

**COSEWIC**  
**Assessment and Status Report**

on the

**Hairy Prairie-clover**  
*Dalea villosa*

in Canada



**SPECIAL CONCERN**  
2011

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



**COSEPAC**  
Comité sur la situation  
des espèces en péril  
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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## COSEWIC Assessment Summary

### Assessment Summary – November 2011

**Common name**

Hairy Prairie-clover

**Scientific name**

*Dalea villosa*

**Status**

Special Concern

**Reason for designation**

A perennial, herbaceous legume that inhabits sand dune landscapes within the prairies of south-central Saskatchewan and southwestern 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.

**Occurrence**

Saskatchewan, Manitoba

**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 Executive Summary

### Hairy Prairie-clover *Dalea villosa*

#### Wildlife species description and significance

Hairy Prairie-clover (*Dalea villosa*) is member of the Fabaceae (pea) family. It is a perennial with a woody taproot and stem base. Hairy Prairie-clover is a sand dune specialist and, as a nitrogen-fixing legume, would be an important source of nutrients in an otherwise somewhat impoverished habitat. In the United States, the species has been developed as a horticultural species.

#### Distribution

Hairy Prairie-clover is restricted to the Great Plains region of North America. In Canada it is distributed from south-central Saskatchewan to southwestern Manitoba and extends southward into the United States to New Mexico and Texas and eastward to Michigan. Within its Canadian range, it is found only in sand or sand dune complexes and so distribution is limited to these habitats. To date, it has been found in the areas of Dundurn Sand Hills and the Mortlach/Caron area in Saskatchewan and Lauder, Routledge, Carberry, Treesbank, and Portage Sandhills in Manitoba.

#### Habitat

Hairy Prairie-clover is found locally on active sand or sandhill blowouts although it also tolerates partially stabilized sandy sites. Habitat generally includes some element of open or active sand including old deltas of glacial lakes formed 10,000 to 17,000 years ago. During this time, all of the modern sites of Hairy Prairie-clover were connected by a series of glacial lakes and their spillways.

#### Biology

Hairy Prairie-clover is a warm-season species that is well-adapted to dry environments. Flowers appear in July-August and are insect-pollinated. Seed is set in late August to September and seed is dispersed by wind, rodents and deer. Deer are the major grazer, while sheep are the most threatening domestic grazer of Hairy Prairie-clover.

## **Population sizes and trends**

The largest known population exists in the Dundurn area, with roughly 110,000 plants. Sites in the Mortlach/Caron (SK), Shilo/Treesbanks (MB) and Lauder/Routledge (MB) areas each have on the order of 10,000 plants. A smaller population of approximately 2,000 plants occurs in the Portage Sandhills (MB). Total estimated Canadian population size is approximately 145,000. Trends are difficult to discern at this point because the majority of these populations have been found only in the past decade.

## **Threats and limiting factors**

The greatest threats to Hairy Prairie-clover are dune stabilization, in part due to changes in ecological processes such as fire suppression and disruption of natural grazing regimes, and the introduction and spread of invasive species. Many of the southern sites have been invaded by Leafy Spurge, and some are threatened by Smooth Brome and Crested Wheatgrass. Further, invasive species may be introduced through hay for deer feed. Recreational activities are problematic; in particular, unrestricted all-terrain vehicle activities and hiking are thought to have crushed plants. Also due to the nature of the sites, sand removal by humans results in a complete loss of habitat and presumably the seed bank.

## **Protection, status, and ranks**

The Hairy Prairie-clover is listed as Threatened under Schedule 1 of the Canadian *Species at Risk Act*, as of June 2003. In Saskatchewan, the plant has been protected since 1999 under *The Wildlife Act*. In Manitoba, Hairy Prairie-clover has been protected since July 2007 on all lands under the *Endangered Species Act*. The plant is protected also in Spruce Woods Provincial Park through the *Manitoba Provincial Park Act*. In Saskatchewan, the Dundurn Sand Hills population is partially protected because it occurs in 17-Wing Detachment Dundurn, which restricts public access.

A Recovery Strategy is being drafted identifying critical habitat. Within Saskatchewan, recommendations regarding Hairy Prairie-clover are listed in the *Saskatchewan Activity Restriction Guidelines*. On federal lands, recommendations regarding Hairy Prairie-clover are listed in the activity set-back distance guidelines for prairie plant species at risk.

Globally, both the full species and variety of Hairy Prairie-clover are ranked secure (G5T5) by NatureServe. Its national status in Canada is imperilled to vulnerable (N2N3), and in Saskatchewan it is ranked critically imperilled (S1). In Manitoba, it is ranked imperilled to vulnerable (S2S3). Hairy Prairie-clover is not on the IUCN Red List of Threatened Species.

The conservation status has not been assessed nationally in the United States by NatureServe or by 11 of the states where it occurs. In Montana, Iowa and Wyoming, it is ranked critically imperilled (S1); and in Wisconsin it is ranked imperilled (S2).

## TECHNICAL SUMMARY

*Dalea villosa*

Hairy Prairie-clover

Range of occurrence in Canada: MB, SK

Dalée velue

### Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines(2008) is being used). <i>Plants may be capable of reproduction at 2 years. A limited study recorded an annual mortality rate of &lt;5% of mature individuals indicating individual plants could be much older.</i>	Unknown but at least 2+ yrs
Is there an observed, continuing decline in number of mature individuals? <i>Lacks long-term monitoring data. Recent increases are the result of increased search effort.</i>	Unknown
Estimated percent of continuing decline in total number of mature individuals within 5 years.	Unknown
Suspected percent reduction in total number of mature individuals over the last 10 years.	Unknown
Suspected percent reduction in total number of mature individuals over the next 10 years.	Unknown
Suspected percent reduction in total number of mature individuals over any 10 year period, over a time period including both the past and the future.	Unknown
Are the causes of the decline clearly reversible and understood and ceased? <i>Declines in habitat have been documented due to dune stabilization, woody encroachment, impacts of invasive species and recreational activities. Declines in mature individuals have not been documented. Increasing numbers are the result of increased search effort.</i>	No
Are there extreme fluctuations in number of mature individuals?	No

### Extent and Occupancy Information

Estimated extent of occurrence	65,973 km <sup>2</sup>
Index of area of occupancy (IAO) (using 2 x 2 km grid). <i>This is likely an underestimate as more populations are believed to exist.</i>	344 km <sup>2</sup> +
Is the total population severely fragmented?	No
Number of "locations*" <i>The number of locations is not defined but is greater than 10 (a threshold number for COSEWIC's B assessment criterion). At least 28 separate sites are known.</i>	>10
Is there an observed continuing decline in extent of occurrence? <i>New sites continue to be discovered as a result of increased search effort.</i>	No
Is there an observed continuing decline in index of area of occupancy? <i>The known area of occupancy has increased in the past 10 years due to greatly increased survey effort.</i>	No
Is there an observed continuing decline in number of populations? <i>The number of known populations has increased in the past 10 years due to greatly increased survey effort.</i>	No
Is there an observed continuing decline in number of locations? <i>The number of known locations has increased in the past 10 years due to greatly increased survey effort.</i>	No

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\* See definition of location.

Is there an observed, inferred, or projected continuing decline in quality of habitat? <i>Habitat is subject to a past and projected reduction in area and quality due to increase of invasive exotic species and woody vegetation.</i>	Yes
Are there extreme fluctuations in number of populations?	No
Are there extreme fluctuations in number of locations*?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

**Number of Mature Individuals (in each population)**

<b>Population</b>	<b>N Mature Individuals</b>
Dundurn East	No estimate
Dundurn Proctor Lake	>109,556
Dundurn West	2,850
Mortlach/Caron	>11,682
Routledge	2,255
Oak Lake Jiggins Bluff	200
Oak Lake Jiggins South	No estimate
Oak Lake Jiggins East	500
Lauder Sandhills	>3,930
Lauder East	6
Lauder West	4,740
Lauder South	200
Spruce Woods townsite	No estimate
Shilo Sewell Ridge	1,190
Shilo Ridge Trail	275
Shilo Ridge Trail South	No estimate
Shilo Central	112
Shilo East	9
Spruce Woods	3,040
Glenboro	290
Treesbank	4,110
Portage West	>70
Portage South Central	200
Portage Central	1577
Portage South	100
Portage East	16
Austin	>150
New Site	2
Total	>147,000

**Quantitative Analysis**

Probability of extinction in the wild is at least 10% within 100 years.	Not done
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**Threats (actual or imminent, to populations or habitats)**

Major threats include the disruption of natural disturbance regimes including lack of grazing and fire disturbance needed to maintain early to mid-successional habitats in these sand dune systems, as well as invasive alien species, recreational activity, and sand removal.



**Rescue Effect (immigration from outside Canada)**

Status of outside population(s)? <i>Two subspecies are known for North America. Only subspecies villosa is known from Canada and is the most widespread taxon. It is not ranked over much of its range (11 states) but is listed as Endangered in Iowa, critically imperilled (S1) in Montana and Wyoming, and imperilled (S2) and Special Concern in Wisconsin.</i>	
Is immigration known or possible?	No
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada? <i>Given the declines in habitat quality, sufficient habitat is uncertain.</i>	Uncertain
Is rescue from outside populations likely?	No

**Current Status**

COSEWIC: Special Concern (November 2011)
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**Status and Reasons for Designation**

<b>Status:</b> Special Concern	<b>Alpha-numeric code:</b> Not applicable
<b>Reasons for designation:</b> A perennial, herbaceous legume that inhabits sand dune landscapes within the prairies of south-central Saskatchewan and southwestern 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.	

**Applicability of Criteria**

<b>Criterion A</b> (Decline in Total Number of Mature Individuals): Not applicable as there are no trend data and no apparent decline in the number of mature individuals.
<b>Criterion B</b> (Small Distribution Range and Decline or Fluctuation): Not applicable. Although the IAO is <500 km <sup>2</sup> , and would imply a possible endangered category under B2, and habitat quality and extent is declining, populations are not severely fragmented, there are >10 locations and the population is not subject to extreme fluctuations.
<b>Criterion C</b> (Small and Declining Number of Mature Individuals): Not applicable. There are >10,000 individuals in the Canadian population.
<b>Criterion D</b> (Very Small or Restricted Total Population): Not applicable. There are >1,000 individuals, the IAO is >20 km <sup>2</sup> , and there are >5 locations.
<b>Criterion E</b> (Quantitative Analysis): No quantitative analyses available.

