PROPOSED

Species at Risk Act
Management Plan Series

Management Plan for the Hairy Prairie-clover (*Dalea villosa*) in Canada

Hairy Prairie-clover

2017

Government of Canada
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For copies of the management plan, 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].

Cover illustration: © Hairy Prairie-clover by Candace Neufeld

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[1] http://sararegistry.gc.ca/default.asp?lang=En&n=24F7211B-1

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 management plans for listed species of special concern and are required to report on progress within five years after the publication of the final document on the Species at Risk Public Registry.

The Minister of Environment and Climate Change is the competent minister under SARA for the Hairy Prairie-clover and has prepared this management plan, as per section 65 of SARA. To the extent possible, it has been prepared in cooperation with: Department of National Defense, Agriculture and Agri-Food Canada, Province of Saskatchewan, and Province of Manitoba, as per section 66(1) of SARA.

Success in the conservation of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this plan and will not be achieved by Environment and Climate Change Canada, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this plan for the benefit of the Hairy Prairie-clover and Canadian society as a whole.

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

[2] http://registrelep-sararegistry.gc.ca/default.asp?lang=En&n=6B319869-1%20

Acknowledgments

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Executive Summary

Hairy Prairie-clover (*Dalea villosa*) is a perennial plant with purple-pink flowers, velvety stems and leaves, and seeds within hairy pods. In Canada, it is associated with sand dune complexes in southwestern Manitoba and south-central Saskatchewan. Currently, there are 31 known extant native populations in Canada (four extant populations in Saskatchewan and 27 in Manitoba), with an estimated Canadian population size of over 147,000 plants. Hairy Prairie-clover has been assessed as Special Concern by the Committee on the Status of Endangered Wildlife in Canada and is listed as Special Concern on Schedule I of the federal *Species at Risk Act*.

The most significant threats to the Hairy Prairie-clover are factors that promote habitat loss or degradation, habitat succession and dune stabilization. Currently identified threats of low impact or higher are invasive non-native/alien species, mining/quarrying, road maintenance and construction activities, recreational activities, fire suppression, military activities, problematic native species, pesticide use, and prolonged wet climatic periods.

The management objective for the Hairy Prairie-clover is to ensure long-term maintenance and natural expansion of all extant native populations in Canada, including any newly located or reconfirmed populations within the natural range of variation. Broad strategies and conservation measures to address the threats are presented in the section on Broad Strategies and Conservation Measures.

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1. COSEWIC* Species Assessment Information

Date of Assessment: November 2011

Common Name (population): Hairy Prairie-clover

Scientific Name: *Dalea villosa*

COSEWIC Status: Special Concern

Reason for Designation: A perennial, herbaceous legume that inhabits sand dune landscapes within the prairies of south-central Saskatchewan and south-western Manitoba. Threats to the extent and quality of habitat continue, including a lack of fire allowing encroachment of competing vegetation, invasive alien plant species, recreational traffic, sand extraction as well as a general decline in open sandy habitat. However, a larger population size is now known due to greatly increased survey effort, and as a result the level of risk is now thought to be much reduced.

Canadian Occurrence: Saskatchewan, Manitoba

COSEWIC Status History: Designated Threatened in April 1998. Status re-examined and confirmed in May 2000. Status re-examined and designated Special Concern in November 2011.

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

2. Species Status Information

In Canada, the Hairy Prairie-clover (*Dalea villosa*) is listed as special concern under Schedule 1 of the *Species at Risk Act* (SARA). It is protected in Manitoba where it is listed as threatened under the provincial *Endangered Species and Ecosystem Act,* and in Saskatchewan where it is listed as Endangered under *The Wildlife Act*. The conservation status of the Hairy Prairie-clover throughout its range in North America is described in Table 1. No information is available on the abundance of the Hairy Prairie-clover in the United States (Heidel et al. 2000, Heidel and Marriot 2002). The percent of the species' global distribution and abundance currently found in Canada is less than 5%, based on its known range.

Table 1. Conservation status of the Hairy Prairie-clover (NatureServe 2016a).

Global (G) Rank[a]	National (N) Rank[a]	Sub-national (S) Rank[a]
G5T5	Canada: N2N3 United States: NNR	Canada: Saskatchewan (S1), Manitoba (S2S3) Colorado (SNR), Iowa (SNR), Kansas (SNR), Michigan (SNR), Minnesota (SNR), Missouri (SNR), Montana (S1), Nebraska (SNR), New Mexico (SNR), North Dakota (SNR), Oklahoma (SNR), South Dakota (SNR), Texas (SNR), Wisconsin (S2), Wyoming (S1)

[a] Rank: 1– critically imperiled; 2– imperiled; 3- vulnerable to extirpation or extinction; 4- apparently secure; 5– secure; NR – status not ranked.

3. Species Information

3.1. Species Description

Figure 1. Hairy Prairie-clover flowers.

Hairy Prairie-clover is a member of the Pea Family (Fabaceae or Leguminosae). It is a perennial herb with a woody taproot and branching shoots that grow upright or along the ground to lengths of 20-50 cm (Looman and Best 1979, Great Plains Flora Association 1986). Stems can form from adventitious buds along the reddish-orange roots when the roots are exposed by shifting sand (Great Plains Flora Association 1986). Alternate leaves are approximately 2-4 cm long and have 7-21 leaflets, which are 5-15 mm long (Looman and Best 1979, Great Plains Flora Association 1986). A dense covering of silvery, silky hairs give plants a velvety appearance. Flowers are pale-rose to purple, or rarely, white, and appear between late July to August in cylindrical spikes (3-12 cm long) at the ends of branches or stems (Fig. 1). Reproduction is primarily by seeds, contained in small, hairy, egg-shaped pods, set in late August-September and dispersed by wind and small mammals (Smith 1998). Hairy Prairie-clover is also called Silky Prairie-clover and *Petalostemon villosus* (Harms 2003).

3.2. Species Population and Distribution

Hairy Prairie-clover is native to North America, occurring in both Canada and the United States. In Canada, it ranges from south-central Saskatchewan to south-central Manitoba (Fig. 2), and south in the United States from Montana to New Mexico, Texas,

and Michigan (COSEWIC 2011). Hairy Prairie-clover is localized in its range and is found only in sand dune or sand hill areas.

Figure 2. Known range of the Hairy Prairie-clover in North America.

In Canada, the Hairy Prairie-clover is restricted to localized sand dune complexes in Manitoba and Saskatchewan (Fig. 3). These sand dunes complexes total 1574 km^2 and are comprised of the Brandon (964 km^2), Lauder-Routledge-Oak Lake-Souris (198 km^2), and Portage (27 km^2) sand hills in Manitoba, and the Pelican Lake (73 km^2) and Dundurn (312 km^2) sand hills in Saskatchewan (Ellis and Shafer 1943, Wolfe 2001)[3].

[3] The Portage sandhills area was estimated from the land coverage in the Portage Sandhills Wildlife Management Area and by using soil maps in Ehrlich et al. (1957) and Ellis and Shafer (1943). Otherwise, data are adapted from Wolfe (2001).

In Manitoba, there are four confirmed areas (likely metapopulations[4]) of Hairy Prairie-clover, comprised of 27 extant[5] native populations[6], occupying approximately 121 quarter-sections, and 3 historical[7] populations (Appendix A; Table A1). In Saskatchewan, there are two confirmed areas (or metapopulations) comprised of four extant native populations, occupying approximately 65 quarter-sections, and two historical populations (Appendix A; Table A1). Many new populations have been discovered in recent years due to increased search effort (COSEWIC 2011, Environment and Climate Change Canada unpubl. data, Manitoba and Saskatchewan Conservation Data Centres unpubl. data). The most recent population counts suggest a Canadian population size of over 147,000 plants (COSEWIC 2011, Appendix A). This is an underestimate as only portions of most populations were enumerated during surveys, with some populations having area of occupancy[8] data collected and not population counts. In addition, some large areas have not been searched due to inaccessibility (e.g., on military bases in Saskatchewan and Manitoba; COSEWIC 2011).

There is insufficient historical, long-term and statistically defensible data collected for this species to determine a trend in population size (COSEWIC 2011, C. Neufeld pers. obs. 2016). Standardized methods have been used to revisit the same occurrences[6] two or three times within populations in Saskatchewan to obtain area of occupancy or population count data, but additional years of data are required for trend analysis. With the data available so far, three years of population counts along transects at two occurrences in the Dundurn population in Saskatchewan indicated no significant difference in population size between 2003 and 2005 (Godwin and Thorpe 2006).

