune Moth surveys in Alberta and Saskatchewan during the adult flight period confirming the species' presence at several new locations.

- 2009 Lepidoptera surveys of Cramersburg Sand Hills (Golder Associates 2009, unpubl. data)

- From 2009 to 2014, Manitoba has surveyed the Portage Sandhills (two seasons), Lauder Sandhills (6 seasons), Routledge Sandhills (2 seasons), and other small sandhill areas around St. Claude, Treesbank, St. Lazare, Whitemud Watershed Wildlife Management Area. The Brandon/Carberry Sandhills (specifically the active dunes at the border of Spruce Woods Provincial Park and CFB Shilo) for several seasons (C. Friesen, pers. comm. 2014).

Habitat Assessment, Management and Conservation

- Since 2007, Suffield National Wildlife Area in collaboration with the University of Calgary has worked to restore eighteen sand dunes to an active state through various treatments such as hand-digging, prescribed burning and placing grazing attractants. The sections have met with varying degrees of success (A. Taylor pers. comm. 2011).

6.2 Strategic Direction for Recovery

Table 3. Recovery Planning Table. Priorities are defined as: Urgent= top priority action; Necessary = needed to evaluate and guide conservation actions; Beneficial = action would be beneficial but not necessarily a priority.

Threat or Limitation	Priority[1]	General Description of Research and Management Approaches
Inventory and Monitoring		
Knowledge gaps	Urgent	• Survey unconfirmed and potential Dusky Dune Moth habitat and determine the extent of the Canadian distribution. • Continue monitoring current known populations. • Coordinate Dusky Dune Moth monitoring programs with those for other sand dune specialist Lepidoptera in the Canadian Prairies.
Research		
All threats and knowledge gaps related to species' biology	Urgent	• Fill important knowledge gaps on all Dusky Dune Moth life history stages (e.g., timing and length of various life stages, host plant requirements for both larvae and adults, predators and parasites, and microhabitat requirements).
Habitat Assessment, Management and Conservation		
All	Urgent	• Determine and implement beneficial 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 Dusky Dune Moth habitat management and stewardship efforts with those for other sand dune specialist species (e.g., Gold-edged Gem) in the Canadian Prairies.
Communication, Collaboration and Engagement		
All	Beneficial	• Increase public awareness of the ecological uniqueness and value of sand dune habitat as well as their awareness of Dusky Dune Moth and other sand dune species in the Canadian Prairies. • Inform land users about beneficial land management practices to conserve sand dune habitat.

[1]"Priority" reflects the degree to which the broad strategy contributes directly to the recovery of the species or is an essential precursor to an approach that contributes to the recovery of the species.

6.3 Narrative to Support the Recovery Planning Table

Inventory and Monitoring

A large percentage of potential Dusky Dune Moth habitat has never been surveyed, or, has only been superficially surveyed and often under less than ideal conditions. Consequently it is probable that additional search effort targeted at these un-surveyed and under-surveyed sites will identify previously unreported populations of Dusky Dune Moths. Comprehensive surveys of unconfirmed populations (e.g., Bigstick-Crane Lake and Dominion Sand Hills) as well as surveys of additional suitable habitat in the Prairie Provinces are needed. Population surveys should be combined with surveys for several other SARA-listed moth species that occupy the same habitat type (e.g., Gold-edged Gem (*Schinia avemensis*), White Flower Moth (*Schinia bimatris*), and the Pale Yellow Dune Moth (*Copablepharon grandis*)).

Research

Effective recovery and management of the Dusky Dune Moth depends on scientific research into its biology and ecology, as well as a better understanding of the factors influencing sand dune stabilization. In particular, life history data for Dusky Dune Moths is almost entirely lacking. The life history and requirements of each developmental stage (eggs, larvae, pupae and adults) needs to be investigated and described, and larval host plants and adult nectar sources need to be identified. Factors influencing disease, parasitism and predation need to be investigated, as do the effects of climatic variables.

Habitat Assessment, Management and Conservation

All negative effects of various land-uses and potential threats need to be identified as soon as possible. Once data regarding the severity and urgency of each habitat and population threat has been obtained, techniques to mitigate these threats as well as beneficial management practices can be developed and initiated. Specific threats to each occupied site need to be identified as soon as possible, and management options to address them need to be implemented as soon as possible.The need for, and type of habitat management (e.g. fire and grazing management, invasive species control etc.) would need to be determined on a site by site basis with an understanding of site specific issues and needs.

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 the habitat requirements for

many species. As such, grazing and the maintenance of the infrastructure supporting it may be a beneficial management practice for the Dusky Dune Moth.

Management activities for the Dusky Dune Moth should be combined with activities for other species occurring in dune ecosystems.

Communication, Collaboration and Engagement

A communication plan should be developed as soon as possible to inform landowners, land managers, land users and local residents regarding the value and ecological uniqueness of sand dune habitat and the concerns and needs of the Dusky Dune Moth and other sand dune specialist species.

7. CRITICAL HABITAT

7.1 Identification of the Species' Critical Habitat

Critical habitat is defined in the *Species at Risk Act* (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 for the Dusky Dune Moth is fully identified in this recovery strategy, to the extent possible, based on the best available information. Dusky Dune Moth critical habitat encompasses 21 confirmed and natural locations (active sand dunes and blowouts) within 10 sand hills (Table 1), and is considered sufficient to achieve the population and distribution objectives for the species at this time. Additional critical habitat may be identified across the species range as more information about the occurrence of the species becomes available.

Identification of Dusky Dune Moth critical habitat followed the same approach used to identify critical habitat for Gold-edged Gem, a sympatric endangered flower moth species that inhabits similar habitat and locations (Environment Canada 2014). Critical habitat identification was based on the following three criteria with location data obtained from various data sources[7]:

1.) One or more Dusky Dune Moth individuals confirmed in suitable natural habitat as identified by a trained observer.

[7] Dusky Dune Moth occurrence data was obtained from Alberta Conservation Information Management System, E.H. Strickland Entomological Museum, Environment Canada, Golder Associates Ltd. 2009, N.A. Page unpubl. data, Manitoba Conservation Data Center (CDC), Saskatchewan CDC.