## PREFACE

Most changes in Hairy Prairie-clover (*Dalea villosa*) information are due to greatly increased survey effort. Most known sites have been found to be more extensive, particularly in the Dundurn area where extensive survey work has been done, and many show increased population estimates. The previous total population estimate was well under 10,000; presently, it is known to be larger than the minimum estimate of 147,000 because there are many sites with no or incomplete population estimates.

New sites have been recorded in Portage Sandhills, near Austin, within Canadian Forces Base/Area Support Unit Shilo, and to the east of the previously known Mortlach site. Two sites reported as likely extirpated in the previous status report, Mortlach and Treesbank, are now known to have populations in the thousands.

Threats to the species remain the same: invasive exotic species, dune stabilization, recreational vehicle and trampling damage, roadway maintenance, and sand removal. Generally, loss of habitat to cultivation, which may have been an issue in the past, is not an issue because the present distribution doesn't overlap with lands considered to be useful for annual crops.

Research is underway on critical habitat, the effects of grazing, seed production, and genetic markers that will help our understanding of changes in range, which will all greatly aid our understanding of this species.



### COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

### COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

### COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

### DEFINITIONS (2011)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

\* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

\*\* Formerly described as "Not In Any Category", or "No Designation Required."

\*\*\* Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.



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The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

# **COSEWIC Status Report**

on the

## **Hairy Prairie-clover**

*Dalea villosa*

**in Canada**

2011

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## WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

### Name and classification

Scientific Name: *Dalea villosa* (Nutt.) Spreng. var. *villosa*

Synonyms: *Petalostemon villosus* Nutt.; *Kuhnistera villosa* (Nutt.) O. Kuntze

Common Name: Hairy Prairie-clover; Silky Prairie-clover; Dalée velue

Family: Fabaceae or Leguminosae (Legume or Pea) Family

*Dalea villosa* (Nutt.) Spreng. var. *villosa* is one of 62 species of the genus *Dalea* that occur in North America (USDA 2010) and one of only three *Dalea* that occur in Canada. Purple Prairie-clover *Dalea purpurea* (*Petalostomum p.*) and White Prairie-clover *Dalea candida* (*Petalostomum c.*) are the other *Dalea* species in Canada. The genus *Dalea* has 160+ species worldwide. (Cronquist 1981).

*Dalea* is named after Samuel Dale, 1659-1739, an English botanist and author on pharmacology (Bailey 1942). The species name *villosa* refers to the hairy foliage of the species. The variety *villosa* is the only variety that occurs in Canada. Variety *grisea*, occurs in Texas, Arkansas, and Louisiana (USDA 2010). For this reason, simply the genus and species names will be used in subsequent discussions.

### Morphological description

Hairy Prairie-clover is a perennial herb with a woody taproot and bushy, ascending or reclining stems that are 30-60 cm tall (Figure 1). The alternate, pinnately compound leaves are 2-4 cm long and have 9-21 linear leaflets which are 5-15 mm long (Looman and Best 1979; Great Plains Flora Association 1986). The foliage has numerous sunken glands and dense hairs, which gives it a silvery appearance (so silvery that, at a glance, small non-flowering seedlings can be mistaken for small *Artemisia* spp.; Figure 2). The exposed root and root crown may appear red-orange (USGS 2010) and adventitious shoots form along roots exposed by shifting sand, leading to the appearance of what may be mistaken for rhizomes or stolons (Great Plains Flora Association 1986; see Godwin and Thorpe 2006, for photo). Rooting depth is approximately 120 to 150 cm, and radial spread of roots is up to 75 cm (Weaver 1958).



Figure 1. Hairy Prairie-clover with stem reclining into open sand along old juniper stem. Inset close-up of pinnate, hairy leaf (photo credit: Heather Peat Hamm).





Figure 2. Young non-flowering Hairy Prairie-clover with bushy, soft, silvery appearance, similar to the colour and shape of Pasture Sage (*Artemisia frigida*) at a glance (photo credit: Heather Peat Hamm).

Pale-rose to purple flowers appear in July to late August and are densely crowded (50 to 100/spike) in cylindrical spikes 3-12 cm long at the ends of stems and branches (Figure 3). Flowers may occasionally be white. Each flower is 4-6 mm long and has 4 separate petals, a densely spreading, hairy, 5-lobed, cup-shaped calyx, and 5 stamens that are usually longer than the petals.



Figure 3. Dense, cylindrical flowering spike of Hairy Prairie-clover (photo credit: Heather Peat Hamm).

Hairy Prairie-clover reproduces primarily by seeds contained in small, narrowly egg-shaped, single-seeded pods (Neufeld pers. comm. 2010), which are 2-3 mm long and densely hairy (Figure 4). Seed is set in late August to September and dispersed by wind and small mammals (Smith 1998).



Figure 4. Seed head of Hairy Prairie-clover with some seeds still attached. Lower inset shows densely hairy pods; upper inset shows dark, bean-shaped seeds (photo credit: Candace Neufeld, Environment Canada).

The white petals and glabrous herbage of the White Prairie-clover quickly separate it from Hairy Prairie-clover. The Purple Prairie-clover has fewer leaflets, at most seven, that are linear not elliptic or oblong. Flowering spikes are denser and shorter, to about 5 cm long, and the plant is glabrous to sparingly hairy not silky-hairy throughout as in the Hairy Prairie-clover (Scoggan 1978).

### **Population spatial structure and variability**

The habitat requirements for Hairy Prairie-clover are such that isolated populations are separated by tens to hundreds of kilometres of unsuitable habitat in both Saskatchewan and Manitoba. Existing Hairy Prairie-clover sites mark the positions of old deltas of glacial lakes formed 10,000 to 17,000 years ago when all of the modern sites of Hairy Prairie-clover were connected by a series of glacial lakes and their spillways (SK CDC 2006). The retreat of glaciers and decline in glacial lakes left Hairy Prairie-clover habitats disconnected geographically.

Landscape genetic studies of Hairy Prairie-clover from 32 patches of Hairy Prairie-clover in Saskatchewan's Dundurn population have determined that genetic variability is high and likely not a conservation concern in those areas (Fu *et al.* 2011). Amplified fragment length polymorphism (AFLP) technique was used to assess genetic variation within and among patches in the population. Three AFLP primer pairs were used and 100 polymorphic AFLP bands were scored to genotype 610 Dundurn plants as well as 15 plants representing the composite North Dakota population. The Dundurn plants displayed 23% less AFLP variation than the North Dakota plants, but maintained a high level (91%) of AFLP variation within patches; only 9% of the variation was among-patch variation (Fu *et al.* 2011). Frequent seed dispersal by deer and pollen dispersal by bees at scales >2 km contributes to the relative lack of landscape variation, while the near obligate outcrossing (<3% selfing rate) contributes to the high within-patch variation (Henderson pers. comm. 2009). Further genetic studies would be helpful to determine if the isolated patches of Hairy Prairie-clover represent colonizing satellites of an expanding range, or fragmented remnants of a retracting and formerly more extensive range (Environment Canada 2009).

### **Designatable units**

In Canada, Hairy Prairie-clover occurs in geographically separated areas within one ecozone, the Prairies. The habitats used within these areas are similar and only one variety is recognized for the Hairy Prairie-clover in Canada; no information on other distinctions is available. This report thus treats the species as a single designatable unit in Canada.

### **Special significance**

Hairy Prairie-clover is a sand dune specialist and, as a nitrogen-fixing legume, would be an important source of nutrients in an otherwise somewhat impoverished habitat. Positive effects of nitrogen-fixing species on the growth and reproduction of other nearby plant species have been demonstrated in a sand dune environment (Shumway 2000). In the United States, the plant has been developed as a horticultural species (Lindgren *et al.* 2003).

## **DISTRIBUTION**

### **Global range**

Hairy Prairie-clover is a native species of the North American Great Plains region, occurring in two provinces in Canada and 15 U.S. states. Within these political boundaries, the occurrences are scattered based in part on the discontinuity of necessary habitat (USDA 2010). Hairy Prairie-clover ranges from its northernmost sites in south-central Saskatchewan and southwestern Manitoba southward throughout the central plains of the United States to New Mexico, Texas and eastward into Michigan (Scoggan 1978; Maher *et al.* 1979; USDA 2010) (Figure 5). Populations in the United

States that are closest to Canadian populations, include those at Medicine Lake National Wildlife Refuge in Montana (240 km from the Saskatchewan populations), and the J. Clark Salyer National Wildlife Refuge in North Dakota (100 km from the Manitoba populations). The species is not ubiquitous through this range but rather is generally found only in sandy or coarse-textured soils.