[4] A metapopulation is a spatial network of clustered but partially isolated populations of one species that are in various stages of colonization, recolonization, expansion, decline or extirpation. Usually, a metapopulation consists of larger, more stable core populations and smaller, transient satellite populations, with occasional exchange of genetic material among them. Within a metapopulation, individual populations may fluctuate temporally and spatially. Additionally, in poor growing years, plants may only exist at the core sites, while in good growing years, satellite and core populations may prosper, and propagules from core sites may disperse to form new satellite populations (see Hanski and Gilpin 1991, Primack 1996, White 1996, Freckleton and Watksinson 2002, Freckleton and Watkinson 2003 for more discussion).

[5] Extant means the population has been recently verified as still existing, information is accurate, and habitat still exists at the time of writing.

[6] For the purposes of this management plan, a population is equivalent to an “element occurrence” in a “dynamic landscape mosaic” as defined by NatureServe (2016c). As such, a population is considered separate from another population if there is unsuitable habitat of more than 1 km between them, and if not, if they are more than 3 km apart. A population is made up of one or more occurrences (source features, as defined by NatureServe) where an occurrence is a patch or grouping of plants separated by another patch of plants, usually by a distance of 30 m or more in the case of Hairy Prairie-clover.

[7] Historical means that the habitat still exists, or could exist with proper management, but presence of the species has not been reconfirmed at that occurrence or population for 25 or more years. In some cases, historical may also indicate an occurrence or population greater than 25 years old that also has inaccurate or vague locational information, making it difficult or impossible to confirm relocations (NatureServe 2016b).

[8] Area of occupancy, as defined in the management plan, is the actual area occupied by an occurrence of Hairy Prairie-clover as detected by presence of mature plants or seedlings during surveys in a given year, and separated from another occurrence by 30 metres or more. Area of occupancy is determined by walking the perimeter of the occurrence using a GPS unit.

A comparison of the survival and recruitment rates of plants monitored in plots in Dundurn over three years showed significant among-year differences in recruitment and mortality of plants, with recruitment being higher than mortality, leading to a small increasing, or stable, growth rate (Environment Canada unpubl. data 2011, Levesque 2011); this may be attributable to annual environmental variation like large precipitation events which appears to encourage seed germination and seedling growth (Environment Canada unpubl. data). A comparison of area of occupancy data for the four extant populations in Saskatchewan between two years (data collected in 2016 and one year between 2007-2012 depending on the population) shows a small increase in area of occupancy at each population (Environment and Climate Change Canada unpubl. data). Population counts were also done at the Mortlach population (Saskatchewan), which showed an increase between counts done in 2009 or 2012 and 2016 (Environment and Climate Change Canada unpubl. data). Hairy Prairie-clover plants appear to undergo dormancy in some years, likely due to drought stress, so minor fluctuations in populations may be observed, particularly if only a few visits have been made (COSEWIC 2011). Lowe (2011) found that the trend of sand dunes in the Dundurn population were towards a more successional state, leading to a decrease in habitat suitability for the Hairy Prairie-clover, particularly in the absence of natural disturbances.

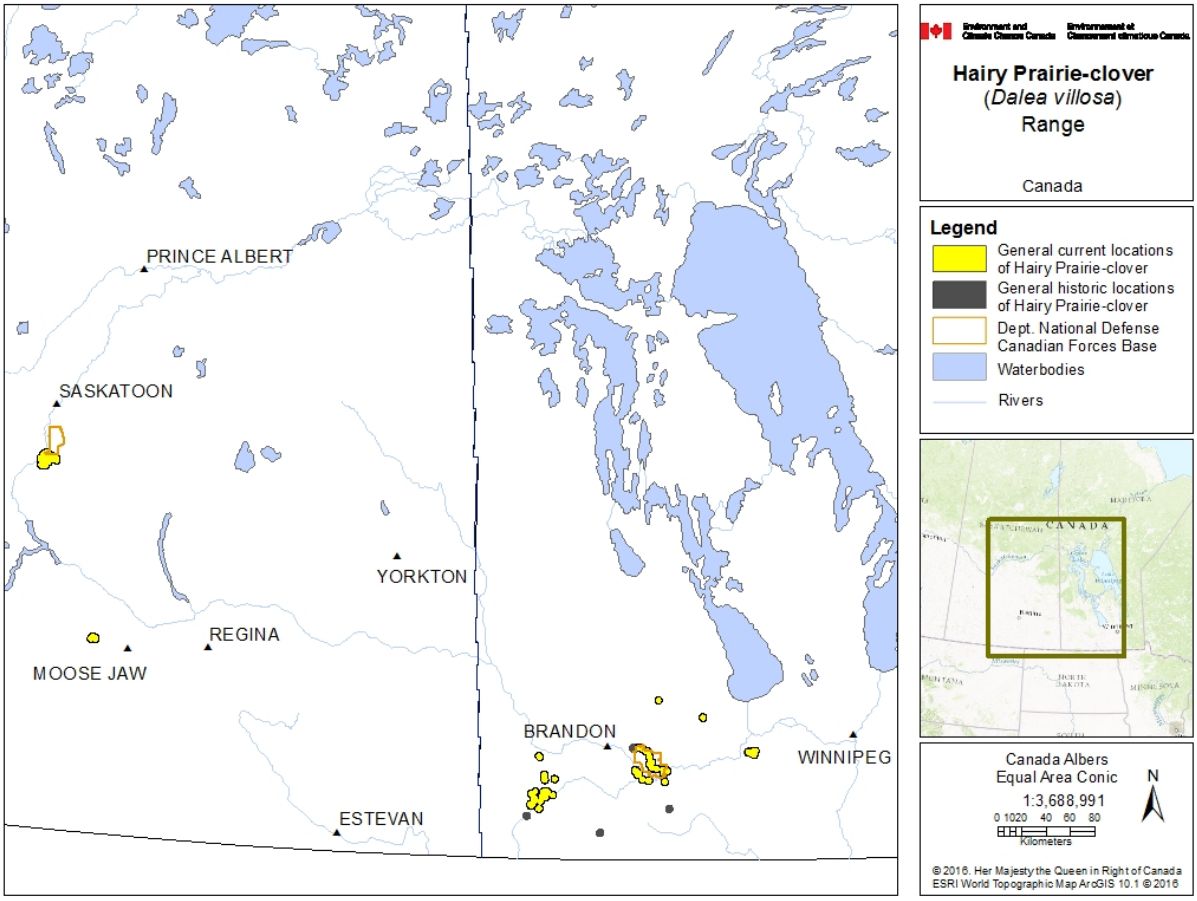

Figure 3. Canadian range of the Hairy Prairie-clover.

3.3. Needs of the Hairy Prairie-clover

Hairy Prairie-clover occurs in the Aspen Parkland and Lake Manitoba Plain Ecoregion of Manitoba, and the Moist Mixed Prairie Ecoregion of Saskatchewan, within the Prairie Ecozone (Marshall and Schut 1999). Hairy Prairie-clover primarily grows in a climate characterized as being dry year-round due to low annual precipitation levels, high rates of evaporation, and fast surface runoff (Fung et al. 1999); mean annual precipitation ranges from 355 mm (Saskatchewan) to around 500 mm (Manitoba) (Environment and Climate Change Canada 2016).