2.) Precise geographical coordinates were available and the specific sand dune on which the species had been observed could be located on a map.

3.) Critical Habitat is mapped using point locations, and encompasses the surrounding suitable habitat that meets the following biophysical attributes:
    - Active open sand dune and/or blowout, which is bounded by the crest of the dune to the edge where native vegetation grows and the dune is stabilized[8].
    - The presence of one or more species of sand dune plants (e.g., Prairie Sunflower, Common Skeletonweed, Sand Dock and Lance-leaved Scurf-pea).

Based on the above stated criteria, Dusky Dune Moth critical habitat identified in this Recovery Strategy comprises 21 active sand dune and blowout locations for 10 populations. Two unconfirmed populations and one population occurring in anthropogenic habitat did not meet the above stated criteria and are therefore not included as critical habitat. On the maps presented below, each green point represents the location of a sand dune within which critical habitat is found, where the biophysical attributes described in this section are met (Figures 4 - Figure 13). Critical habitat is identified, following the criteria listed above, in 1 sand dune in Manitoba, 14 sand dunes in Saskatchewan and 6 sand dunes in Alberta. Critical habitat does not include any areas that do not possess the biophysical attributes of critical habitat (e.g., shrub land, forests, marshes, water bodies, and current human-made features such as roads and fire guards). The 1 x 1 km Standardized UTM grid shown on these figures are a Standardized national grid system that highlights the general geographic area containing critical habitat, for land use planning and/or environmental assessment purposes.

[8] Active open sand dunes and/or blowouts will be identified according to Wolfe (2010) or confirmed by trained individuals.

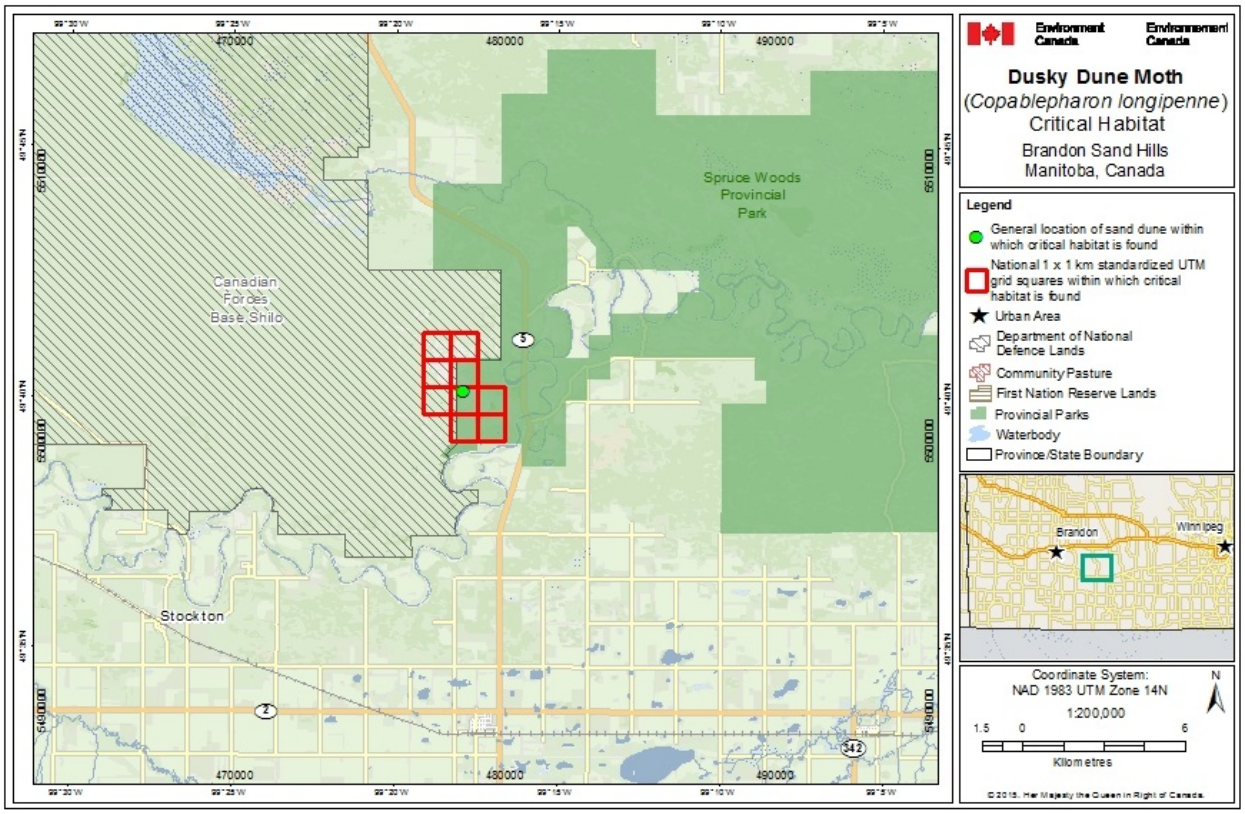


Figure 4. Critical habitat for Dusky Dune Moth in Manitoba (Brandon Sand Hills) occurs within the sand dune, with a general location represented by the green point, where the biophysical attributes described in Section 7.1 are met. The 1 km x 1 km UTM grid overlay shown on this figure is a standardized national grid system that indicates the general geographic area containing critical habitat.