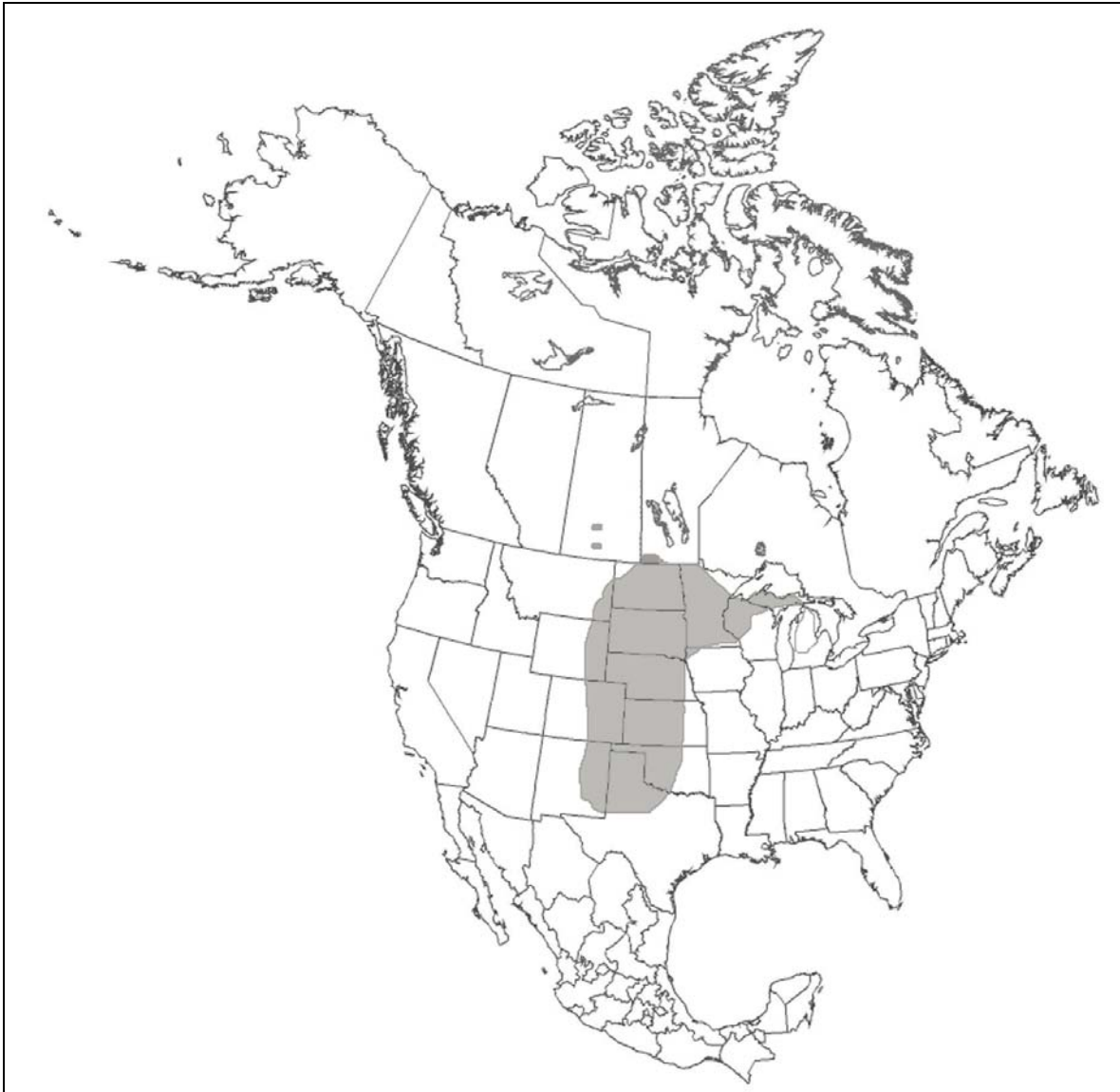


Figure 5. Known range of Hairy Prairie-clover in North America (permission granted for use by Candace Neufeld; source: Environment Canada, 2009).

No information is available on the abundance of Hairy Prairie-clover in the United States; however, USDA (USDA 2010) provides on-line maps of counties in which the species has been observed to occur.

## Canadian range

In Canada, the species is found in southwestern Manitoba and south-central Saskatchewan (Figure 6). It is restricted to a few sand dune complexes that encompass a total area of 1,571 km<sup>2</sup> (Table 1; Environment Canada 2009). The populations of Hairy Prairie-clover are not ubiquitous over the sandhill complexes; rather plants occur in disjunct patches within the complexes isolated by considerable distances of unsuitable habitat. Based on a 2 km by 2 km grid the index of area of occupancy (IAO) is 344 km<sup>2</sup> (Table 2.), although there is considerable additional habitat in Brandon Sandhills both inside and outside Canadian Forces Base/Area Support Unit (CFB) Shilo and within Spruce Hills Provincial Park that has yet to be searched, as well as habitat that is inaccessible and unsearched due to military training in the Dundurn area (Henderson pers. comm. 2011). Thus the true IAO may be considerably larger.

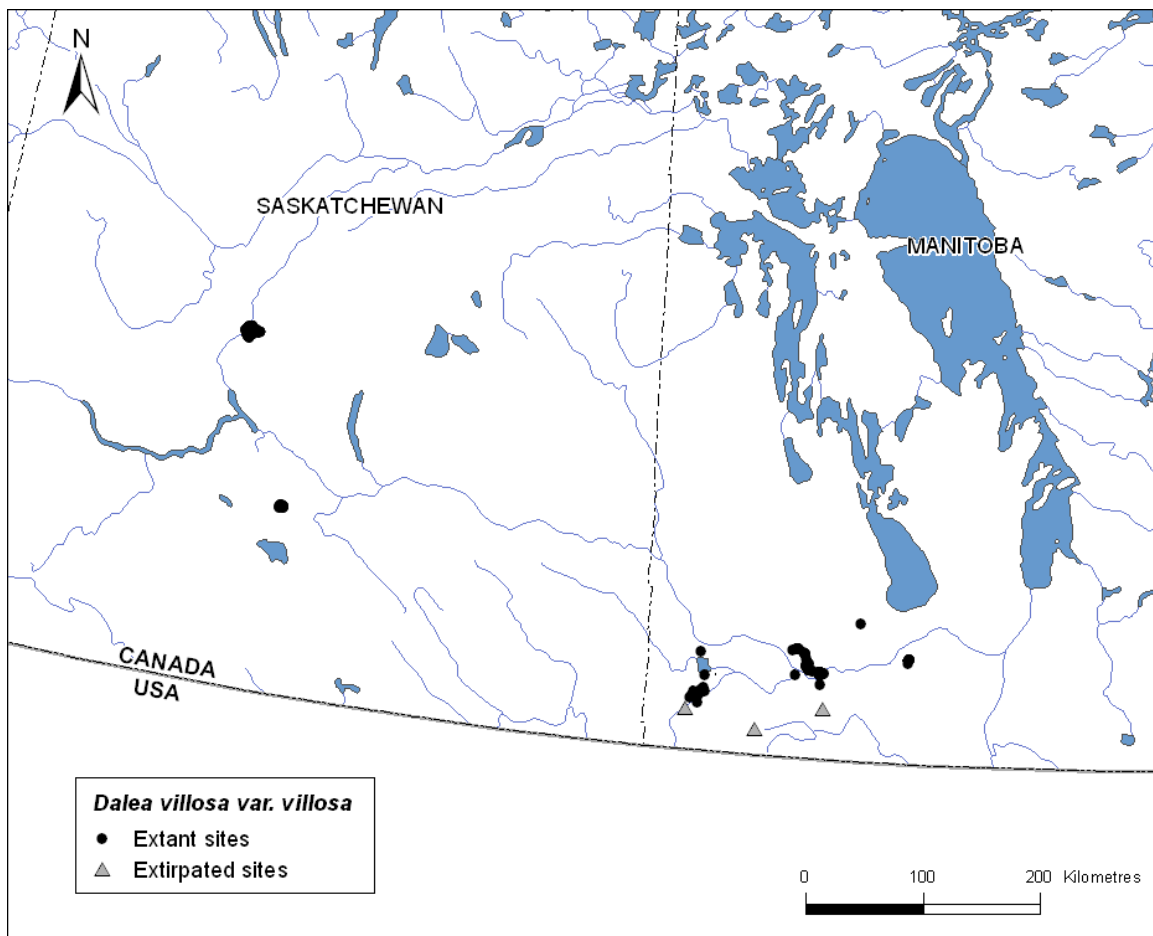


Figure 6. Canadian occurrences of Hairy Prairie-clover.

**Table 1. Extent of sandhill complexes in Canada containing Hairy Prairie-clover.**

Sandhill complex	Extent <sup>#</sup>	Occupied areas within complex	Area of occurrence
<b>Manitoba</b>			
Brandon	964 km <sup>2</sup>	Shilo/Treesbank Austin*	76 km <sup>2</sup> 4 km <sup>2</sup>
Lauder-Routledge-Oak Lake-Souris	198 km <sup>2</sup>	Lauder Routledge/Oak Lake	68 km <sup>2</sup> 28 km <sup>2</sup>
Portage	27 km <sup>2</sup>	Portage	20 km <sup>2</sup>
<b>Saskatchewan</b>			
Pelican Lake	73 km <sup>2</sup>	Mortlach/Caron	20 km <sup>2</sup>
Dundurn	312 km <sup>2</sup>	Dundurn	92 km <sup>2</sup>

<sup>#</sup> Based on Environment Canada 2009.

\* This site is an outlier but is closest to the Brandon complex.

**Table 2. Population estimates and index of area of occupancy (IAO) by site.**

Site	Present estimate	Most recent observation	Ownership	(IAO) (km <sup>2</sup> )*
<b>Dundurn Area</b>				
Dundurn West	2,850 <sup>#</sup>	2009	Federal AAFC-AESB	32
Dundurn Proctor Lake	109,556 <sup>#</sup>	2009	Federal AAFC-AESB	40
Dundurn East	No estimate	2003	Federal AAFC-AESB /DND	20
<b>Pelican Lake Area</b>				
Mortlach/Caron	>11,682	2009	Provincial/private	20
<b>Routledge/Oak Lake Area MB</b>				
Routledge	2,255	2006	Crown/ private	4
Oak Lake Jiggins Bluff	200	2001	Private/Crown	4
Oak Lake Jiggins South	No estimate	2007	Private/ROW	16
Oak Lake Jiggins East	500	2005	provincial	4
<b>Lauder Area MB</b>				
Lauder Sandhills	>3,930	2010	Private/ROW/ WMA	56
Lauder East	6	2010	?	4
Lauder West	4,740 <sup>#</sup>	2010	MHHC/RM/ private/Crown	28
Lauder South	200			12
<b>Brandon Sandhills Area MB</b>				
Spruce Woods townsite	No estimate	-	Private	4
Shilo Sewell Ridge	1,190	2005	DND	12
Shilo Ridge Trail	275	2007	DND	4
Shilo Ridge Trail South	No estimate	2006	DND	8
Shilo Central	112 <sup>++</sup>	2007	DND	16
Shilo East	9	2007	DND	4
Spruce Woods Provincial Park	3,040 <sup>++</sup>	2007	DND/ Prov. park	12
Glenboro	290	2001	Private	4
Treesbank	4,110 <sup>#</sup>	2008	Private/ROW	28

Site	Present estimate	Most recent observation	Ownership	(IAO) (km <sup>2</sup> )*
<b>Portage Sandhills Area MB</b>				20
Portage West	>70	2009	Private	4
Portage South Central	200	2007	Private	4
Portage Central	1577 <sup>#</sup>	2010	WMA	20
Portage South	100	2001	Private	4
Portage East	16	2009	WMA	4
Austin	>150	2009	Private	4
New Site -	2	2010		4
<b>Total Canadian population</b>	<b>&gt;147,060</b>			

\* Based on 2 km x 2 km blocks.