Hairy Prairie-clover inhabits sand dune complexes shaped by wind activity, and derived mostly from old deltas of glacial lakes or glacial river deposits; after glaciers retreated, the sand dune complexes were geographically isolated (Trenhaile 1990, Wolfe 2001, COSEWIC 2011). Within the sand dune complexes, the Hairy Prairie-clover is more commonly associated with partially stabilized dunes that are sparsely vegetated, particularly early in the growing season, with low litter levels and moderate levels of bare sand, at some early to mid-stage in soil development and ecological succession (Heidel et al. 2000, Godwin and Thorpe 2007, Lowe 2011). Less commonly, plants have also been found on more marginal habitat, stabilized with lichens and clubmoss (C. Neufeld pers. obs., Lowe 2011). Plants typically occur on level to moderately-sloped terrain, particularly on south or west-facing slopes at middle to lower positions (Leighton and Marchand 2001, Godwin and Thorpe 2006, Godwin and Thorpe 2007). Hairy Prairie-clover seeds have the highest germination rates at higher temperatures, which is likely why plants are associated with sparsely vegetated south to west exposures (Schellenberg and Biligetu 2015). In the Saskatchewan Dundurn population, sand dunes that were occupied by the Hairy Prairie-clover were associated with larger patches of open sand that were more elongated and in closer proximity to other Hairy Prairie-clover occurrences as opposed to unoccupied sand dunes (Lowe 2011). There was also less forest and shrub cover in between the habitat patches; this may be related to movement of seed-dispersing herbivores (e.g. deer) (Lowe 2011). Associated plants include species which also occur in early to mid-successional sand dunes (Godwin and Thorpe 2007).

Limiting Factors

Sand dunes are not evenly distributed across the Canadian range of the Hairy Prairie-clover. This results in multiple isolated population clusters separated by several tens to hundreds of kilometers of unsuitable habitat. While the Canadian range of the Hairy Prairie-clover represents the northern extreme limit, it is not known if isolated populations represent colonizing satellites of an expanding range, or fragmented remnants of a retracting and formerly more extensive range. These isolated populations likely comprise larger metapopulations, with satellite populations potentially lost through competitive exclusion by native and invasive alien plant species. The isolated populations may also have low rates of immigration from distant populations, have low dispersal and colonization of new habitat, and have potential reproductive problems

from lack of specialized pollinators (Reed pers. comm. 2006, Bizecki Robson 2014) or through inbreeding and genetic drift, although the latter was not found in the Dundurn population (Fu et al. 2011). Further genetic analysis of populations in Canada and adjacent parts of the United States could help resolve whether this species is in a phase of expansion or contraction. Dune stabilization may be accelerating the rate of contraction, and is reducing the amount of suitable habitat for the Hairy Prairie-clover (Lowe 2011).

Although there have been some recent preliminary studies conducted on demographics of the Hairy Prairie-clover, there is still limited information on seed and seed bank dynamics (e.g., seed production, seed viability, seed longevity in the seed bank, germination success, dispersal), and recruitment and survival to know whether these are limiting factors. Hairy Prairie-clover plants are thought to be primarily pollinated by insects and through out-crossing, although self-pollination is likely possible at a very low rate (Environment Canada unpubl. data, Cane 2006). In a preliminary study in the Dundurn population, Hairy Prairie-clover appeared to yield similar results to a study conducted on the common Purple Prairie-clover (*Dalea purpurea*) with respect to percentage of seeds produced when flowers were pollinated (52-57%) and not allowed to be pollinated (1-5%), although viability of the seed was not tested (Environment Canada unpubl. data, Cane 2006). In a few studies, one in Manitoba, Hairy Prairie-clover was repeatedly reported as one of the most visited plants by a high diversity of insect species, including some species that only visited Hairy Prairie-clover, with 29 insect taxa observed feeding on nectar or pollen from the Hairy Prairie-clover plants in a population in Manitoba (Reed 1993, C. Reed pers. comm. 2006, Bizecki Robson 2014), although these studies didn't examine flowers for seed production or seed viability. The influence of seed predators has also not been investigated, although they have been noted on a variety of prairie-clover species, including the Hairy Prairie-clover (Environment Canada unpubl. data, Cane et al. 2012, Cane et al. 2013). Although preliminary studies suggest pollination and seed production may not be factors affecting the Hairy Prairie-clover's rarity, this hasn't been studied on a wider scale or in habitats which are becoming more stabilized (Bizecki Robson 2014), and some aspects haven't been investigated at all. Since pollinators are so important to reproduction of the Hairy Prairie-clover, disruption of the pollination community is a potential limiting factor, particularly at the periphery of the range where both plant and pollinator populations may be fragmented. Experiments in the United States indicate establishment of the Hairy Prairie-clover in a tallgrass prairie habitat was limited by seed dispersal or seed bank (Tilman 1997). A germination study using wild-collected seed from the Dundurn population found germination of unscarified Hairy Prairie-clover seed to be low at 5% compared to 51% and 27% for the more common related Purple Prairie-clover and White Prairie-clover (*Dalea candidum*), respectively; scarification, which would likely occur in the wild, increased germination by 20% (Schellenberg and Biligetu 2015). Therefore, it is possible low germination of seeds is a limiting factor, although more experiments are needed.

4. Threats

4.1. Threat Assessment

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

Table 2. Threat calculator assessment.

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Detailed threats
2	Agriculture & aquaculture	Negligible	Pervasive	Extreme	High	
2.1	Annual & perennial non-timber crops	Negligible	Negligible	Extreme	Moderate-Low	Cultivation or conversion of native prairie to tame pasture or cropland.
2.3	Livestock farming & ranching	Not a threat	Pervasive	Neutral or Potential Benefit	High	Overgrazing (high stocking densities) from domestic livestock, but helps counteract impacts of dune stabilization
3	Energy production & mining	Low	Small	Serious	Moderate	
3.2	Mining & quarrying	Low	Small	Serious	Moderate	Sand and gravel extraction and sand removal.
4	Transportation & service corridors	Low	Restricted	Moderate	High	
4.1	Roads & railroads	Low	Restricted	Moderate	High	Road maintenance, improvement and construction activities; spraying pesticides; fireguard creation and maintenance; mowing/haying at inappropriate time.
6	Human intrusions & disturbance	Low	Restricted	Slight	High	
6.1	Recreational activities	Low	Small	Slight	High	Recreational activity (e.g., dirt bike use, motocross tracks, ATV use, off-road vehicles, trampling).
6.2	War, civil unrest & military exercises	Low	Restricted	Slight	High	Military activity (e.g. off-road tracked or wheeled vehicles, exploding ordinances, trampling; other factors related to military activity covered under 4.1 and 8.1).
7	Natural system modifications	Low	Pervasive	Slight	High	
7.1	Fire & fire suppression	Low	Pervasive	Slight	High	Fire suppression (contributing to dune stabilization)
8	Invasive & other problematic species & genes	Medium-Low	Large	Moderate-Slight	High	
8.1	Invasive non-native/alien species	Medium - Low	Large	Moderate - Slight	High	Invasive alien plant species
8.2	Problematic native species	Low	Large	Slight	High	Browsing by wild ungulates (deer), woody vegetation encroachment leading to dune stabilization
9	Pollution	Negligible	Negligible	Extreme	High	
9.3	Agricultural & forestry effluents	Negligible	Negligible	Extreme	High	Pesticide use (roadside use captured under 4.1)
11	Climate change & severe weather	Low	Pervasive	Slight	Moderate-Low	
11.1	Habitat shifting & alteration	Low	Pervasive	Slight	Moderate-Low	Prolonged wet climatic periods contributing to dune stabilization (other factors contributing to dune stabilization covered under 7.1, 8.1, 8.2).

[a] **Impact** – The degree to which a species is observed, inferred, or suspected to be directly or indirectly threatened in the area of interest. The impact of each threat is based on Severity and Scope rating and considers only present and future threats. Threat impact reflects a reduction of a species population or decline/degradation of the area of an ecosystem. The median rate of population reduction or area decline for each combination of scope and severity corresponds to the following classes of threat impact: Very High (75% declines), High (40%), Medium (15%), and Low (3%). Unknown: used when impact cannot be determined (e.g., if values for either scope or severity are unknown); Not Calculated: impact not calculated as threat is outside the assessment timeframe (e.g., timing is

insignificant/negligible or low as threat is only considered to be in the past); Negligible: when scope or severity is negligible; Not a Threat: when severity is scored as neutral or potential benefit.

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

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

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

4.2. Description of Threats

Table A1 in Appendix A identifies the threats associated with each population.

Loss of habitat quantity and quality among the known populations of Hairy Prairie-clover may adversely affect the species persistence in Canada (COSEWIC 2012). Future loss of habitat will be partially as a result of threats acting together or on their own, ultimately leading to dune stabilization or habitat succession (e.g. changes to the natural disturbance regime of grazing and fire, invasive alien plant species, encroachment of woody vegetation, climate). Direct habitat loss, fragmentation or degradation is also likely from threats such as cultivation, mining/quarrying, road maintenance/construction, recreational activities, military activities, invasive alien plant species, and pesticide use. Threats are discussed in more detail below.