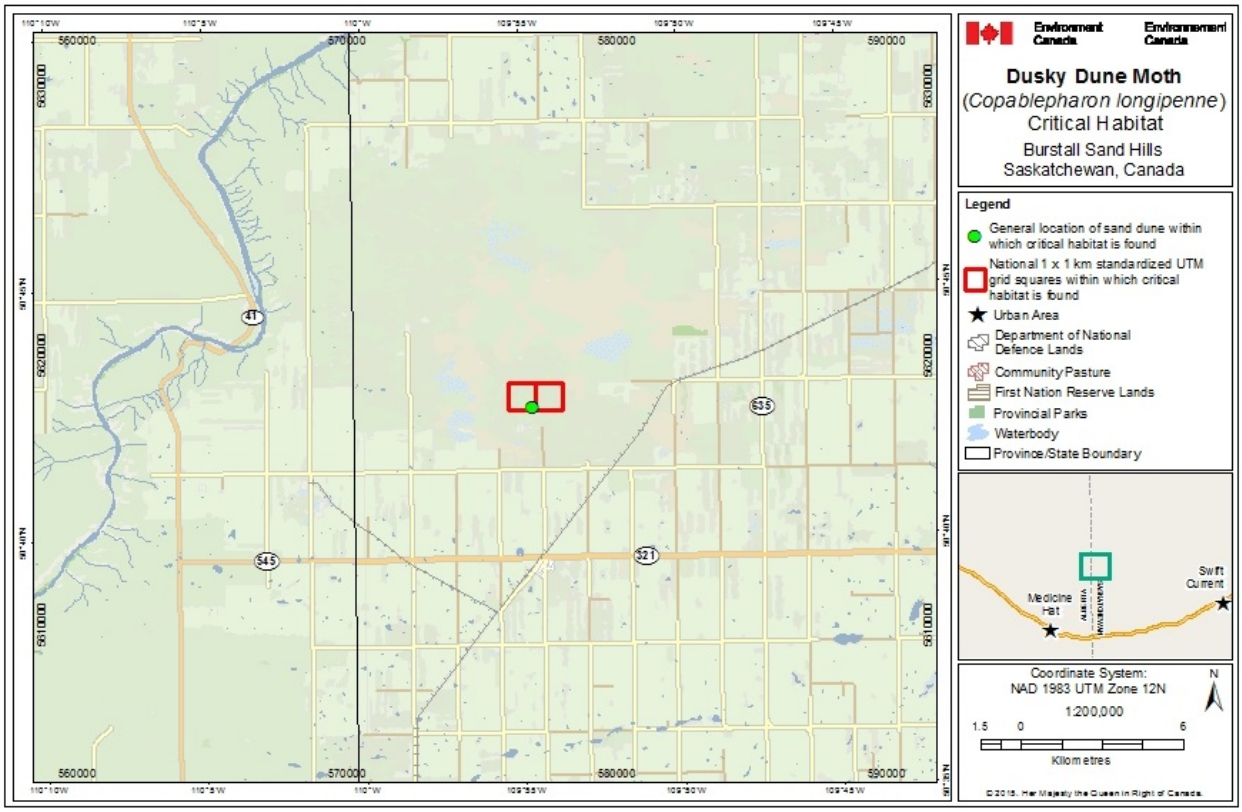


Figure 5. Critical habitat for Dusky Dune Moth in Saskatchewan (Burstall Sand Hills) occurs within the sand dune, with a general location represented by the green point, where the biophysical attributes described in Section 7.1 are met. The 1 km x 1 km UTM grid overlay shown on this figure is a standardized national grid system that indicates the general geographic area containing critical habitat.

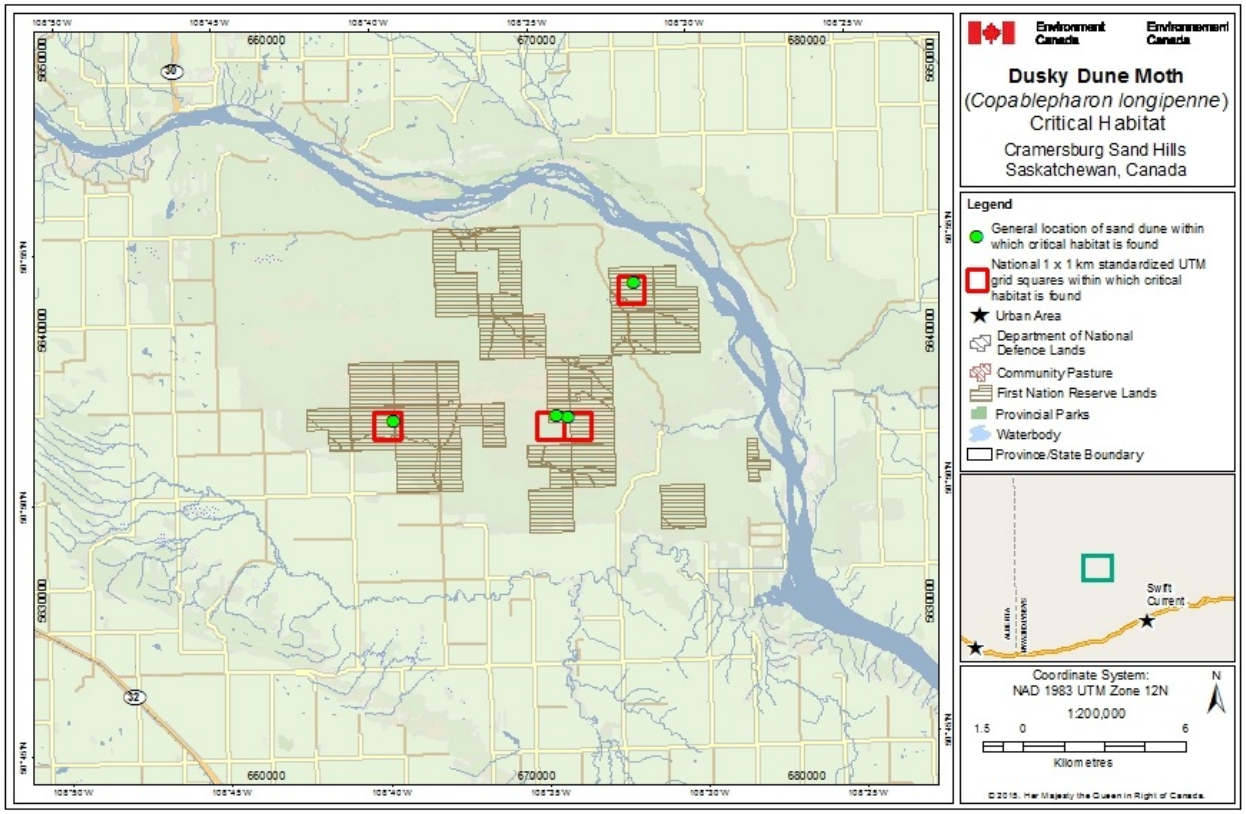


Figure 6. Critical habitat for Dusky Dune Moth in Saskatchewan (Cramersburg Sand Hills) occurs within the sand dune, with a general location represented by the green point, where the biophysical attributes described in Section 7.1 are met.
The 1 km x 1 km UTM grid overlay shown on this figure is a standardized national grid system that indicates the general geographic area containing critical habitat.