++ Based on encounters along transects only, and thus the total is an underestimation.

# Site has some patches for which there were no population estimates, and thus the total is an underestimation.

The number of locations is difficult to define for Hairy Prairie-clover, but with occurrences in at least 28 geographically separated sites, many with different ownership, management regimes, and threats, the number of locations is expected to be greater than 10 (a threshold number for COSEWIC's B assessment criterion). For this reason, detailed discussions of populations are referred to here as sites. It is highly unlikely that a single threatening event could impact the entire area of the population, as required by the IUCN definition (IUCN 2010). Finally, the main threats, invasive plants and habitat change, are general or broad-acting and may act too slowly to be useful for the definition of location. Most of the populations are in habitat patches that are large enough to support viable populations; therefore Hairy Prairie-clover is not considered to be severely fragmented.

The total extent of occurrence (EO) in Canada is 65,973 km<sup>2</sup>, which includes the unoccupied area between sites as well as the area occupied by Hairy Prairie-clover.

Three sites in Manitoba were originally included in the previous status report (Smith 1998) because these were listed as collection sites on three herbarium specimens. These sites have all been revisited and the available habitat has been searched, but no Hairy Prairie-clover was found (Manitoba Conservation Data Centre unpublished data). In some cases, the soil is entirely unsuitable for Hairy Prairie-clover, and it seems highly likely that the initial locations listed on herbarium sheets were imprecise (Figure 6). In the absence of better information these sites are not included in the EO calculation.



## **Search effort**

Since the last status report, considerable survey effort has been expended in both Manitoba and Saskatchewan. In Saskatchewan, the Mortlach/Caron site has been surveyed, partly in 2002 and the remaining large portion in 2009 (Vinge pers. comm. 2010). Within the Dundurn site, 200-300 person-days have been spent in finding and delineating the populations there (Henderson pers. comm. 2009). In Manitoba, observations were recorded on 37 different days in the past decade. Although the exact person-days are not known, on most occasions two people were listed on the observation data sheet; therefore, likely 74 person-days or more were spent searching for and field-mapping Hairy Prairie-clover (Manitoba Conservation Data Centre, unpublished data). Additionally, 36 person-days were spent surveying the central portion of the Shilo site (Golder 2007).

## **HABITAT**

### **Habitat requirements**

Hairy Prairie-clover occurs in the Moist Mixed Grassland ecoregion in Saskatchewan and the Lake Manitoba Plain and the Aspen Parkland ecoregions of Manitoba (MB CDC 2010; SK CDC 2010). Mean annual precipitation ranges from 350 mm to 535 mm, with the wetter sites being in Manitoba (Environment Canada 2010). Within these ecoregions, Hairy Prairie-clover occupies several sandhill complexes, characterized by active sand, stabilized blowouts, stabilized dunes, dune depressions and sand flats (Richards 1969). The species appears to be best adapted to active sand or sandhill blowouts (Harms 1990), although it is also found growing on partially stabilized sand in dune slack areas (Smith 1996). In-depth surveys at two of the Saskatchewan sites showed the occurrence of Hairy Prairie-clover to be associated with sparse cover of live vegetation and litter, moderate levels of bare soil, and level to low slope angles of southerly and westerly aspect (Godwin and Thorpe 2007). Similar habitat relationships have been noted in parts of the U.S. range by Box (1967), White (1971), and Tilman (1997).

Associated plants mainly include species that occur at the early to mid-successional stages of the transition from active to stabilized sand (Godwin and Thorpe 2004). The importance of some stabilization is suggested by a good population of Hairy Prairie-clover on a relatively steep slope that has become partially vegetated (Godwin and Thorpe 2004).

## Habitat trends

Determining habitat trends is difficult because changes in population size are a result of increased search effort and more accurate mapping of sites. In addition, sites have not been consistently monitored for long enough to accurately determine trends. The most significant habitat trend is encroachment by Leafy Spurge (*Euphorbia esula*). Numerous sites in Manitoba and some at Mortlach/Caron have Leafy Spurge (Manitoba Conservation Data Centre unpublished data; Elchuk 2002).

On a larger scale of habitat trends, dunes in the southern Canadian prairies have been stabilizing since the early to mid-1900s, possibly part of a larger trend in action since the 1700s (Wolfe *et al.* 2001; Hugenholtz and Wolfe 2005; Hugenholtz *et al.* 2010). Studies of increased stabilization in recent decades suggest that the trend is in response to recent climate variation, namely increased precipitation (Wolfe 1997; Hugenholtz and Wolfe 2005; Hugenholtz *et al.* 2010). In the Brandon Sandhills, area of open sand has decreased by about 60% in the southern area since 1947 and in the northern area has decreased by 91% in a similar period (Hugenholtz and Wolfe 2005).

## BIOLOGY

While Hairy Prairie-clover has been tested for agricultural and horticultural uses (Olmstead *et al.* 2001; Lindgren *et al.* 2003) very little basic study has been done on this species. A few new studies are underway on critical habitat, effects of herbivory, pollination, seedling recruitment, survival, genetics, and seed production (Henderson pers. comm. 2009; Lowe pers. comm. 2009) that will provide more information in the future.

### Life cycle and reproduction

Hairy Prairie-clover is a perennial with a woody taproot; however, there is very little information on generation time or the longevity of individual plants. Plants will mature and produce seed by at least age two (Benders *et al.* 2000). Ramets produced from buds on lateral roots up to a metre from the parent plant are also a common feature of Hairy Prairie-clover in Canada. Mature plants flower annually in July and August and seed is produced in late August and September in the form of a single small brown seed per floret (Environment Canada, unpublished data). There are no published studies quantifying longevity, dormancy, or the seed bank for Hairy Prairie-clover; however, vegetative dormancy has been noted when spring temperature or precipitation is low, wherein plants fail to emerge in spring but emerge later or in subsequent year (Neufeld pers. comm. 2011). Seed addition experiments by Tilman (1997), using a one-time seeding rate of 2,500 seeds per square metre in tallgrass prairie where Hairy Prairie-clover was absent, resulted in 30% of sites becoming occupied after four years and plants achieving an average cover of 0.5% across all sites. This implies, for the tallgrass prairies sites, the species was limited by dispersal or seed bank.

Hairy Prairie-clover is insect-pollinated as is common with other *Dalea* spp. (Center for Plant Conservation 2010). Pollination in the closely related Purple Prairie-clover is primarily xenogamous, with out-crossing yielding the best seed but self-pollination possible as well (Cane 2006). Pollinator exclusion studies in the Dundurn Sand Hills indicate a similar pattern in Hairy Prairie-clover, with 45-50% of florets fertilized in the presence of pollinators, but only 2-5% fertilized where pollinators were excluded (Henderson pers. comm. 2011).

A study of germination at varied temperatures showed Hairy Prairie-clover to be tolerant of higher germination temperatures (30°C) than Purple or White prairie-clover (Schellenberg *et al.* 2010). A study of an array of species being considered as cover crops found emergence of Hairy Prairie-clover to be very poor in a cropping situation (Olmstead *et al.* 2001); however, the conditions were very different than the semi-stable sand that it favours.

### **Adaptability**

Hairy Prairie-clover is considered a warm-season legume, well adapted for xeric environments (Craine *et al.* 2002). Containerized plants that were subject to artificial drought by restricting soil water contents below the wilting point until shoots senesced, were able to recover and regrow when water was added (Potter 1953). A similar “resurrection” of plants has been observed multiple times in the Dundurn populations between 2008 and 2010 (Henderson pers. comm. 2011).

Hairy Prairie-clover has been developed as a horticultural species and is recommended as a native alternative to numerous invasive exotics (Lindgren *et al.* 2003; University of Texas at Austin 2009). Clearly then, it is able to grow in soils other than the sand in which it exists naturally in Canadian sites and thus is somewhat adaptable and amenable to cultivation in unnatural conditions. Given the above, it seems reasonable that the species could be artificially propagated and re-introduced to sites.

### **Dispersal**

While it is generally thought that Hairy Prairie-clover is wind and rodent-dispersed, few data are available. Godwin and Thorpe (2007) found stashes of seed heads by a rodent (presumed microtine) burrow, implying that rodents aid in dispersal. In the Dundurn Sand Hills, both Mule Deer (*Odocoileus hemionus*) and White-tailed Deer (*Odocoileus virginianus*) are the primary herbivores on Hairy Prairie-clover, and the proportion of plants browsed increases to 80% at the time seed ripens. Because deer are mainly feeding on the flowering stems and seed heads, it is assumed deer are the major vectors for dispersal in that sand dune complex (Henderson pers. comm. 2011). Given that deer in this region are capable of long-distance (>100 km) dispersal and migratory movements in periods of as little as 24 hours (Skelton 2010), it is possible that deer are responsible for the historic long-distance colonization of sand dune complexes by Hairy Prairie-clover.

## **Interspecific interactions: herbivory**

Grazed specimens of Hairy Prairie-clover have been observed in numerous sites (Mortlach Sheep Pasture: Elchuk 2002; plant uprooted by unknown grazer: Godwin and Thorpe 2007; collected seed heads by rodent burrow: Godwin and Thorpe 2007; presumed grazing by cattle: Godwin and Thorpe 2007). The extent to which grazing by domestic stock affects Hairy Prairie-clover is undocumented; however, in the Dundurn Sand Hills, a combination of field observations and image captures using remotely triggered infrared cameras in 2009 indicate deer are responsible for nearly all herbivory, with only the occasional plant getting clipped by hares (*Lepus americanus* and/or *L. townsendii*) or cattle. Deer typically clip off stems mid-way along the length, and only clip 60% of the stems on an individual plant. After three years of monitoring plants protected from or exposed to deer herbivory, there was no difference in mortality rates (Henderson pers. comm. 2011). In Texas, the naturally low cover of Hairy Prairie-clover in sandy mixedgrass prairie was reduced from 1% cover to a trace where it was subject to grazing during a drought (Box 1967).

Grazing by sheep seems to be the most threatening because a large number of plants were severely cropped in Mortlach Sheep Pasture (Neufeld pers. comm. 2010). Presently, it is estimated that a moderate level of grazing by cattle may be beneficial for Hairy Prairie-clover because it may indirectly help prevent complete stabilization of active dune sites by reducing other vegetation (Foster and Hamel 2006).