IUCN Threat 2. Agriculture & aquaculture

Threat 2.1 Annual & perennial non-timber crops

Historical conversion of native sandy grassland habitats to cultivated cropland likely contributed to the loss and fragmentation of the Hairy Prairie-clover habitat. In general, sand dune areas that support the Hairy Prairie-clover are not considered suitable habitat for agriculture due to low soil moisture, low soil fertility, and high risk of wind erosion (Geological Survey of Canada 2001). However, within sand dune complexes where there are level sandy plains between dunes, it is possible to grow certain types of crops which need irrigation, such as potatoes, corn and sugar beets. Similar landscapes in Manitoba and Alberta have been converted to irrigated crops. It is possible this practice may increase in the future, but it is currently limited by the economics of irrigation infrastructure development, crop prices, and water supply (Honey and Oleson 2006, Farm Credit Canada 2013, Wright and Wimberly 2013). Some of the remaining populations in Manitoba are in remnant strips of native prairie between cultivated fields and roadsides and may be further impacted by cultivation of the remaining strips, pesticide drift (threat 9.3) or encroachment of tame forage species from adjacent cultivated fields (threat 8.1). Cultivation results in habitat loss for which there is no mitigation.

Threat 2.3 Livestock farming & ranching

Hairy Prairie-clover would have evolved with periodic natural disturbances like fire, grazing, and drought (Samson and Knopf 1994). The timing, intensity, duration and diet selection of domestic and wild animals today in the Hairy Prairie-clover habitat differ from historical natural grazing regimes (Milchunas and Lauenroth 1993, Houston 1999, Knapp et al. 1999, Fuhlendorf and Engle 2001, Kohl et al. 2013). In addition, stocking rates, frequency, and duration of grazing will differ among, and within, populations. Cattle grazing occurs at the majority of the Hairy Prairie-clover populations in Canada, with sheep grazing occurring at the population near Mortlach, Saskatchewan. Recent

research suggests it is when stocking densities[9] of cattle are high that herbivory on Hairy Prairie-clover occurs (Catellier 2012). Otherwise, it appears that cattle will not preferentially feed on Hairy Prairie-clover, and may even avoid Hairy Prairie-clover habitat due to the steeper sand dunes slopes, wooded areas between populations, and lower forage quality and quantity within sand dunes (Bailey and Provenza 2008, Catellier 2012). Overall grazing on Hairy Prairie-clover actually decreased or was unchanged with higher cattle stocking rates[10], likely due to the absence of wild herbivores like deer which forage on Hairy Prairie-clover (threat 8.2), as deer avoid foraging in areas with cattle (Coe et al. 2005, Catellier 2012). Cattle grazing and trampling may also aid in reactivation of dunes or maintain dune habitats at earlier successional stages, slowing the rate of dune stabilization and woody vegetation encroachment (threat 8.2) (Hayes and Holl 2003, Rook et al. 2004, Hugenholtz and Wolfe 2005a,b). High stocking densities of sheep or goat grazing in spring may aid in reducing invasive alien species in Hairy Prairie-clover habitat (threat 8.1), however, sheep were found to preferentially feed on Hairy Prairie-clover plants in one study and heavy grazing of Hairy Prairie-clover by sheep is occurring in part of the Mortlach population, although this isn't always the case (Cattelier 2012, C. Neufeld pers. comm. 2016). Grazing after seed set in fall may be beneficial for dispersal of seed. Therefore, responsible grazing at appropriate intensity, frequency and duration, is likely not detrimental in a system that evolved under grazing pressure, and in fact, likely has a neutral or beneficial impact by preventing succession, maintaining vegetation structure, and maintaining range condition (Higgins et al. 1989, Milchunas et al. 1989, Milchunas et al. 1992, Samson and Knopf 1994, Biondini et al. 1998).

IUCN Threat 3. Energy production & mining

Threat 3.2 Mining & quarrying

Sand and gravel extracted from sand dunes is used for road construction, oil and gas activities (e.g., fracking), agriculture (e.g., potato farming), and personal use. There are no sites currently under immediate threat from sand and gravel extraction. However, this is a recurrent threat for other species at risk in sand dune ecosystems and with the continued need for aggregate (e.g., Environment Canada 2012, Environment Canada 2015), it is expected to become a large threat for the Hairy Prairie-clover populations. In Saskatchewan, extraction of sand from the Dundurn Sand Hills is of interest for highway improvement and fracking in Alberta. In Manitoba, gravel extraction was reported adjacent to a population, and sand removal was reported from a roadside population (Table A1). Removal of the soil substrate not only kills living plants, but permanently removes all, or portions of, the seed bank; this can have substantial implications for the

[9] Stocking density is the "relationship between number of animals and the specific unit of land being grazed at any one point in time" or animal units at a specific time per area of land (Society for Range Management 1998).

[10] Stocking rate is the "relationship between the number of animals and the grazing management unit utilized over a specified time period" or animal units per unit of land area (Society for Range Management 1998).

future survival of the populations at those locations. This type of disturbance to the habitat can also lead to introduction and/or invasion by alien species (threat 8.1).

IUCN Threat 4. Transportation & service corridors

Threat 4.1 Roads & railroads

There are many populations of Hairy Prairie-clover in Manitoba and Saskatchewan where the Hairy Prairie-clover plants occur in remnant native prairie ditches along roadsides or road allowances where disturbance has provided loose sand for the plants to establish themselves. Habitat and plants in these populations can be damaged or destroyed by road construction or maintenance activities such as road widening, ditch deepening, grading trenching, drainage projects, and realigning or improving the road. Habitat and plants can also be affected by incompatible or inappropriately-timed road maintenance activities on shoulders and in ditches, such as spraying pesticides (threat 9.3), haying or mowing. In Manitoba, there have been reports of heavy machinery crushing Hairy Prairie-clover plants, haying or mowing equipment defoliating or uprooting plants, roadside pesticide use decreasing population size, and in Saskatchewan, reports of plants being damaged from road maintenance (Table A1; Hughes 2001, Foster and Hamel 2006, Murray and Church 2015, C. Neufeld pers. obs.). Fireguard maintenance in Canadian Force Base (CFB) Shilo may also impact plants or habitat of a few populations although most plants growing along fireguards are higher on the slopes and not impacted by discing (S. Punak Murphy, pers. comm. 2016). Although roadside areas are not ideal habitat for the Hairy Prairie-clover, they may be important for gene flow among populations or within a population. It may be possible to mitigate some of the damage by avoiding maintenance activities during the flowering period, but other public safety issues may arise that prevent this form of mitigation. Linear disturbances from roads may also increase the potential for introduction and invasion of invasive alien species (threat 8.1).

IUCN Threat 6. Human intrusions & disturbance

Threat 6.1 Recreational activities

Tourism and recreational activities have caused habitat disturbances and physical plant damage at some locations with Hairy Prairie-clover. Activities such as hiking not restricted to trails and horse-drawn wagon rides occur within Spruce Woods Provincial Park (Manitoba) in areas with Hairy Prairie-clover (Smith 1998, Hughes 2001). Use of motorized or recreational vehicles (dirt bikes, all-terrain vehicles (ATV), snowmobiles) have been reported at six populations in Manitoba (Table A1); at a few populations there are established ATV trails or extensive motocross tracks (Foster and Reimer 2007, Foster 2008, Krause Danielson and Friesen 2009). Recreational vehicle use has been prohibited within the Portage Sandhills Wildlife Management Area since 1995 but compliance and enforcement have been difficult (Reimer and Hamel 2002, Foster 2008). Although some disturbance can help destabilize dunes thereby keeping open sand habitat available, repeated disturbance can lead to shifting or eroding dunes which

does not support any vegetation growth (COSEWIC 2011). Vehicle tires and foot traffic can physically damage plants (Hughes 2001, Foster 2008), ultimately leading to their mortality or reduced reproductive output. Invasive species (threat 8.1) may also be transported and introduced by ATVs or dirt bikes (Rooney 2005).