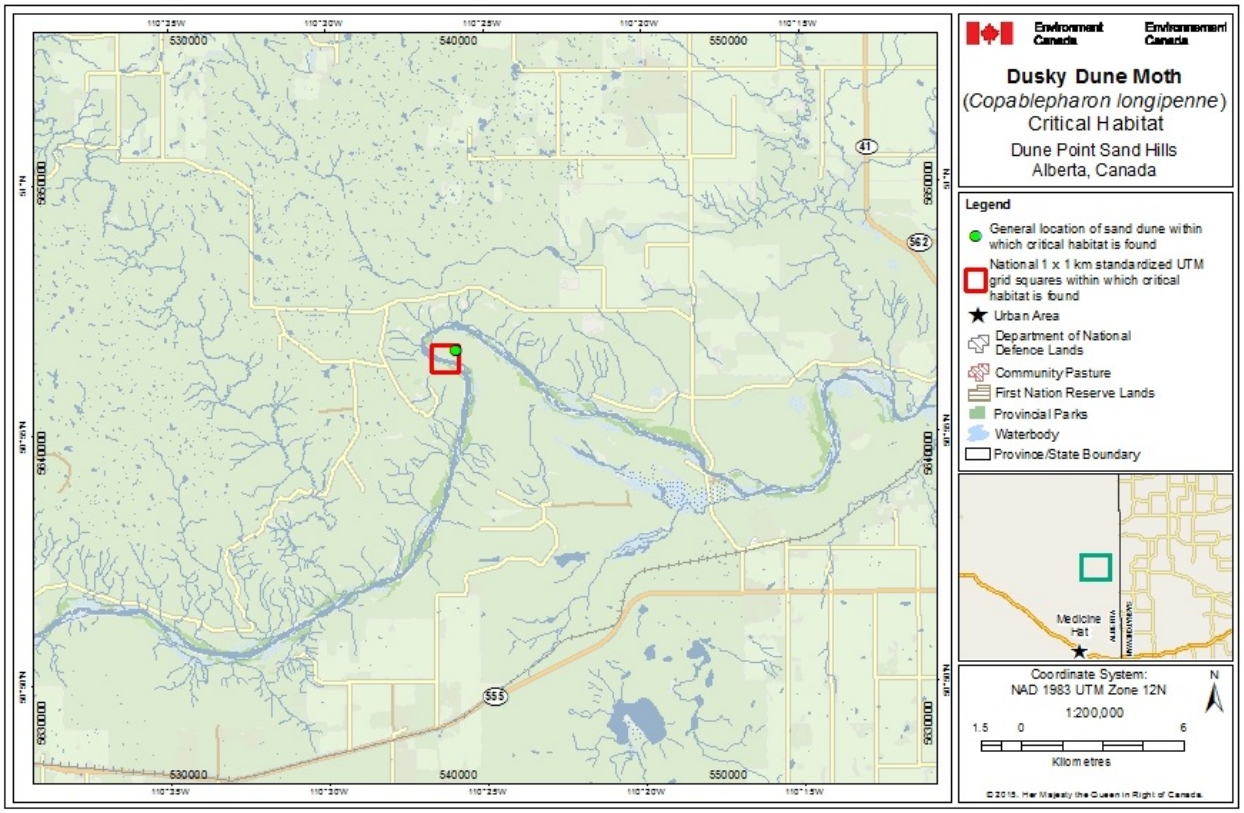


Figure 7. Critical habitat for Dusky Dune Moth in Alberta (near Dune Point Sand Hills) occurs within the sand dune, with a general location represented by the green point, where the biophysical attributes described in Section 7.1 are met. The 1 km x 1 km UTM grid overlay shown on this figure is a standardized national grid system that indicates the general geographic area containing critical habitat.