## **POPULATION SIZES AND TRENDS**

### **Sampling effort and methods**

Almost all previously known populations of Hairy Prairie-clover have been recognized as either remaining the same, increasing, or having been initially underestimated. Many new sites have been observed.

Survey efforts have been made more efficient by the use of satellite imagery, aerial photographs, remote sensing and GIS to delineate areas of habitat likely to contain Hairy Prairie-clover.

Populations are discussed in terms of sites. The site delineations used are those provided by the provincial Conservation Data Centre for Manitoba and by Environment Canada for Saskatchewan. Individuals are sometimes difficult to define because of the decumbent habit of Hairy Prairie-clover. To standardize Canadian population counts stems that are separated by 20 cm or more are considered separate plants (Foster and Hamel 2006). This approach seems to be common although often the plant counts are very rough estimates rather than complete counts of individuals (Table 2).

## Saskatchewan occurrences (Figure 7)

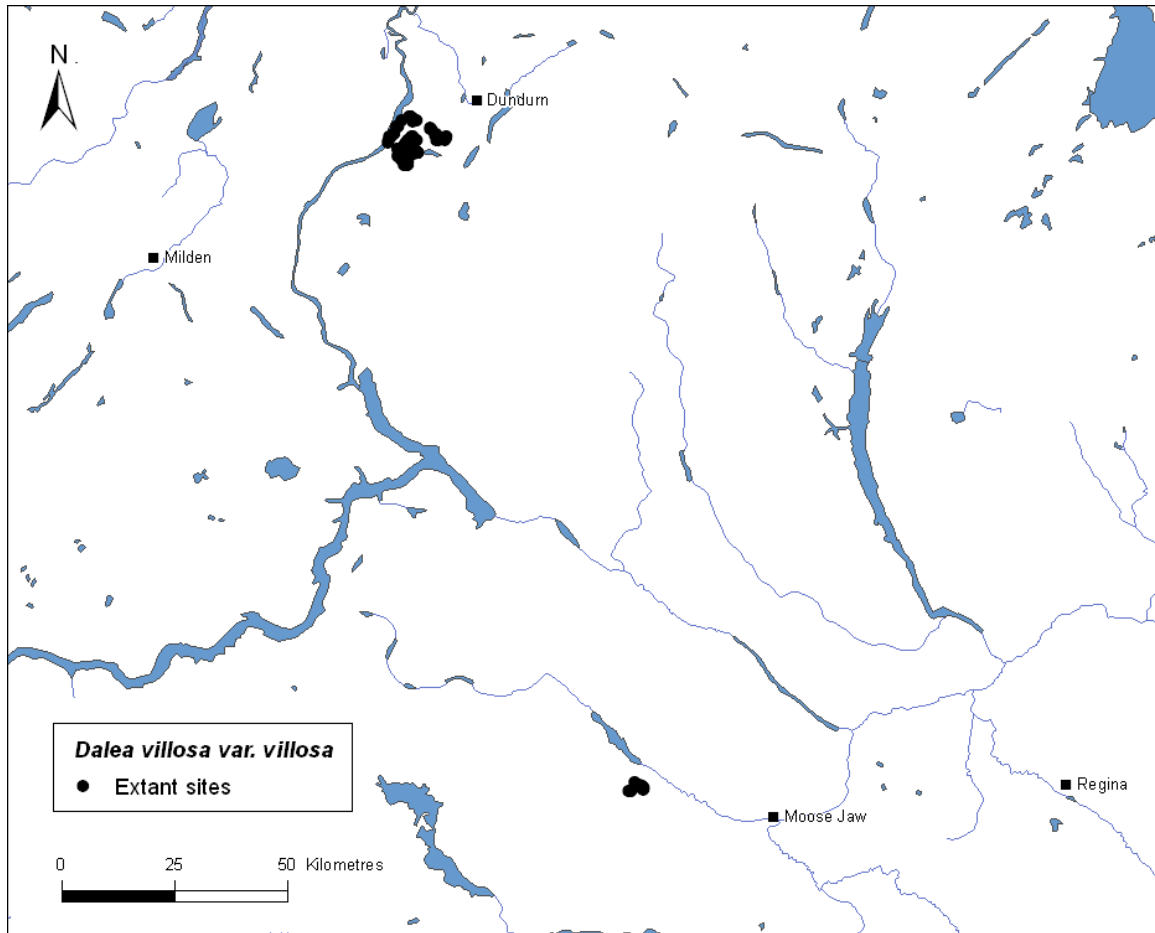


Figure 7. Saskatchewan occurrences.

### *Dundurn area*

The Dundurn populations have been subjected to considerable study since 2003 (200-300 person-days; Henderson pers. comm. 2009) The focus of a large part of the work is to identify critical habitat. In doing so, large numbers of populations have been identified and delineated. The methods (Neufeld pers. comm. 2010) employed the creation of a map of priority polygons to search, assuming that Hairy Prairie-clover occurred primarily in sand dune habitat as well as surrounding sandy grassland, juniper, gravel pavements and disturbed areas. Habitat was classified using two types of satellite imagery and two different remote sensing classification software, resulting in four different map layer products (pixel-based panchromatic 2.5 m resolution, object-oriented panchromatic 2.5 m resolution, pixel-based multispectral 10 m resolution, and object-oriented multispectral 10 m resolution). Resulting land cover classes were then sand dunes, saline, disturbed, grassland, aspen, or shrubs. For each map layer,

polygons identified as sand dunes were isolated, and a 30 m buffer around them was applied to include potentially suitable habitat for Hairy Prairie-clover. The four classification layers were overlaid and polygons that were classified as suitable habitat by all four classification schemes were identified and ranked as the highest priority for surveying. Similarly, polygons identified by three classification schemes were ranked as second priority, *et cetera*. In 2008, 2009 and 2010, the polygons identified as being the top two highest priorities were surveyed.

Surveys of the selected polygons were conducted on foot between July 15 and September 1, with observers walking three to five metres apart. The search area would extend a few metres into adjacent shrub cover to accommodate GPS and mapping error. Where Hairy Prairie-clover was found, the patch itself was delineated by including plants that were less than 30 metres apart as being part of the same patch. Once flagged temporarily, GPS track functions were used to map the patch perimeter. The Saskatchewan Conservation Data Centre (SK CDC) considers the Dundurn populations to fall into three sites, based on NatureServe guidelines (NatureServe 2004).

While this work does not provide direct population estimates, it provides area of occupancy data useful for critical habitat identification. Parallel efforts to estimate herbivory rates among patches resulted in collection of plant density information in 179 belt transects distributed across the Dundurn populations. The combination of area of occupancy and density data can be used to extrapolate a population size and measure of variation (Godwin and Thorpe 2004, 2006 and 2007). Rough population estimates were made for this area (Environment Canada 2009; Table 2).

#### *Pelican Lake - Mortlach/Caron area*

Subsequent to being reported as extirpated (Smith 1998), the Mortlach Sheep Pasture and an additional dune on adjacent private land were revisited in 2002 (Elchuk 2002). At that time, all suitable habitat was searched for Hairy Prairie-clover plants and the number of plants was estimated. All patches were within a single site. During that survey, Hairy Prairie-clover plants were found in a quarter-section where they were previously unrecorded.

In 2009, approximately 45 person-days were spent on occupancy surveys and estimating abundance in the easterly portion of the same site (Vinge 2010). These surveys were on quarter-sections where Hairy Prairie-clover had been observed previously. The perimeter of each patch was marked and mapped with GPS. A patch was defined, in this case only, by having a separation distance of no more than 30 metres between plants or by a significant change of habitat between plants (e.g., wetland, dense shrub patch) of at least 10 m (Nature Saskatchewan 2009). Following delineation of the area of occupancy, the number of plants present was counted or estimated. If the patch was small, all plants were counted; if the patch was large, the number of plants was counted in at least two random 1 m<sup>2</sup> quadrats per hectare and total numbers were estimated by extrapolation by the area of the patch.

Manitoba occurrences (Figure 8)

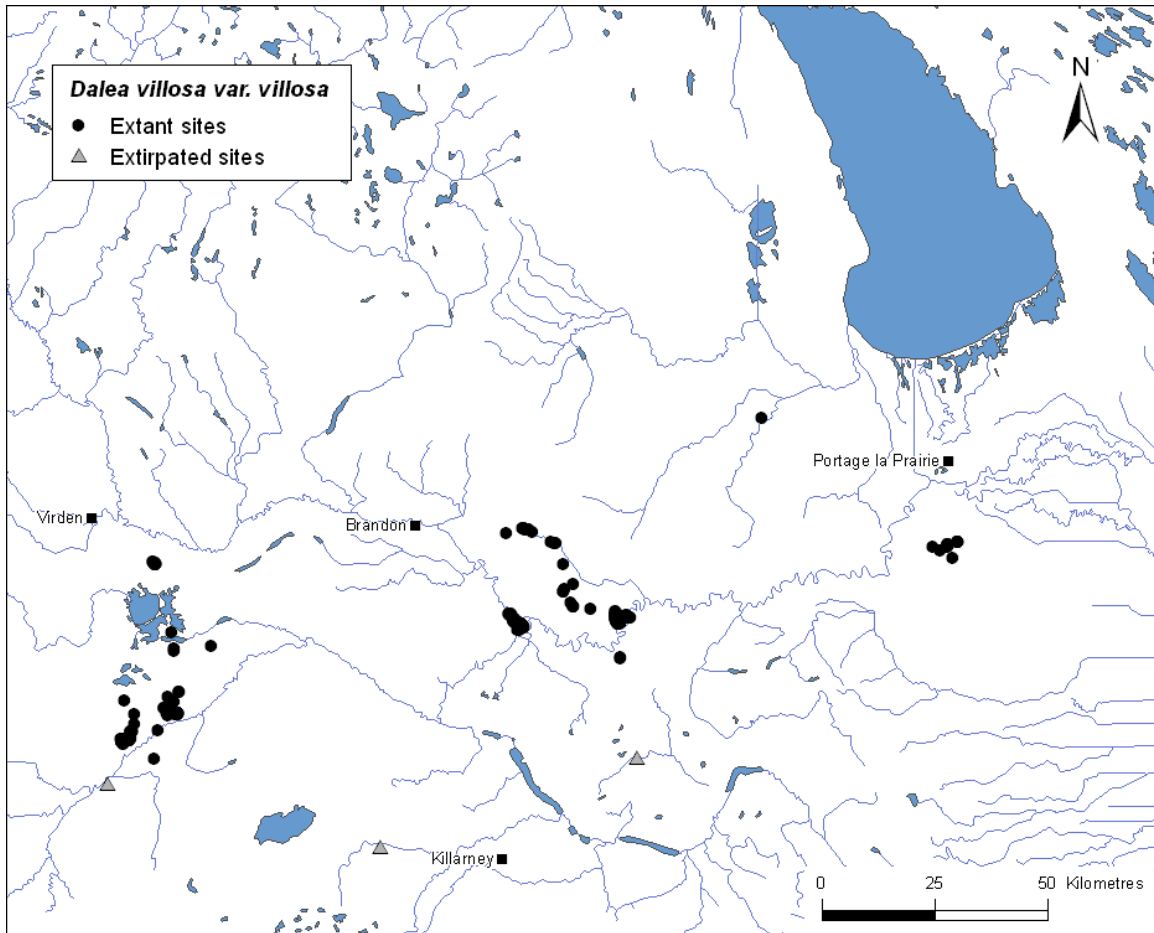


Figure 8. Manitoba occurrences.