Threat 6.2 War, civil unrest & military exercises

Activities such as road or fireguard creation and maintenance (threat 4.1), use of heavy tracked or wheeled tactical vehicles off-road, training activities (e.g., trampling) and exploding ordinances can negatively alter native prairie, particularly in sand habitats, by reducing vegetation cover and altering species composition (McKernan 1984, Wilson 1988, Severinghaus 1990). These activities have the potential to directly damage plants and the seed bed. Some minor disturbances, however, may initially stimulate germination of seeds by opening habitat, reactivating dunes, and suppressing competition from other plant species. A recent analysis of North American and European military training areas indicates that these areas contain large numbers of species at risk and high biodiversity, potentially due to the large tracts of natural vegetation and the heterogeneous disturbance that results in a plethora of different habitats in space and time (Warren et al. 2007). If these disturbances occur too frequently (e.g. beyond a natural disturbance regime) the areas can become “population sinks” where plants and/or seedbeds are destroyed by vehicles or machinery, and invasive aliens species (threat 8.1) are introduced via seed transport off equipment. To date, the populations of Hairy Prairie-clover at Department of National Defence’s (DND) Canadian Forces Base (CFB) Shilo are outside of active military training areas where there is vehicle traffic and it is rare for military ammunition strikes to happen in habitat occupied by the Hairy Prairie-clover. Monitoring of impacts has not occurred for a number of years but past monitoring shows no impacts so far from military training (S. Punak-Murphy, pers. comm. 2016). The population of Hairy Prairie-clover at 17-Wing Detachment Dundurn (DND) is also located in an area where no military activities currently occur; more occurrences may be found in the future within the active training area as there are historical records and suitable habitat in this area.

IUCN Threat 7. Natural system modifications

Threat 7.1 Fire and fire suppression

As discussed in threat 2.3, the Hairy Prairie-clover would have evolved under a natural disturbance regime which included ecological processes such as grazing, fire, and drought, acting independently or together to maintain the open, early successional dune habitat required by the Hairy Prairie-clover (Daubenmire 1968, White 1979, Collins 1987, Lesica and Cooper 1999). A combination of fire and grazing likely destabilizes sand dunes and disrupts vegetative succession more effectively than either disturbance independently (Wallis and Wershler 1988, Lesica and Cooper 1999). 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). In the absence of these disturbances, woody vegetation (threat 8.2), invasive alien species (threat 8.1) and/or natural succession can stabilize the open sandy areas and dunes with vegetation

(Potvin and Harrison, 1984, Higgins et al. 1989, Milchunas et al. 1989, Milchunas et al. 1992, Samson and Knopf 1994, Hayes and Holl 2003). Since habitat had a higher probability of being occupied by the Hairy Prairie-clover if in close proximity to other occurrences and not separated from other occurrences by forest or shrubs, fire may be an important tool in providing connectivity among habitat patches and increasing occupancy of dunes (Lowe 2011).

Changes in land use practices since European settlement have resulted in reduction in the frequency and extent of prairie fires (Higgins et al. 1989). Dunes have been stabilizing in some areas where there have been repeated fires but minimal grazing, while in other areas dunes have stabilized where there has been grazing but few fires (Wallis 1988). While natural disturbance is required to disrupt natural succession and maintain the open habitat conditions required by this species, the level of tolerance of the Hairy Prairie-clover to fire in terms of frequency, intensity, and timing is unknown. Hairy Prairie-clover had notable vigour and produced multiple stems after a fire in Montana, and increased in abundance after a fire in the Nebraska Sandhills (Wolfe 1972, Vanderhorst et al. 1998). Fire does not occur at historical fire intervals at any of the populations of Hairy Prairie-clover in Canada, although some of the habitat within CFB Shilo is subject to occasional burning, either through accidental ignition during training exercises or through purposeful ignition for safety and management purposes. CFB Shilo has a long term research and monitoring program in place to determine sustainability thresholds of plants and wildlife to fire frequency (CFB/ASU Shilo 2013).

IUCN Threat 8. Invasive & other problematic species & genes

Threat 8.1 Invasive non-native/alien species

Invasive alien plant species is the threat with the highest impact currently reported for more than half of the Hairy Prairie-clover populations (Table A1). Invasive alien plants can pose indirect threats through stabilization of sand dunes, or direct threats through competition for resources with the Hairy Prairie-clover plants. Invasive species in general have the potential to displace native species, reduce plant community richness and diversity, and alter ecosystem function in habitats where they occur (Wilson 1989, Wilson and Belcher 1989, Reader et al. 1994, Christian and Wilson 1999, Bakker and Wilson 2001, Henderson 2005, Henderson and Naeth 2005). Leafy Spurge (*Euphorbia esula*), was reported as a threat at 12 populations in Manitoba and 2 populations in Saskatchewan, with some infestations reported as extensive (Foster and Hamel 2006, Foster and Reimer 2007, Foster 2008, Krause Danielson and Friesen 2009, Catellier 2012, C.R. Neufeld pers. comm. 2016, C. Neufeld pers. obs). Leafy Spurge is an invasive Eurasian species that reduces the abundance of native species in areas where it occurs (Wilson and Belcher 1989); its extensive root systems can stabilize sand dunes and it can form a dense stand, spreading quickly, which can affect distribution and abundance of other plant species occupying the habitat (Selleck et al. 1962, Belcher and Wilson 1989, Butler and Cogan 2004). Wilson and Belcher (1989) found that 95% of Leafy Spurge occurrences within their study area in Manitoba were associated with human disturbances such as fireguards or vehicle tracks since it is

easier for the Leafy Spurge to establish in areas with more exposed soil; therefore, sand dunes with shifting bare sand may be particularly susceptible to Leafy Spurge infestation. An added concern is that Leafy Spurge is extremely difficult to control by chemical and physical means. Chemicals can have limited benefits when used on their own and can impact the health of the existing native plant communities (Crone et al. 2009, Rinella et al. 2009). Leafy Spurge produces a milky substance that is an irritant to some animals; cattle and deer usually avoid eating it (Kronberg et al. 1993, Trammell and Butler 1995), however, sheep and goats will feed on it (Walker et al. 1994). Some insects such as Spurge Beetles (*Aphthona* species) or the Spurge Hawk (*Hyles euphorbiae*) moth larvae can be used to control spurge with varying success, but more research is needed on its efficacy and their impact on the associated plant community (Pachkowski 2003, Lesica and Hanna 2004, Progar et al. 2011). Other invasive alien plant species including Smooth Brome (*Bromus inermis*), Crested Wheatgrass (*Agropyron cristatum*), Kentucky Bluegrass (*Poa pratensis*), Baby's-breath (*Gypsophila* sp.) and Sweet Clover (*Melilotus* sp.) were reported from a few populations in Manitoba and Saskatchewan (Table A1). Inappropriate use of herbicide intended to control invasive species has the potential to directly kill Hairy Prairie-clover plants, or to negatively alter habitat occupied by the Hairy Prairie-clover (threat 9.3; Foster and Hamel 2006, Foster and Reimer 2007).

Threat 8.2 Problematic native species

In the absence of natural disturbances like fire or grazing, or during extended wet climatic periods, woody vegetation can encroach thereby suppressing wind erosion and sand movement which leads to dune stabilization and vegetation succession, as well as increase competition for limited resources (e.g., sunlight), limit availability of suitable sites for establishment, and alter moisture and temperature levels needed for germination and growth (Higgins et al 1989, Milchunas et al. 1989, Milchunas et al. 1992, Samson and Knopf 1994, Thorpe et al. 2001, Wolfe et al. 2001, Hayes and Holl 2003). The disruption of the natural disturbance regime has allowed encroachment of native trees and shrubs like Trembling Aspen (*Populus tremuloides*), Chokecherry (*Prunus virginiana*), Juniper (*Juniperus horizontalis* and *Juniperus communis*) and Bur Oak (*Quercus macrocarpa*; Manitoba only) into Hairy Prairie-clover habitat at half of the populations (Table A1).