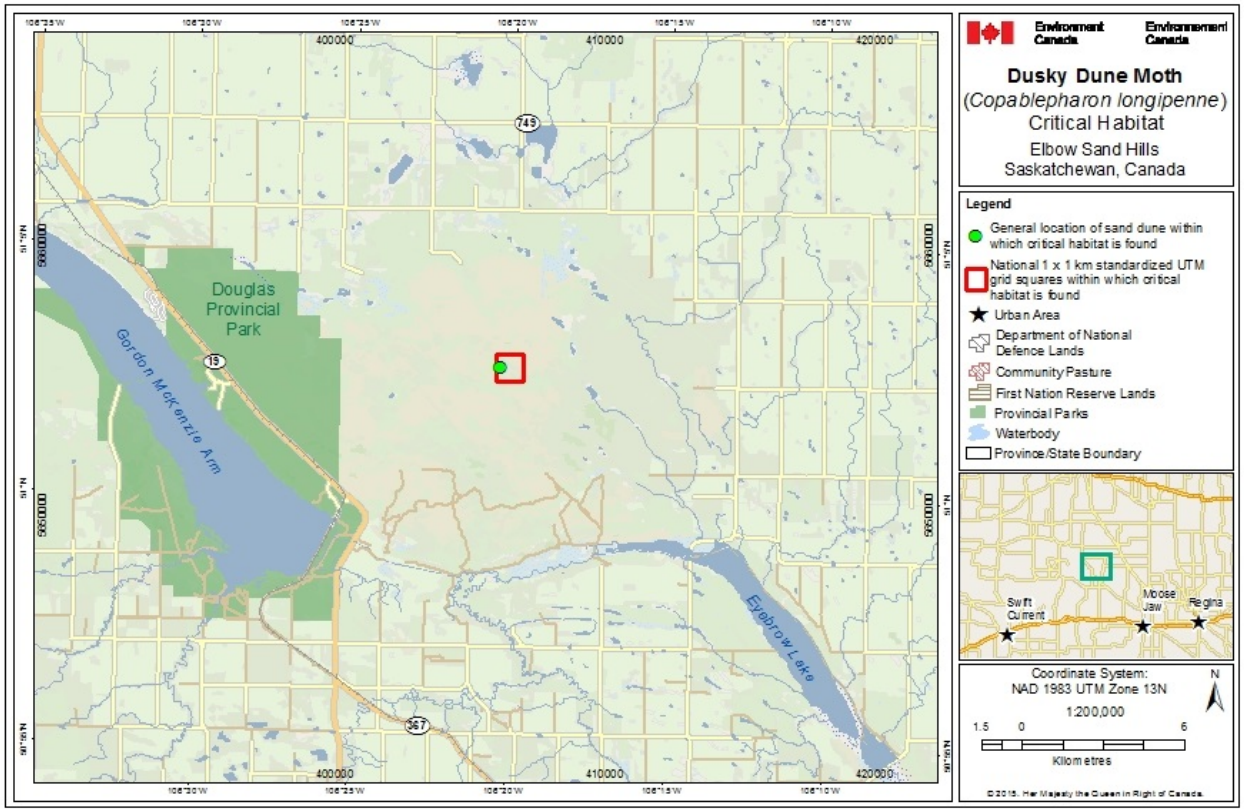


Figure 8. Critical habitat for Dusky Dune Moth in Saskatchewan (Elbow Sand Hills) occurs within the sand dune, with a general location represented by the green point, where the biophysical attributes described in Section 7.1 are met. The 1 km x 1 km UTM grid overlay shown on this figure is a standardized national grid system that indicates the general geographic area containing critical habitat.

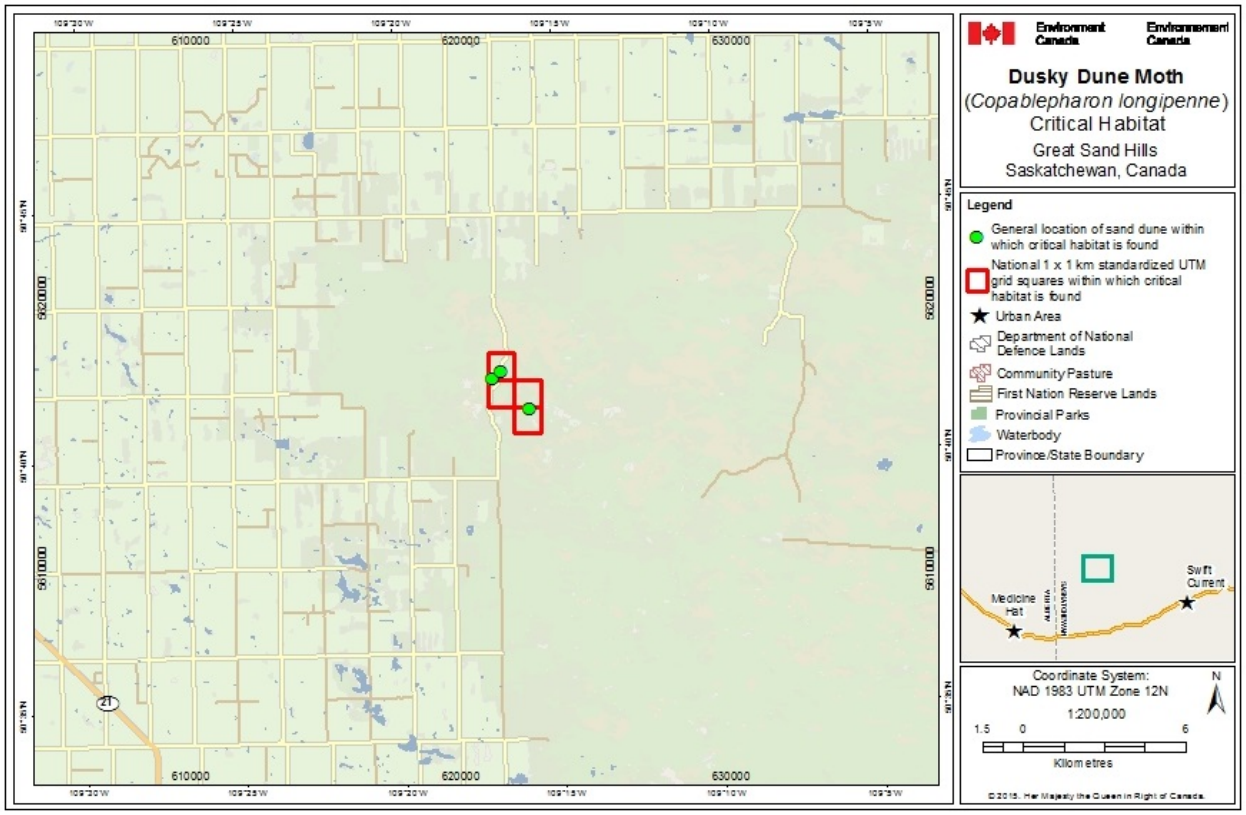


Figure 9. Critical habitat for Dusky Dune Moth in Saskatchewan (Great Sand Hills) occurs within the sand dune, with a general location represented by the green point, where the biophysical attributes described in Section 7.1 are met. The 1 km x 1 km UTM grid overlay shown on this figure is a standardized national grid system that indicates the general geographic area containing critical habitat.