*Lauder area*

Populations recorded in this area have been amalgamated into three sites. A new site, to the east of the hills, was located in June 2010. Lauder Sandhills has recorded observations from herbarium collections in 1950, 1951 and 1960. On twenty different occasions between July 1990 and July 2010, the Lauder sites were visited. Population estimates were made for three of the four sites.

*Routledge/Oak Lake area*

South Oak Lake sites have been visited four times between 2001 and 2007 and three sites have been observed, including population estimates for two of them. One site was estimated and mapped digitally in 2006.

### *Brandon - Shilo/Treesbank area*

This area contains nine sites over the areas of Treesbank (1 site), Shilo/Spruce Woods (7 sites) and Glenboro (1 site). The Glenboro site is the earliest recorded occurrence of Hairy Prairie-clover in the Manitoba Conservation Data Centre (MB CDC) records, found in 1943 and revisited in 1999 and 2001. The Treesbank site was visited five times between 2001 and 2009 and population size estimates were made of three of the patches. The Shilo/Spruce Woods is a sprawling area of Hairy Prairie-clover with seven sites between Spruce Woods Provincial Park and Shilo. A survey of CFB Shilo was attempted in 2007 wherein 250 500-metre transects were laid out to bisect landscape patterns created by sand dunes. Due to time constraints, only 158 of the transects were surveyed over the course of 36 person-days (Golder 2007) in an area >100 km<sup>2</sup> (Henderson pers. comm. 2011) making population size extrapolations on the basis of the designed survey difficult (in a study of the Dundurn site, it was calculated that 252 transects would need to be surveyed there in order provide an estimate and confidence limits that would be meaningful) (Godwin and Thorpe 2004). Population size has been estimated for four of the nine known sites.

### *Portage area*

Hairy Prairie-clover was recorded in the Portage Sandhills during 11 visits between 2000 and 2010. Population estimates have been made for four of the five sites.

### *Austin area*

An outlying population in the vicinity of Austin was discovered in 2004 during the course of the Mixed Grass Prairie Inventory and the population was estimated to be greater than 150 clumps in 2009. Another northerly outlying site was located in August 2010, although it is a small population with only two plants observed.

## **Abundance**

Population sizes, ownership, threats, and area of occupancy are estimated based on the best information available (Table 2). In some cases, where plant occurrence was noted without population size, the occurrence contributed zero to the total population size for the site. The population estimates for many sites are based on incomplete data; with some based on presence/absence and some on transect data and some on rough visual estimates. In all cases, the estimates are lower than the actual population sizes because most sites have some patches that are mapped but not counted.



## **Fluctuations and trends**

There has been no long-term monitoring of populations in Canada and so trends are unknown. At most populations, revisitation was intended to better delineate the occurrence or estimate the population size of Hairy Prairie-clover. Within the Dundurn site, a three-year monitoring project revealed no significant changes in population size from 2003 to 2005 (Godwin and Thorpe 2006). A subsequent monitoring project on a cohort of 200 mature plants from 2008 to 2010 indicated annual mortality rates were <5%, and an uncounted number of seedlings were present among populations in each of those years (Henderson pers. comm. 2011). Dormancy and/or regrowth following senescence, both due to drought stress, has been observed frequently among this cohort, such that minor fluctuations in populations up to 10% may be interpreted, and incorrectly so, if only two visits were made to a population.

A single site (Lauder West) has shown a marked decline in a small population that is recognized as being the subject of riverbank erosion, heavy grazing, and Leafy Spurge and woody encroachment, and thus it is not possible to determine trends.

## **Rescue effect**

Due to the disjunct nature of Canadian populations and the lack of intermittent suitable habitat, it is highly unlikely that Hairy Prairie-clover populations can be naturally recolonized from populations in the USA. The Medicine Lake National Wildlife Refuge population in Montana is approximately 240 km from the closest Canadian population, "Mortlach/Caron". Known populations in the J. Clark Slayer National Wildlife Refuge in North Dakota are approximately 100 km from the closest Canadian population, "Lauder South".

## **THREATS AND LIMITING FACTORS**

The number of locations is difficult to define for Hairy Prairie-clover (see **Canadian range**); however, although dune stabilization is broad-acting; the effects are not rapid enough to be considered a single threatening event, and dune stabilization depends on the management of the site.

## Dune stabilization

The greatest threat to Hairy Prairie-clover appears to decline in the absence of disturbance that creates partially active to active sand (Smith 1998). In Manitoba, the decline in the areal extent of open sand has been attributed to the lack of controlled burns or light grazing (Reimer and Hamel 2002). However, “the historical decline of sand dune activity in the southern Canadian prairies involves a multitude of factors and different spatio-temporal scales. While a variety of local factors may enhance or slow this trend, climate is the main driver of dune activity at the regional scale and appears to be the most significant factor forcing the landscape towards a vegetation-stabilized state.” (Hugenholtz *et al.* 2010).

Encroachment by native woody species has been noted as a threat in seven sites in Manitoba, three of them in the Portage Sandhills area (Table 2). In most cases, Trembling Aspen (*Populus tremuloides*) is responsible, although Chokecherry (*Prunus virginiana*), juniper (*Juniperus horizontalis*, *J. communis*), and Bur Oak (*Quercus macrocarpa*) may also be problematic. Dune stabilization generally (not specifically by woody species) is a threat in two other sites in Manitoba (Shilo Ridge Trail and Oak Lake Jiggins Bluff). Woody encroachment has been reported to decrease under fire (Moss 1932). Two other *Dalea* spp. have been shown to increase following fire (Towne and Knapp 1996).

In one case, at the Glenboro site, managed dune stabilization using site plantings is a threat to Hairy Prairie-clover.

## Invasive exotic plant species

Invasive exotic species are the most common threat to the persistence of Hairy Prairie-clover. Leafy Spurge is the most commonly reported invasive exotic plant. In 11 of 25 sites in Manitoba, generally in the most western sites, Leafy Spurge has been observed and recorded as a present or potential threat. In the Mortlach/Caron sites in Saskatchewan, Leafy Spurge is also present and a threat. The effects of Leafy Spurge infestations on native prairie result from the plant’s ability to displace existing vegetation; Leafy Spurge expansion leads to a decline in native plant species (Government of Saskatchewan 2008). Leafy Spurge is generally avoided by cattle and horses but, if ingested, may be fatal. Sheep and goats are not affected by the toxic latex in the plant (Government of Saskatchewan, 2008). Sheep and goats can reduce Leafy Spurge infestations; however, sheep are also known to graze Hairy Prairie-clover and may spread Leafy Spurge seeds (Olson *et al.* 1997). In Manitoba, 95% of Leafy Spurge occurrences within the study area were associated with human disturbances such as fireguards or vehicle tracks, implying it was easier for Leafy Spurge to establish in areas with more exposed soil (Wilson and Belcher 1989; Environment Canada 2009).

At the Glenboro site, Smooth Brome (*Bromus inermis*) was reported as a threat (MB CDC, unpublished data) and Crested Wheatgrass (*Agropyron cristatum*) was reported as a threat from the Dundurn site in Saskatchewan (Environment Canada 2009). In addition, two sites in the Lauder area and one in the Portage area were threatened or potentially threatened by the practice of feeding domestic hay to either cattle or wild ungulates; this practice can, and in one case has, introduced exotic invasive species to Hairy Prairie-clover sites. Invasive species have the potential to outcompete and/or reduce available habitat for Hairy Prairie-clover.

## **Overgrazing**

The effect of grazing on Hairy Prairie-clover has not been directly researched, although studies are underway (Henderson pers. comm. 2009). In the Dundurn Sand Hills, deer are recognized as the primary grazers of Hairy Prairie-clover (see **Dispersal** above), even though cattle range in the area. Grazing by cattle may not be a direct issue for Hairy Prairie-clover as cattle seem not to graze it readily (Godwin and Thorpe 2004). It may, however, be an indirect issue because of the shift in species that accompanies overgrazing (e.g., increase of Pasture Sage (*Artemisia frigida*); MB CDC unpublished data). Light to moderate levels of grazing, however, are important in maintaining active dune sites as it reduces the stabilizing vegetation (Foster and Reimer 2007; Environment Canada 2009).

There is evidence that sheep readily graze Hairy Prairie-clover (Neufeld pers. comm. 2010) and so overgrazing by sheep is a distinct threat to Hairy Prairie-clover, reducing its vigour if persistent. The Mortlach site is the most likely to be threatened by sheep overgrazing.

At Lauder, heavy grazing or trampling by cattle has been perceived to be a threat by contributing to riverbank erosion and thereby threatening Hairy Prairie-clover.

## **Recreation**

Hiking and the use of recreational vehicles is a threat in five sites in Manitoba, primarily in the eastern areas of Portage, Spruce Woods and Glenboro. At Spruce Woods Provincial Park, hiking is not restricted to the trails, and tours by horse-drawn wagon are offered from mid-May to early September (Smith 1998). All-terrain vehicles have been reported as threats in Manitoba at the Austin and Glenboro sites as well as the Portage and Lauder sandhills (Smith 1998; MB CDC unpublished data). While disturbance may reduce stabilization to a degree, both of these activities can cause physical damage to plants, which may result in decreased vigour and death. Additionally, all-terrain vehicle trails and human disturbances such as these can be vectors of movement for invasive species (Rooney 2005).