As discussed in threat 2.3, although these plants evolved with ungulate grazing as natural disturbances, it is possible the current timing, duration, location, and diet selection of ungulates today is unlike what occurred naturally with Bison, Elk (*Cervus canadensis*), Mule Deer (*Odocoileus hemionus*), and Pronghorn (*Antilocapra americana*) prior to 1850 (Coe et al. 2005, Chaikina and Ruckstuhl 2006). Within the three populations in the Dundurn Sand Hills, Saskatchewan, deer (Mule Deer and White-tailed deer [*Odocoileus virginianus*]) were responsible for the high herbivory rates on Hairy Prairie-clover (Catellier 2012); herbivory reduced the number of inflorescences that survived until seed production by about 50%, reducing seed output up to 58% (Henderson and Neufeld 2011). Deer, however, make short and long distance movements within their home range or during migration, respectively (Skelton 2010),

which may be helpful in dispersing seeds of the Hairy Prairie-clover both within a dune complex or possibly among dune complexes (Myers et al. 2004); within the home range of a white-tailed deer, it was found that 95% of ingested seeds of *Trillium grandiflorum* were dispersed more than 100 m, while 25% were dispersed more than 1 km (Vellend et al. 2003). Using remote infrared cameras, Moose (*Alces alces*) were also observed foraging on Hairy Prairie-clover plants, and Elk are present in the pasture (C. Neufeld, pers. obs. 2009). Since Hairy Prairie-clover reproduces primarily by seed but appears to have low germination rates, intensive herbivory during flowering may impact seed production, and chronic, intensive grazing pressure may affect plant growth and survival (Briske and Richards 1995, Briske et al. 2008, Schellenberg and Biligetu 2015, Environment Canada unpubl. data).

IUCN Threat 9. Pollution

Threat 9.3 Agricultural & forestry effluents

Indiscriminate or inappropriate use of herbicides intended to control broad-leaved plant species or woody vegetation encroachment will kill Hairy Prairie-clover plants. Indiscriminate or inappropriate use of insecticides used to control insect pests may kill pollinators of the Hairy Prairie-clover, thereby affecting reproductive output. These activities are likely more of a threat in populations adjacent to cultivated fields where use of herbicides and insecticides are more prevalent and overspray, run-off, or drift may occur, as well as along linear disturbances (transmission lines, roads), and/or in populations where herbicides are being used to control invasive alien species. Herbicides killed Hairy Prairie-clover plants at two populations in Manitoba, but are used near multiple populations in both provinces for the purposes of controlling invasive alien plant species (Foster and Hamel 2006, Manitoba CDC unpubl. data 2015).

IUCN Threat 11. Climate change & severe weather

Threat 11.1 Habitat shifting & alteration

Climate has historically been an important driver of dune activity (Hugenholtz et al. 2010). Progressive stabilization of sand dunes dating back as far as the 1700s and driven mainly by decreased periods of drought and decreased wind speed and erosion may have contributed to active sand dune habitat loss, even in the absence of anthropogenic factors that are currently contributing to dune stabilization (Wallis 1988, Wolfe et al. 2001, Hugenholtz and Wolfe 2005a, 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 2005a). In some areas, as much as 90% of active dunes have vegetated since the early 1900s (Wallis 1988, Hugenholtz and Wolfe 2005a). 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).

5. Management Objective

The management objective for the Hairy Prairie-clover is to ensure long-term maintenance and natural expansion of all extant native[11] populations in Canada, including any newly located or reconfirmed[12] populations, within the natural range of variation.

Rationale: There has been an increase in knowledge about the populations and distribution of the Hairy Prairie-clover over the last decade as survey effort has increased, to the result of the Hairy Prairie-clover being downlisted by COSEWIC from threatened to special concern in 2012 (COSEWIC 2011). Substantial increases to number of populations or area of occupancy are less likely to be documented in the future given that: 1) the suitable habitat for the species is limited and highly fragmented; 2) the majority of suitable habitat has been surveyed; and 3) the Canadian populations exist at the northern limit of the species' range. However, it is likely that some additional populations will be found with future survey effort. If habitat quality and quantity continue to decline, known populations may also decline as a result. Therefore, the management objective has been set in the context of reversing or preventing further declines in quality and quantity of habitat through beneficial management practices and stewardship arrangements in order to maintain, and if possible, increase existing populations over the long-term.

6. Broad Strategies and Conservation Measures

6.1. Actions Already Completed or Currently Underway

Inventory and Monitoring

In Manitoba, Manitoba Conservation (Conservation Data Centre), Nature Conservancy of Canada, CFB Shilo, and Environment and Climate Change Canada (via contract, Golder Associates 2007), along with other botanists, have conducted targeted surveys for Hairy Prairie-clover over the last 15 years; surveys and/or monitoring continue at some of the Manitoba populations through some of these organizations (Foster and Hamel 2006, Foster and Reimer 2007, Foster 2008, Krause Danielson and Friesen 2009, Friesen and Murray 2010, Murray and Friesen 2012, Murray 2013, Murray 2014, Murray and Church 2015, Manitoba Conservation Data Centre unpubl. data 2015). In Saskatchewan, Environment and Climate Change Canada, Native Plant Society of Saskatchewan, Nature Saskatchewan, Saskatchewan Research Council and various botanists and contractors have invested considerable effort in targeted surveys for Hairy

[11] Native population refers to any population within the native range on naturally occurring habitat. It excludes horticultural populations or those that are dispersed by humans and establish themselves outside the native range or on unnatural habitats.

[12] Populations, or occurrences within populations, that are considered historical or inaccurate (Table A1) are excluded from these objectives until such time as they are reconfirmed.

Prairie-clover over the last 15 years; surveys and/or monitoring continue through some of these organizations at all Saskatchewan populations (Saskatchewan Conservation Data Centre unpubl. data 2016, Environment and Climate Change unpubl. data 2016).

Research as Part of an Adaptive Management Framework[13]

Numerous research projects have been undertaken within Hairy Prairie-clover populations in Saskatchewan. Over three years in the Dundurn population, Environment and Climate Change Canada staff examined Hairy Prairie-clover mortality and recruitment rates, pollination rates, and the importance of herbivory on Hairy Prairie-clover survival and reproductive output (Environment Canada unpubl. data 2011, Levesque 2011). A graduate research project investigated different aspects of occupied and unoccupied Hairy Prairie-clover habitat in the Dundurn population including land cover type and spatial arrangement on the landscape to predict where Hairy Prairie-cover should occur (Lowe 2011). A second graduate research project investigated effects of herbivory (deer versus cattle) and grazing management on Hairy Prairie-clover, ecological processes affecting Hairy Prairie-clover productivity, and the costs and benefits of different grazing strategies to control Leafy Spurge infestations in Hairy Prairie-clover habitat (Catellier 2012). A genetic study was conducted to assess genetic diversity and genetic risk for the Hairy Prairie-clover population at Dundurn (Fu et al. 2011). Wild seed from the Dundurn population was used to determine germination factors (temperature, scarification, germination success) of Hairy Prairie-clover seed (Schellenberg and Biligetu 2015). In Manitoba, a study in Spruce Woods Provincial Park detailed the insect pollinator community and insect visitation rate to Hairy Prairie-clover (Bizecki Robson 2014).

Habitat Assessment, Management, and Conservation

Agriculture and Agri-Food Canada developed management guidelines and decision support tools for pasture land managers who have species at risk on their properties, including for the Dundurn and Rudy-Rosedale Pastures. In Manitoba, some habitat containing Hairy Prairie-clover has been conserved through stewardship agreements, conservation easements, or fee-simple purchase through agencies like Manitoba Habitat Heritage Corporation (MHHC) and Nature Conservancy of Canada (NCC). Grazing management agreements or management plans have been implemented on some of those properties. MHHC owns and manages 1 quarter section and holds easements on an additional 33 quarter sections containing Hairy Prairie-clover. NCC owns and manages 2 quarter sections and holds easements on an additional 2.5 quarter sections containing Hairy Prairie-clover. The Manitoba provincial government has also set aside Wildlife Management Areas and Spruce Woods Provincial Park for general habitat conservation, which include a large number of Hairy Prairie-clover populations. In Saskatchewan, stewardship agreements have been set up on some properties containing Hairy Prairie-clover through Nature Saskatchewan. The

[13] Research and management actions should be guided by the concept of adaptive management whereby specific actions are implemented, monitored, evaluated, and adjust, as necessary, to achieve and/or improve the desired outcome.

Native Plant Society of Saskatchewan has created and implemented property-specific beneficial management plans (BMPs) for Hairy Prairie-clover and other co-occurring species at risk on numerous properties of landowners with stewardship agreements, including monitoring of the properties to assess the effect of the BMPs.

6.2. Broad Strategies

In order to achieve the management objective, conservation measures will be organized under four broad strategies:

- Inventory and monitoring
- Research as part of an adaptive management framework
- Communication, collaboration and engagement
- Habitat assessment, management and conservation

6.3. Conservation Measures

Table 3. Conservation Measures and Implementation Schedule.