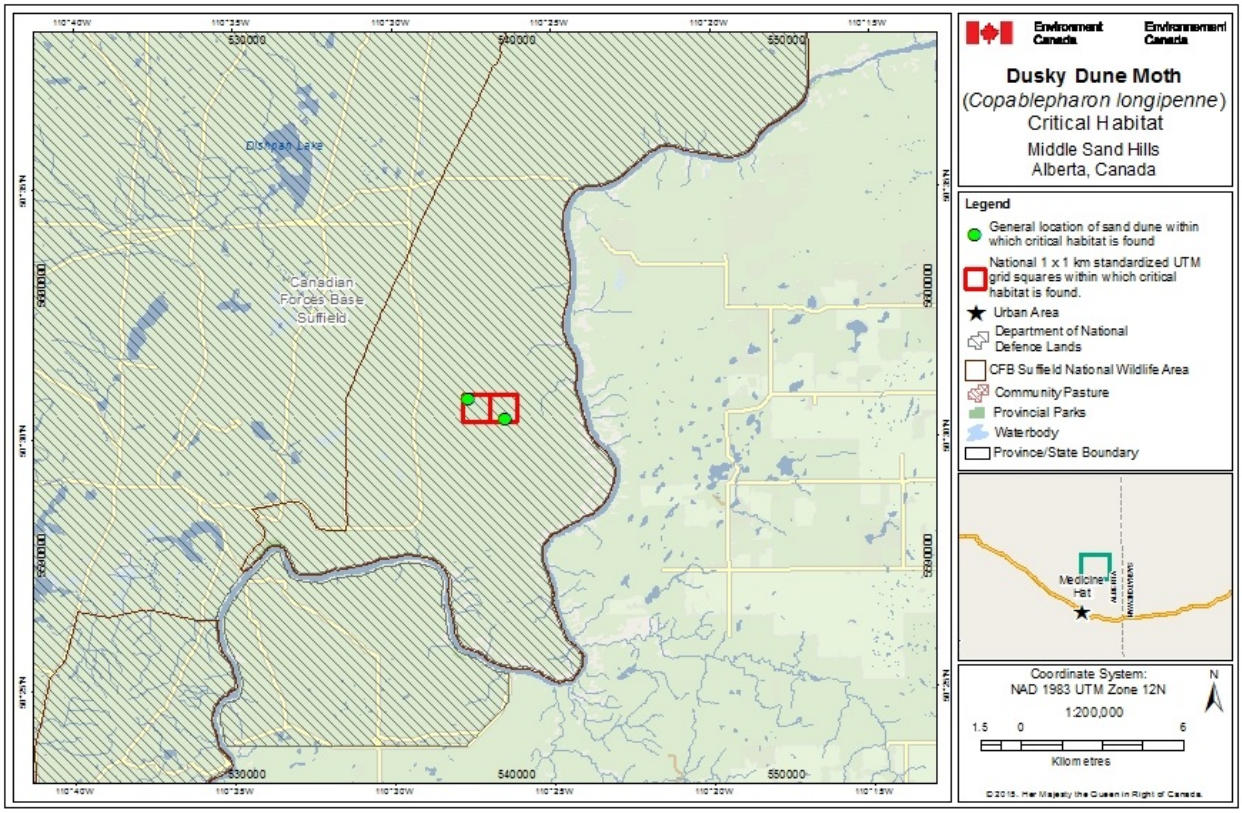


Figure 10. Critical habitat for Dusky Dune Moth in Alberta (Middle Sand Hills) occurs within the sand dune, with a general location represented by the green point, where the biophysical attributes described in Section 7.1 are met. The 1 km x 1 km UTM grid overlay shown on this figure is a standardized national grid system that indicates the general geographic area containing critical habitat.

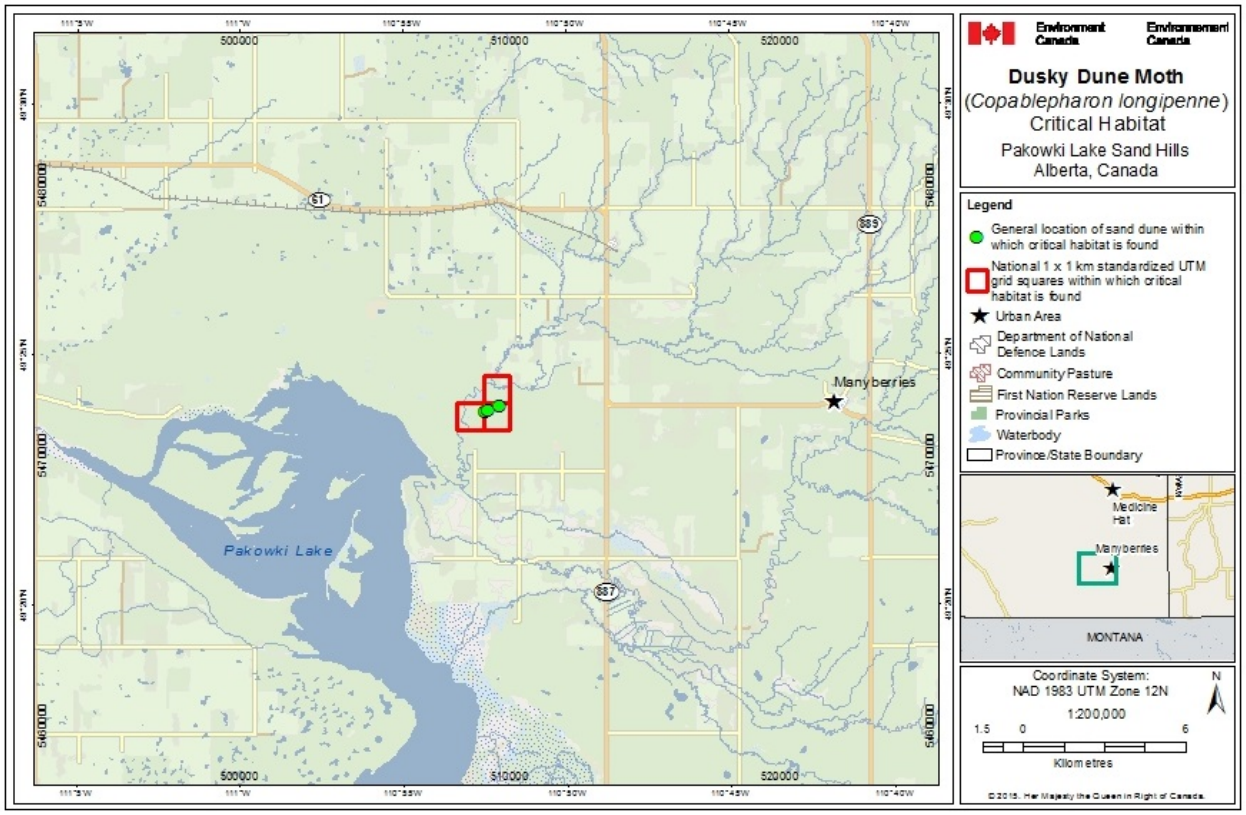


Figure 11. Critical habitat for Dusky Dune Moth in Alberta (Pakowki Sand Hills) occurs within the sand dune, with a general location represented by the green point, where the biophysical attributes described in Section 7.1 are met. The 1 km x 1 km UTM grid overlay shown on this figure is a standardized national grid system that indicates the general geographic area containing critical habitat.