## Road maintenance and sand removal

In Manitoba, Hairy Prairie-clover has been found along roadsides, and road maintenance activities have threatened Hairy Prairie-clover in Glenboro and Lauder Southwest. Roadside mowing and spraying are both threatening to Hairy Prairie-clover (Foster and Hamel 2006) and any roadside rebuilding may entirely wipe out the roadside populations. Heavy machinery has reportedly crushed Hairy Prairie-clover plants, and haying or mowing equipment defoliated or uprooted plants (Hughes 2001). These sandy roadsides may be important vectors of movement for Hairy Prairie-clover where other habitat has been lost.

Because of the sandy nature of Hairy Prairie-clover habitat, sand removal by people for use elsewhere is a threat. In two sites in Manitoba (Glenboro and Lauder Southwest), sand removal has been observed in the vicinity of Hairy Prairie-clover patches. Some plants or entire patches may have already been lost to this threat.

Oil and gas development is not considered a threat for this species other than the threat of sand extraction for road development which is purely speculative.

## PROTECTION, STATUS, AND RANKS

### Legal protection and status

Hairy Prairie-clover is listed as Threatened under Schedule 1 of the Canadian *Species at Risk Act* (SARA) (5 June 2003). A Recovery Strategy is presently being drafted identifying critical habitat (Environment Canada 2009). On federal lands, recommendations regarding Hairy Prairie-clover are listed in the activity set-back distance guidelines for prairie plant species at risk (Henderson 2010).

In Saskatchewan, the plant has been protected since 1999 under the *Wildlife Act*, which means protection is afforded on private, provincial, and federal lands, and it is unlawful to pick or collect any part of the endangered plant, including seeds, without a special permit (Government of Saskatchewan 2010). In Manitoba, Hairy Prairie-clover has been protected since July, 2007 on all lands under the *Endangered Species Act*. The plant is protected also in the Spruce Woods Provincial Park through the *Manitoba Provincial Park Act*. In Saskatchewan, the Dundurn Sand Hills population is partially protected because it occurs in 17-Wing Detachment Dundurn, which restricts public access. Military activities are ongoing on most of 17-Wing Detachment Dundurn land; however, the military land where Hairy Prairie-clover has recently been found is used for grazing by AAFC-AESB (Agriculture and Agri-Food Canada – Agri-Environment Services Branch) with no plans for use by the military (Environment Canada 2009).

Within Saskatchewan, recommendations regarding activities in close proximity to Hairy Prairie-clover are identified in the Saskatchewan *Activity Restriction Guidelines* (SK CDC 2003).

### **Non-legal status and ranks**

The global status of both the species and variety of Hairy Prairie-clover is secure (G5T5). Its national status in Canada is imperilled to vulnerable (N2N3) and in Saskatchewan, it is ranked critically imperilled (S1). In Manitoba, it is ranked imperilled to vulnerable (S2S3) (NatureServe 2011). Hairy Prairie-clover is not on the IUCN Red List of Threatened Species.

The conservation status has not been assessed nationally in the United State, or in 11 of the states in which it occurs (Colorado, Kansas, Michigan, Minnesota, Missouri, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, and Texas). In Montana and Wyoming it has received a status of critically imperilled (S1) in Wisconsin imperilled (S2) (NatureServe 2011). It has a state listing of Endangered in Iowa (Parks, Recreation, and Preserves Division 1994) and state status of Special Concern in Wisconsin (University of Wisconsin, 2010; Wisconsin Department of Natural Resources 2010).

### **Habitat protection and ownership**

Hairy Prairie-clover exists in the full range of land ownership situations, including private, provincial parks, provincial Crown land, and Manitoba Habitat Heritage Corporation lands. There are also lands under federal jurisdiction managed by the Department of National Defence and Agriculture and Agri-Food Canada including Prairie Farm Rehabilitation Administration (PFRA) lands. Hairy Prairie-clover habitat is protected from off-road vehicles and all resource extraction within the Portage Sandhills Wildlife Management Area (WMA) and Manitoba Habitat Heritage Corporation land, and from all resource extraction, except petroleum, in the Lauder Sandhills WMA. Hairy Prairie-clover is protected partially from habitat loss and public disturbance in the Dundurn and Rudy-Rosedale PFRA pastures.

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## INFORMATION SOURCES

- Bailey, L.H. 1942. The Standard Cyclopedia of Horticulture. Vol.1. MacMillan Company, New York.
- Benders, M.H., J.M. Baskin, and C.C. Baskin. 2000. Age of maturity and life span in herbaceous polycarpic perennials. *Botanical Review* 66:311-349.
- Bohnen, J.L., and A.M. Hanchek. 1994. Flowering and seed yield in three species of prairie plants. *HortTechnology* 4(3):255-259
- Box, T.W. 1967. Influence of drought and grazing on mortality of five west Texas grasses. *Ecology* 48:654-656.
- Cane, J.H. 2006. An evaluation of pollination mechanisms for purple Prairie-clover, *Dalea purpurea* (Fabaceae: Amorphaeae). *The American Midland Naturalist* 156(1):193-197
- Center for Plant Conservation, 2010. CPC National Collection Plant Profile. Web site: [http://www.centerforplantconservation.org/collection/cpc\\_viewprofile.asp?CPCNum=1350](http://www.centerforplantconservation.org/collection/cpc_viewprofile.asp?CPCNum=1350) [accessed April 21, 2010].
- Craine, J.M., D. Tilman, D. Wedin, P. Reich, M. Tjoilker, and J. Knops. 2002. Functional traits, productivity and effects on nitrogen cycling of 33 grassland species. *Functional Ecology* 16:563-574.
- Cronquist, A. 1981. An Integrated system of classification of flowering plants. Columbia University Press, New York. 1242 pp.
- Elchuk, C. 2002. Rare Plant Rescue 2002 Report. Nature Saskatchewan: Regina, SK. 14 pp.
- Environment Canada. 2009. Draft recovery strategy for Hairy Prairie-clover (*Dalea villosa* var. *villosa*) in Canada. *In* Species at Risk Act Recovery Strategy Series. Environment Canada, Ottawa. vi + 31 pp.
- Environment Canada, 2010. Climate Normals Web site: [http://climate.weatheroffice.gc.ca/climate\\_normals/index\\_e.html](http://climate.weatheroffice.gc.ca/climate_normals/index_e.html) [accessed April 15, 2010].
- Foster, C. 2008. Rare Plant Surveys and Stewardship Activities by the Manitoba Conservation Data Centre, 2007. MS Report 08-01. Manitoba Conservation Data Centre, Winnipeg, Manitoba. 35 pp.
- Foster, C., and C. Hamel. 2006. Rare Species Surveys of the Manitoba Conservation Data Centre, 2005. MS Report 06-01. Manitoba Conservation Data Centre, Winnipeg, Manitoba. 43 pp.
- Foster, C., and E. Reimer. 2007. Rare Plant Surveys by the Manitoba Conservation Data Centre, 2006. MS Report 07-01. Manitoba Conservation Data Centre, Winnipeg, Manitoba. 53 pp.

- Fu, Yong-Bi, G.W. Peterson, and K.W. Richards. 2011. Genetic diversity in remnant patches of the threatened hairy prairie clover (*Dalea villosa* var. *villosa*) in the Canadian Prairie: implications for conservation. Botany (submitted on March 8, 2011)
- Godwin, B., and J. Thorpe. 2004. Limited report: PFRA rare plant inventory pilot project. SRC Publication No. 11673-1E04. Environment and Minerals Division, Saskatchewan Research Council, Saskatoon, SK.
- Godwin, B., and J. Thorpe. 2006. Limited report: Plant species at risk surveys in Elbow, Dundurn and Rudy-Rosedale PFRA pastures, 2005. SRC Publication No. 11997-1E06. Environment and Minerals Division, Saskatchewan Resource Council. Saskatoon, SK.
- Godwin, B., and J. Thorpe. 2007. Limited report: Targeted surveys for plant species at risk in Elbow, Dundurn, and Rudy-Rosedale AAFC-PFRA Pastures, 2006. SRC Publication No. 11997-1E07.
- Golder Associates. 2007. Survey for plant species at risk on Canadian Forces base Shilo, Manitoba 2007. Golder Associates: Saskatoon 17pp.+Appendices.
- Government of Saskatchewan, 2005. Biological control of leafy spurge. Web site: [http://www.agriculture.gov.sk.ca/Biological\\_Control\\_Leafy\\_Spurge](http://www.agriculture.gov.sk.ca/Biological_Control_Leafy_Spurge) [accessed April 20, 2010].
- Government of Saskatchewan, 2008. Reducing leafy spurge's impact by using sheep and goats. Government of Saskatchewan: Regina. 8pp.
- Government of Saskatchewan. 2010. Wild species at risk. Web site: <http://www.environment.gov.sk.ca/Default.aspx?DN=5297a6b8-fa52-4af8-8dbf-51196e37fc6a> [accessed April 30, 2010].
- Great Plains Flora Association. 1986. Flora of the Great Plains. University Press of Kansas, Lawrence, Kansas. 1392 pp.
- Harms, V.L. 1990. Rare native vascular plants in the Saskatoon area. Blue Jay 48(2):65-78.
- Heisler, J.L., J.M. Briggs, and A.K. Knapp. 2003. Long-term patterns of shrub expansion in a C4-dominated grassland: Fire frequency and the dynamics of shrub cover and abundance. American Journal of Botany 90(3): 423–428.
- Henderson, D.C. pers. comm. 2009. *Meeting (July 16, 2009) and subsequent email and telephone communication with H. Peat Hamm*. July, 2009 to February, 2010. Grassland Ecologist, Chair of the National Recovery Team for Prairie Plant Species at Risk, Environment Canada - Prairie & Northern Wildlife Research Centre, Saskatoon, Saskatchewan.
- Henderson, D.C. 2010. Set-back distance and timing restriction guidelines for prairie plant species at risk. Environment Canada, Prairie and Northern Region, Canadian Wildlife Service. Edmonton AB.