Conservation Measures	Priority[a]	Threats[b] or Concern Addressed	Timeline
Broad Strategy: Inventory and monitoring			
Using consistent survey guidelines (e.g., Henderson 2010), continue surveys to locate new occurrences and populations, and relocate inaccurate and/or historical records.	Low	Measure progress towards attaining the management objective.	Ongoing through 2027
Using consistent monitoring guidelines, implement a long-term monitoring plan at a subset of populations across the known range collecting information on threats, population and habitat trends, and range of natural variation.	Medium	Measure progress towards attaining the management objective.	Ongoing in some areas. In others, by 2020, then at intervals as determined by the plan.
Broad Strategy: Research as part of an adaptive management framework			
Determine long-term impacts of threats and management practices on populations and habitat quality.	Medium	2.3, 3.2, 4.1, 6.1, 6.2, 7.1, 8.1, 8.2, 9.3, 11.1	Ongoing through 2027 or longer
As needed, conduct further research into species ecology and needs.	Low	Knowledge gaps	Ongoing and as needed
Apply research and monitoring findings to develop or refine adaptive beneficial management practices (BMPs) for the species (landscape, population, or landowner-specific may be required) to reduce threats, improve habitat and maintain or increase populations.	High	2.3, 4.1, 6.1, 6.2, 7.1, 8.1, 8.2, 9.3	Ongoing through 2027
Evaluate effectiveness of adaptive BMPs and adjust or adapt as needed to benefit the species and its habitat.	Medium	2.3, 4.1, 6.1, 6.2, 7.1, 8.1, 8.2, 9.3	Ongoing every 3-5 years
Broad Strategy: Communication, Collaboration and Engagement			
Develop and promote communication/outreach strategies for land-users, stakeholders, land managers and industry to address threats such as recreational activities (e.g., ATV/dirt bike use, trampling), indiscriminate use of herbicides, introduction of invasive alien species, etc., and to change perceptions of management tools such as prescribed burns and grazing.	Medium	2.3, 6.1, 7.1, 8.1, 8.2, 9.3	2020
Broad Strategy: Habitat Assessment, Management and Conservation			
Mitigate the impact of threats to populations and habitat by engaging landowners and land managers in voluntary stewardship agreements, conservation agreements, or fee-simple purchases, especially at high-risk or priority sites; promote or encourage continued stewardship.	High	All threats	Ongoing through 2027
Monitor and assess conservation agreements and stewardship arrangements in conserving habitat quantity and quality for the species.	Medium		2018 and every 3-5 years

Conservation Measures	Priority[a]	Threats[b] or Concern Addressed	Timeline
Mitigate threats and improve or maintain habitat by encouraging implementation of BMPs.	High		Ongoing through 2027
Integrate habitat management with that for other dune specialist species at risk; explore approaches already being used (Appendix B, Table B1).	Medium		Ongoing through 2027

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

[b] Threat numbers refer to the IUCN-CMP classification (see Table 2 for full threat names).

7. Measuring Progress

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

- All extant native populations in Canada, as well as any newly located or reconfirmed populations, are maintained or increased in the long-term.

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Appendix A: Summary of Hairy Prairie-clover Populations in Canada

Table A1. Summary of Hairy Prairie-clover populations in Canada.

COSEWIC Population Name (EO_ID)[1]	First Observed	Last Observed	Last Survey Year	Recent Survey Estimate [Year][2]	Highest Survey Estimate [Year][2]	Current Status	Threats[8]
SASKATCHEWAN							
Dundurn Sand Hills area							
Dundurn West [16025]	1981	2016	2016	>0 [2016]	>798 (2003)	Extant	8.2
Dundurn East [15945]	1975	2016	2016	>0 [2016]	>2,600 [2001]	Extant[3]	8.1 (Leafy Spurge), 8.2
Dundurn Proctor Lake [3006]	1981	2016	2016	>0 [2016]	>109,556 (2006)[6]	Extant	2.3, 4.1, 8.1 (Smooth Brome, Baby's Breath, Crested Wheatgrass), 8.2
Historical Dundurn [3833]	1975	1975	2005	0 [2005]	no count [1975]	Historical, Possibly Extirpated[5]	
Pelican Lake Sand Hills							
Mortlach/Caron [2090]	1955	2016	2016	15,348 [2016]	15,348 [2016]	Extant[3]	4.1, 8.1 (Smooth Brome, Leafy Spurge, Crested Wheatgrass), 8.2
Mortlach [16024]	1960	1960	1960	no count [1960]	no count [1960]	Historical[5]	
MANITOBA							
Brandon Sand Hills							
Shilo East [4973]	2007	2007	2007	9 [2007]	9 [2007]	Extant	6.2, 8.1 (Leafy Spurge)
Shilo Central [4974]	2007	2007	2007	>62 [2007]	>62 [2007]	Extant	6.2, 8.2
Spruce Woods Townsite [2430]	2001	2001	2001	>0 [2001]	no count [2001]	Extant[4]	

COSEWIC Population Name (EO_ID)[1]	First Observed	Last Observed	Last Survey Year	Recent Survey Estimate [Year][2]	Highest Survey Estimate [Year][2]	Current Status	Threats[8]
Treesbank [3273]	1953	2009	2009	>339 [2009]	>3,700 [2001]; 10,000 [2005][7]	Extant[3]	4.1, 6.2, 8.1 (Leafy Spurge, Smooth Brome)
Shilo Ridge Trail South [4971]	2006	2008	2008	>50 [2008]	>50 [2008]	Extant	
Shilo Ridge Trail [4972]	2007	2009	2009	>80 [2009]	>275 [2007]	Extant	6.2, 8.1 (Leafy Spurge)
Shilo Sewell Ridge [1163]	1991	2009	2009	no count [2009]	850 [2001]	Extant	4.1, 6.2, 8.1 (Leafy Spurge), 8.2
[6614]	2011	2011	2011	>661 [2011]	>661 [2011]	Extant	8.2
Spruce Woods, Spirit Sands [4] [3352]	1943	2013	2013	>1,929 [2013]	>2,480 [2012]	Extant[3]	4.1, 6.1, 6.2, 8.2
Glenboro [3793] [4]	1943	2014	2014	>2,438 [2014]	>2,438 [2014]	Extant[3]	3.2, 4.1, 6.1, 8.1 (Smooth Brome)
[6617]	2011	2014	2014	30 [2014]	373 [2011]	Extant	8.2
Lauder Sand Hills							
Lauder South [4833]	2001	2010	2010	>155 [2010]	>155 [2010]	Extant[4]	8.1 (Leafy Spurge)
Lauder East [6092]	2010	2010	2010	6 clumps [2010]	6 clumps [2010]	Extant	
Napinka [1384]	1975	1975	2000	0 [2000]	no count [1975]	Historical[5]	
[6671]	2011	2011	2011	2 [2011]	2 [2011]	Extant	8.1 (Smooth Brome), 8.2
Lauder West [3794]	1950	2014	2014	>413 [2014]	>2,266 [2001]	Extant[3]	2.3, 3.2, 4.1, 6.1, 8.1 (Leafy Spurge, Smooth Brome, Kentucky Bluegrass), 8.2 , 9.3