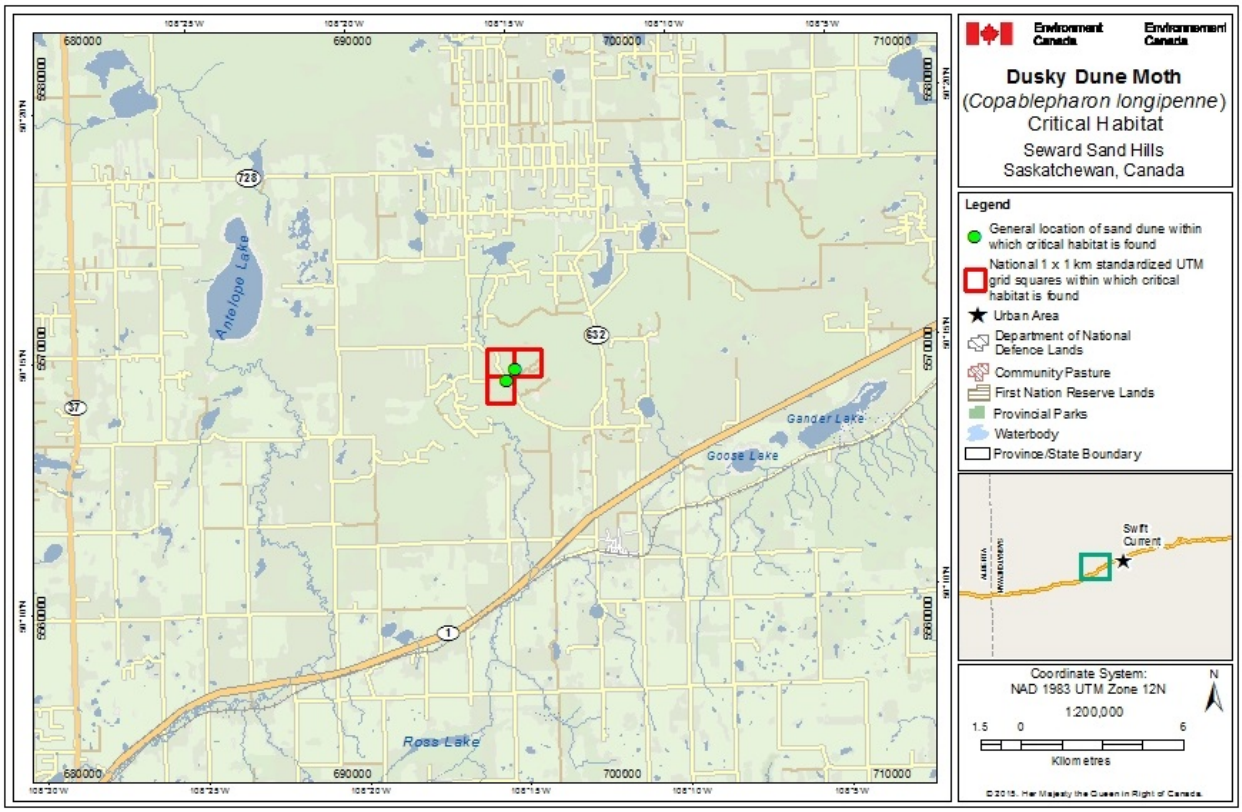


Figure 12. Critical habitat for Dusky Dune Moth in Saskatchewan (Seward Sand Hills) occurs within the sand dune, with a general location represented by the green point, where the biophysical attributes described in Section 7.1 are met. The 1 km x 1 km UTM grid overlay shown on this figure is a standardized national grid system that indicates the general geographic area containing critical habitat.