- Hugenholtz, C.H., D. Bender, and S.A. Wolfe. 2010. Declining sand dune activity in the southern Canadian prairies: Historical context, controls and ecosystem implications. *Aeolian Research* 2:71-82.
- Hugenholtz, C.H., and S.A. Wolfe. 2005. Recent stabilization of active sand dunes on the Canadian prairies and relation to recent climate variations. *Geomorphology* 68:131-147.
- Hughes, M. 2001. Summer 2001 Field inventories of three nationally rare plants in Manitoba: Small White Lady's Slipper, Western Spiderwort, Hairy Prairie-clover. Environment Canada, Canadian Wildlife Service and Biodiversity Conservation Section, Wildlife Branch, Manitoba Conservation, Winnipeg, Manitoba.
- IUCN Standards and Petitions Subcommittee 2010. Guidelines for using the IUCN Red List categories and criteria. Version 8.0. Prepared by the Standards and Petitions Subcommittee in March 2010. Web site: <http://intranet.iucn.org/webfiles/doc/SSC/RedList/RedListGuidelines.pdf>
- Lindgren, D.T., D.M. Schaaf, and J. Locklear. 2003. *Dalea villosa* 'Sandhills Satin.' *HortScience* 38(2):313-314.
- Looman, J., and K.F. Best. 1979. *Budd's Flora of the Canadian Prairie Provinces*. Publication 1662. Agriculture Canada, Ottawa.
- Lowe, S. pers. comm. 2009. *Email correspondence to H. Peat Hamm and telephone communication*. December 7-11, 2009. Graduate Student, University of Saskatchewan, Saskatoon, Saskatchewan.
- Maher, R.V., G.W. Argus, V.L. Harms, and J.H. Hudson. 1979. The Rare vascular Plants of Saskatchewan. National Museum of Natural Sciences. *Syllogeus* 20. National Museums of Canada. 81 pp.
- Manitoba Conservation Data Centre (MB CDC), 2010. Web site: <http://www.gov.mb.ca/conservation/cdc/ecoregions.html> [accessed April 19, 2010].
- Moss, E.H. 1932. The vegetation of Alberta. IV. The poplar association and related vegetation of central Alberta. *J. Ecol.* 20:380-415.
- Nature Saskatchewan. 2009. Rare Plant Rescue: Occupancy Search and Monitoring Protocols. 9 pp.
- NatureServe, 2002. Element Occurrence Data Standard. NatureServe. 201 pp.
- NatureServe. 2004. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Databases. Arlington, VA. U.S.A.
- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available <http://www.natureserve.org/explorer>. [accessed: March 1, 2011]
- Neufeld, C. pers. comm. 2010. *Meeting (July 16, 2009) and subsequent email and telephone communication with H. Peat Hamm*. July, 2009 to April, 2010. Grassland Ecologist, Environment Canada - Prairie & Northern Wildlife Research Centre, Saskatoon, Saskatchewan.



- Olmstead, M.A., R.L. Wample, S.L. Greene, and J.M. Tarara. 2001. Evaluation of Potential Cover Crops for Inland Pacific Northwest Vineyards. *American Journal of Enol. Viticulture* 52(4):292-303.
- Olson, B., R. Wallander, and R. Kott. 1997. Recovery of leafy spurge seed from sheep. *Journal of Range Management* 50:10-15.
- Parks, Recreation, and Preserves Division. 1994. Iowa's threatened and endangered species (20 October 2002). Iowa Department of Natural Resources, Iowa.
- Potter, L.D. 1953. Seedling Growth and Soil Drought Resistance of Northern Great Plains Legumes, Alfalfa and Four Grasses. *Journal of Range Management* 6: 399-404.
- Reimer, E., and C.D. Hamel. 2002. Rare species surveys of the Manitoba Conservation Data Centre, 2001. Manitoba Conservation Data Centre, Winnipeg, Manitoba. MS Report 02-02.
- Richards, J.H., ed. 1969. Atlas of Saskatchewan. University of Saskatchewan, Saskatoon. 236 pp.
- Rooney, T.P. 2005. Distribution of ecologically-invasive plants along off-road vehicle trails in the Chequamegon National Forest, Wisconsin. *The Michigan Botanist* 44:178-182.
- Saskatchewan Conservation Data Centre (SK CDC). 2003. Saskatchewan activity restriction guidelines for sensitive species in natural habitats. 3 pp. Web site: <http://www.biodiversity.sk.ca/Docs/SKactivityrestrictions.pdf> [accessed April 25, 2010].
- Saskatchewan Conservation Data Centre (SK CDC). 2006. Plant Characterization Abstract for Saskatchewan: *Dalea villosa* var. *villosa*. Web site: <http://www.biodiversity.sk.ca/docs/factshts/dalvilvil.pdf> [accessed March 25, 2011]
- Saskatchewan Conservation Data Centre (SK CDC), 2010. Ecoregions of Saskatchewan. Web site: <http://www.biodiversity.sk.ca/eco.htm> [accessed April 17, 2010].
- Schellenberg, M.P., D. Henderson, J. Bolton, and R. St-Pierre. 2010. Do the germination temperature characteristics of the species at risk hairy prairie clover (*Dalea villosa*) differ from the more common prairie clovers (*D. purpurea* and *candida*) found in the Canadian Prairies? 9th Prairie Conservations and Endangered Species Conference: Patterns of Change. Feb 25-27, 2010. Winnipeg, MB. Web site: <http://www.pcesc.ca/postercat5.html> [accessed April 18, 2010]
- Scoggan, H.J. 1978. Flora of Canada. Part 3. Publications in Botany, No. 7. National Museum of Natural Sciences. National Museums of Canada, Ottawa.
- Shumway, S.W. 2000. Facilitative effects of a sand dune shrub species growing beneath the shrub canopy. *Oecologia* 124:138-148.
- Skelton, N.K. 2010. Migration, dispersal, and survival patterns of mule deer (*Odocoileus hemionus*) in a chronic wasting disease-endemic area of southern Saskatchewan. MSc thesis. University of Saskatchewan. Saskatoon SK.

- Smith, B. 1996. Field observations, Alberta and Saskatchewan on *Dalea villosa* (Nutt.) Spreng.
- Smith, B. 1998. COSEWIC status report on the Hairy Prairie-clover *Dalea villosa* var. *villosa* in Canada, in COSEWIC assessment and status report on the Hairy Prairie-clover *Dalea villosa* var. *villosa* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-22 pp.
- Tilman, D. 1997. Community invisibility, recruitment limitation, and grassland biodiversity. *Ecology* 78:81-92.
- Towne, E.G., and A.K. Knapp. 1996. Biomass and density responses in tallgrass prairie legumes to annual fire and topographic position. *American Journal of Botany* 83(2):175-179.
- University of Wisconsin, 2010. Robert W. Freckmann Herbarium, University of Wisconsin - Stevens Point. Web site: <http://wisplants.uwsp.edu/scripts/detail.asp?SpCode=DALVILvVIL> [accessed April 19, 2010].
- University of Texas at Austin, 2009. Wildflower Center Plant Database. Web site: [http://www.wildflower.org/plants/result.php?id\\_plant=DAVI](http://www.wildflower.org/plants/result.php?id_plant=DAVI) [accessed December 13, 2009].
- USGS, 2010. Northern Prairie Wildlife Research Center: Native Wildflowers of the North Dakota Grasslands. Web site: <http://www.npwrc.usgs.gov/resource/plants/wildflwr/species/dalevill.htm> [accessed April 18, 2010].
- USDA, 2010. PLANTS Database. United States Department of Agriculture: Nature Resources Conservation Service. Web site: <http://plants.usda.gov/index.html> [accessed January and April, 2010].
- Vinge, S. 2010. Rare Plant Rescue 2009 Report: Habitat Stewardship of Rare Plant Species in Saskatchewan. Nature Saskatchewan: Regina 37pp.
- Vinge, S. pers. comm. 2010, *Email correspondence with H. Peat Hamm*. August, 19, 2009 to April, 22, 2010. Habitat Stewardship Coordinator, Nature Saskatchewan, Regina, Saskatchewan.
- Weaver, J.E. 1958. Classification of root systems of forbs of grassland and a consideration of their significance. *Ecology* 39:394-401.
- White, E.M. 1971. Some soil age-range vegetation relationships. *Journal of Range Management* 24:360-365.
- Wilson, S.D., and J.W. Belcher. 1989. Plant and bird communities of native prairie and introduced Eurasian vegetation in Manitoba, Canada. *Conservation Biology* 3:39-44.
- Wisconsin Department of Natural Resources. 2010. Endangered Resources Program Species Information, Silky Prairie-clover (*Dalea villosa* var. *villosa*). Web site: <http://dnr.wi.gov/org/land/er/biodiversity/index.asp?mode=info&Grp=20&SpecCode=PDFAB1A1Q0> [accessed April, 2010]

- Wolfe, S.A. 1997. Impact of increased aridity on sand dune activity in the Canadian Prairies. *Journal of Arid Environments* 36:421-432.
- Wolfe, S.A., D.J. Huntley, P.P. David, J. Ollerhead, D.J. Sauchyn, and G.M. MacDonald. 2001. Late 18th century drought-induced sand dune activity, Great Sand Hills, Saskatchewan. *Journal of Earth Science* 38:105-117.

### **BIOGRAPHICAL SUMMARY OF REPORT WRITER**

Heather Peat Hamm has worked in a variety of research situations, from trapping snakes and counting mosquitoes to drilling coral samples and counting seagrass. With her B.Sc. from the University of Saskatchewan, Heather worked for seven years as a pasture weeds technician for Agriculture Canada in Regina before returning to do graduate studies at University of Toronto. After completing an M.Sc. studying C3/C4 species shifts in Grasslands National Park, she briefly ventured to test out the watery research world of seagrass. Eventually returning to work on dry land, she took up doctoral studies at the University of Alaska, Fairbanks on competition for organic nitrogen in the soil. In frustration with lack of bridging between academia and action on the ground, she left her studies to start a freelance communication business focused on science communication. Between 2006 and 2010, Heather worked extensively on a pilot project to identify the effects, positive and negative, of agricultural practices on 14 prairie species at risk. Presently she works freelance, endeavouring at any chance to promote all things prairie. In her other life she is a writer, a musician and a luthier.