COSEWIC Population Name (EO_ID)[1]	First Observed	Last Observed	Last Survey Year	Recent Survey Estimate [Year][2]	Highest Survey Estimate [Year][2]	Current Status	Threats[8]
Lauder Sandhills [3955]	1951	2015	2015	>12 [2015]	>843 [2011]	Extant[3]	4.1, 8.1 (Leafy Spurge, Smooth Brome, Kentucky Bluegrass), roads, 8.2
Routledge/Oak Lake Sand Hills							
Routledge [2121]	2001	2011	2011	15 [2011]	>2,150 [2006]	Extant	6.1, 8.1 (Leafy Spurge)
Oak Lake Jiggins East [361]	2001	2005	2005	300-500 [2005]	300-500 [2005]	Extant	8.2
Oak Lake Jiggens Bluff [1501]	2001	2001	2001	175-200 [2001]	175-200 [2001]	Extant	8.1 (Leafy Spurge), 8.2
Oak Lake Jiggens South [3241]	2001	2014	2014	407 [2014]	407 [2014]	Extant[4]	8.1 (Leafy Spurge), 8.2
Portage Sand Hills							
Portage South [2934]	2001	2001	2001	100 [2001]	100 [2001]	Extant	
Portage South Central [4964]	2007	2007	2007	200 [2007]	200 [2007]	Extant	8.2
Austin [4271]	2004	2009	2009	>121 [2009]	>121 [2009]	Extant	6.1, 8.1 (Leafy Spurge, Kentucky Bluegrass)
Portage West [4836]	2005	2009	2009	>61 [2009]	>61 [2009]	Extant[4]	2.1, 8.1 (Kentucky Bluegrass, Smooth Brome), 8.2
Portage East [1043]	1999	2009	2009	>21 clumps [2009]	>21 [2009]	Extant	6.2, 8.1 (Leafy Spurge), 8.2
Portage Central [3541]	2000	2010	2010	>250 [2010]	1,477 [2000]	Extant[4]	6.2, 8.2
[6091]	2010	2014	2014	7 [2014]	7 [2014]	Extant	9.3

COSEWIC Population Name (EO_ID)[1]	First Observed	Last Observed	Last Survey Year	Recent Survey Estimate [Year][2]	Highest Survey Estimate [Year][2]	Current Status	Threats[8]
Outlying Populations							
Boissevain [869]	1975	1975	2000	0 [2000]	no count [1975]	Historical[5]	
Baldur [943]	1930	1930	2000	0 [2000]	no count [1930]	Historical[5]	

[1] EO_ID refers to the element occurrence identification number, as assigned by the Manitoba Conservation Data Centre (MB CDC) and Saskatchewan Conservation Data Centre (SK CDC) to indicate a distinct element occurrence based on NatureServe's habitat-based plant element occurrence delimitation guidance (NatureServe 2016c). For the purposes of this management plan, we are considering an element occurrence to be analogous to a population. It should be recognized that where we use the term "population", the COSEWIC report (2011) used the term "site". Population names used in the COSEWIC (2011) report were included in the table for cross-refence but it should be noted that due to factors such as some populations being merged with adjacent populations, it was difficult to match the COSEWIC population names with the current data and EO_ID. Values in the table are those known to Environment and Climate Change Canada as of April 2016 for Manitoba and September 2016 for Saskatchewan (SK CDC unpubl. data 2016, MB CDC unpubl. data 2015, Environment and Climate Change Canada unpubl. data 2016). Note that for the majority of populations, the estimates or counts are from only a few occurrences at each population, and therefore values presented here should not be interpreted as an estimate for the entire population and are likely underestimates. In addition, the data show that often counts or estimates are taken at different occurrences in subsequent years, or new occurrences are found in subsequent visits and added on to the estimates for a population. Therefore, it is difficult to compare estimates among years. Estimates or counts also vary among years depending on factors discussed in Sec 3.2 such as yearly fluctuations and use of different census techniques.

[2] If no counts or estimates were provided (e.g. surveyors collected area of occupancy information instead, or simply confirmed presence of plants and habitat), it is recorded here as 'no count' to indicate presence of Hairy Prairie-clover plants.

[3] There are some inaccurate and historical occurrences within this population which are not being considered as part of the population and distribution objectives at this time.

[4] There are some inaccurate occurrences within this population which are not being considered as part of the management objective at this time. With regards to Spruce Woods Townsite (2340) the whole population is being considered inaccurate.

[5] All occurrences within this population are historical; the population is not being considered for as part of the management objective at this time No Hairy Prairie-clover plants were re-located during surveys in these general areas. The location information provided in the reports or herbarium specimens for the historical populations are often vague or general, and as a result, it is difficult to know if the exact historical site has already been found in areas where the historical population is within a few kilometres of another population. The information for the historical Mortlach population (EO 16024) has a latitude/longitude close to towns of Mortlach and Caron with no other description was provided. It is unknown if the Hairy Prairie-clover was actually found near the towns, or if the towns were the nearest landmarks. Therefore, these historical sites may actually be part of the Morlach/Caron (2090) population. The historical Dundurn population (EO 3833) may have been extirpated due to the creation of a fireguard around Canadian Forces Base 17-Wing Detachment Dundurn.

[6] These values are based on counts made along transects situated in two sand dunes, and then extrapolating average density to the area of available suitable habitat on each sand dune; therefore, there are wide confidence limits (109,556 plants +/- 58,136 plants with 95% confidence interval). To view methods and confidence limits associated with the estimates, refer to the documents Godwin and Thorpe 2004, 2006 and 2007. There are occupied sand dunes within this population that weren't included in this estimate but no plant counts have been done for the majority of these in lieu of obtaining area of occupancy data; therefore, the estimate of population size is likely an underestimate.

[7]The MB CDC field report from 2005 (Foster and Hamel 2006) states that the population of Hairy Prairie-clover at Treesbank was approaching 10,000 plants that year. However, population estimates for many of the occurrences they visited at Treesbank in 2005 isn't recorded in the raw data that ECCC received from MB CDC (MB CDC, unpubl. data 2016). Therefore, both the 2001 raw data and 2005 report values are being reported.

[8] The threat of "dune stabilization" was reported in data sheets for almost all the populations (MB CDC unpubl. data 2015, SK CDC unpubl. data 2016), which as discussed in section 4.2 can be attributable to many factors (e.g. see threats 2.3, 7.1, 8.1, 8.2) including threat 11.1 (prolonged wet climatic periods) which wasn't listed under any particular population but would be relevant to all of them.

Appendix B: 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*[14]. 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[15] (FSDS) goals and targets.

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

A number of species rely on sand dunes or the surrounding area for their survival, including other federal species at risk (Table B1) and provincially rare species that co-occur with Hairy Prairie-clover. Most, if not all, of these species will benefit from conservation measures intended to conserve, improve, or maintain habitat for the benefit of Hairy Prairie-clover.

The potential for the management plan to inadvertently lead to adverse effects on other species was considered. Broad strategies for conservation of Hairy Prairie-clover include habitat management activities which may include things like prescribed burns, integrated weed management/ invasive alien plant control, grazing, and brush control of encroaching woody vegetation. Although these activities are aimed at maintaining or improving sand dune habitat, they may have the potential to minimally harm some species, at least in the short term. For the most part, managing for healthy native ecosystems will benefit non-target species, natural communities, or ecological processes. As a general rule, management actions that incorporate or mimic natural disturbance regimes are not likely to negatively impact the persistence of other native species particularly if the timing, intensity and frequency mimic natural processes (Samson and Knopf 1994). Conservation measures and beneficial management plans should strive to benefit as many species as possible and the ecological risks of any action must be considered before undertaking them in order to reduce possible negative effects. Efforts should be coordinated with recovery teams and organizations working in the dune ecosystem. This will ensure the most efficient use of resources, prevent duplication of effort and conflicts with research, and minimize negative impacts to species at risk. The broad strategies described in this management plan are expected

[14] www.ceaa.gc.ca/default.asp?lang=En&n=B3186435-1
[15] www.ec.gc.ca/dd-sd/default.asp?lang=En&n=F93CD795-1

to benefit the environment and not entail any significant adverse effects on other species at risk or biodiversity of sand dune ecosystems.

Table B1. Species at risk which co-occur in areas occupied by Hairy Prairie-clover.

Species Name	**SARA Designation**
Birds	
Loggerhead Shrike (*Lanius ludovicianus excubitorides*)	Threatened
Common Nighthawk (*Chordeiles minor*)	Threatened
Sprague's Pipit (*Anthus spragueii*)	Threatened
Reptiles	
Prairie Skink (*Plestiodon septentrionalis*)	Endangered
Amphibians	
Great Plains Toad (*Anaxyrus cognatus*)	Special Concern
Invertebrates	
Gold-edged Gem (*Schinia avemensis*)	Endangered
Dusky Dune Moth (*Copablepharon longipenne*)	Endangered
Ottoe Skipper (*Hesperia ottoe*)	Endangered
White Flower Moth (*Schinia bimatris*)	Endangered
Pale Yellow Dune Moth (*Copablepharon grandis*)	Special Concern
Vascular Plants	
Western Spiderwort (*Tradescantia occidentalis*)	Threatened
Smooth Goosefoot (*Chenopodium subglabrum*)	Special Concern