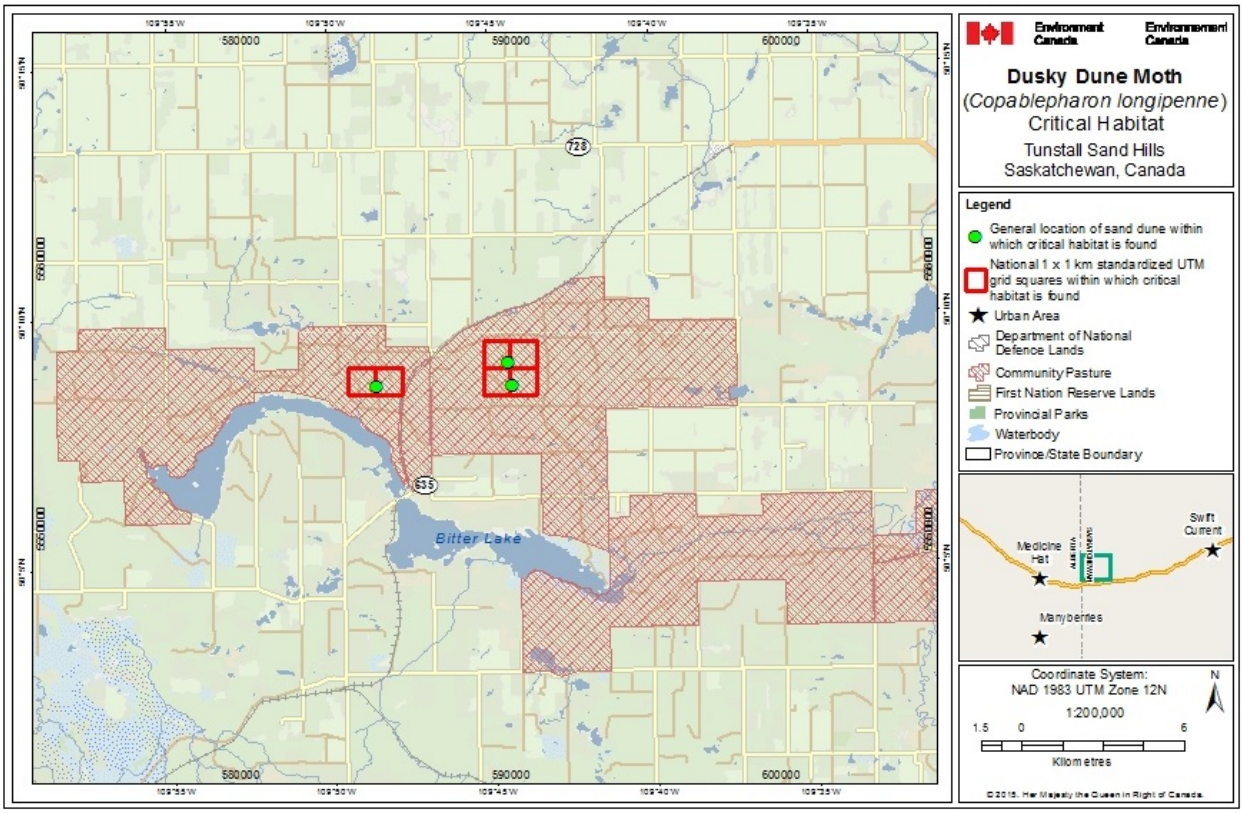


Figure 13. Critical habitat for Dusky Dune Moth in Saskatchewan (Tunstall Sand Hills) occurs within the sand dune, with a general location represented by the green point, where the biophysical attributes described in Section 7.1 are met. The 1 km x 1 km UTM grid overlay shown on this figure is a standardized national grid system that indicates the general geographic area containing critical habitat.

7.2 Activities Likely to Result in the 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).

For most species, the point or threshold at which an activity will destroy the function of the critical habitat is currently unknown. Such thresholds may be dependent on the spatial scale of the species' critical habitat, the condition or integrity of the critical habitat, and the extent or intensity of the habitat alteration caused by the activity. It is acknowledged that such information would be beneficial to fully understand the point at which an activity would degrade the critical habitat such that it would no longer serve its function. Nevertheless, the information presented below is based on the best available information.

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

1) **Purposeful stabilization of active sand dune habitat**
   Seeding, re-vegetation, the use of 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 Dusky Dune Moth 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 disturb 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[9] to sand dune or blowout habitats are activities that would result in destruction of Dusky Dune Moth 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

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

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. These activities also have the potential to introduce exotic species which in turn may 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 sand dune habitat. Because Dusky Dune Moths 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**
Broad scale 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 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 Dusky Dune Moth host and/or nectar plants. Changes to soil nutrient status may also influence the outcome of interspecific competition for nutrients for Dusky Dune Moth 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 overgrazing, trampling, vehicular and recreational traffic, waste application, or deliberate introduction or promotion of invasive exotic species would constitute destruction of critical habitat[10]. These 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.

[10] Properly managed grazing systems and the maintenance of existing infrastructure supporting it, may be a beneficial management practice within the critical habitat of the Dusky Dune Moth because grazing by cattle simulates the role of native ungulate grazing in maintaining open, active sand dunes. Activities or infrastructure in Dusky Dune Moth 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.

8. MEASURING PROGRESS

The performance indicators presented below provide a way to define and measure progress toward achieving the population and distribution objectives.

- The distribution of the Dusky Dune Moth at all 21 natural sand dune and blowout locations within the 10 sand hills where the species has been known to occur in Canada and any additional sand hills discovered in the future are maintained or increased by 2020.

9. STATEMENT ON ACTION PLANS

An action plan for the Dusky Dune Moth will be completed by 2020. Efforts with other organizations working on species at risk in dune habitats should be coordinated; the creation of a multi-species action plan for species inhabiting the active dune ecosystem of a region may be beneficial and cost effective.

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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*[12]. 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[13] (FSDS) goals and targets.

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 in the southern Canadian Prairie Provinces support a number of rare and highly specialized plants and animals, many of which are assessed as at risk by COSEWIC or listed under SARA. Consequently, activities proposed for the recovery of the Dusky Dune Moth can also benefit other species. Therefore activities planned to assist the recovery of Dusky Dune Moths must be coordinated with plans for these other species. In particular, the endangered Ord's kangaroo rat (*Dipodomys ordi*), Gold-edged Gem moth (*Schinia avemensis*) and the White flower moth (*Schinia bimatris*) all share the same habitat with the Dusky Dune Moth. Several listed plants are also found in habitats occupied by Dusky Dune Moths, including the special concern Hairy Prairie-clover (*Dalea villosa var. villosa*), the threatened Smooth Goosefoot (*Chenopodium subglabrum*), Western Spiderwort (*Tradescantia occidentalis*), and possibly the endangered Small-flowered Sand-verbena (*Tripterocalyx micranthus*) and Tiny Cryptanthe (*Cryptantha minima*). Other rare or threatened moths also found in Dusky Dune Moth habitat include two additional species of *Copablepharon* (*C. viridisparsa* (Dod) and *C. grandis* (Strecker)).

Management and conservation measures initiated for Dusky Dune Moth recovery should also have benefits for these other rare and sensitive species. The presence of a suite of both listed and otherwise rare fauna and flora in the remnant dune habitats occupied by the Dusky Dune Moth provides an opportunity to manage at an ecosystem level rather than for each species individually.

[12] http://www.ceaa.gc.ca/default.asp?lang=En&n=B3186435-1
[13] www.ec.gc.ca/dd-sd/default.asp?lang=En&n=F93CD795-1