PROPOSED

Species at Risk Actl
Recovery Strategy Series

Recovery Strategy for the Western Spiderwort (*Tradescantia occidentalis*) in Canada

Western Spiderwort

2013

Canada

Recommended citation:

Environment Canada. 2013. Recovery Strategy for the Western Spiderwort (*Tradescantia occidentalis*) in Canada [Proposed]. *Species at Risk Act* Recovery Strategy Series. Environment Canada, Ottawa. iv + 36 pp.

For copies of the recovery strategy, or for additional information on species at risk, including COSEWIC Status Reports, residence descriptions, action plans, and other related recovery documents, please visit the Species at Risk Public Registry (www.sararegistry.gc.ca).

Cover Photo: Candace Neufeld © Environment Canada.

Également disponible en français sous le titre
« Programme de rétablissement de la tradescantie de l'Ouest (*Tradescantia occidentalis*) au Canada [Proposition] »

ISBN
Catalogue no.

PREFACE

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

The Minister of the Environment is the competent minister for the recovery of the Western Spiderwort and has prepared this strategy, as per section 37 of SARA. It has been prepared in cooperation with:

1) provincial jurisdictions in which the species occurs – Saskatchewan, Alberta and Manitoba
2) industry stakeholders – Canadian Cattlemen's Association
3) federal land managers –Agriculture and Agri-Food Canada – Agri-Environment Services Branch (previously known as Prairie Farm Rehabilitation Administration)

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

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

ACKNOWLEDGMENTS

The recovery strategy was prepared by Candace Neufeld (Environment Canada). Previous versions were prepared by Candace Neufeld and Darcy Henderson (Environment Canada). The Recovery Team for Plants at Risk in the Prairie Provinces provided valuable comments on various drafts of this document (see Section 11 for past and present members). Helpful comments on previous drafts were also provided by M. C. Bélair, M. Curteanu, M. Dube, M.J. Ribeyron, and M. Wayland of Environment Canada and K. Remarchuk (contractor). The Saskatchewan Conservation Data Centre, Alberta Conservation Information Management System and the Manitoba Conservation Data Centre provided updated element occurrences for this species. The co-operation of all the landowners, lessees and land managers who granted access to their land to do surveys is greatly appreciated.

EXECUTIVE SUMMARY

- Western Spiderwort is a perennial monocot with three-petaled purple flowers, grass-like foliage, and seeds in capsules. In Canada, it is associated with semi-arid sand dune complexes in all three Prairie Provinces. Currently there are four confirmed populations in Canada with two in Manitoba, one in Saskatchewan and one in Alberta. As of 2010, the Canadian population was estimated to be over 100,000 plants on 39 quarter sections with an index area of occupancy of 76 km^2. Western Spiderwort was listed as Threatened under the *Species at Risk Act* in 2005.

- Any additional loss of habitat among the known populations of Western Spiderwort would adversely affect the species' survival in Canada. Threats to Western Spiderwort are not the same across the range, but rather more pervasive in some populations than others. Current or potential future identified threats to Western Spiderwort include invasive alien species, alteration to, or suppression of, grazing and/or fire regimes, prolonged wet climactic period, incidental mortality from overgrazing by wildlife and domestic livestock, cultivation, sand and gravel extraction, road maintenance and construction, oil and gas activities and recreational activities.

- Recovery of Western Spiderwort is deemed biologically and technically feasible. The population and distribution objectives are to maintain and, if possible, increase the current estimated distribution of the existing naturally occurring populations and to similarly maintain and, if possible, increase the distribution of any newly-discovered naturally occurring populations. Specifically for each of the four existing populations the population and distribution objectives are to maintain mature individuals in at least 6 quarter sections of the Lauder Sand Hills in MB, 7 quarter sections of the Routledge Sand Hills in MB, 18 quarter sections of the Elbow Sand Hills in SK, and 8 quarter sections of the Pakowki Sand Hills in AB. Broad strategies to be taken to address the threats to the survival and recovery of Western Spiderwort are presented in the section on Strategic Direction for Recovery.

- Critical habitat is identified for all known naturally occurring Western Spiderwort populations in Canada. The primary habitat needed by Western Spiderwort consists of moderately sloped, partially stabilized sand dunes with patches of bare sand, as well as more stabilized dune slacks, rolling sand hills and grasslands. Critical habitat consists of all known occupied primary habitat patches, plus all natural landforms, soil and native vegetation within 300 m of the habitat patch.

- One or more action plans for Western Spiderwort will be completed by 2017.

RECOVERY FEASIBILITY

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

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

Yes. Currently, there are four naturally occurring Western Spiderwort populations known to exist in Canada which are successfully reproducing. Under similar conditions, individuals are likely to continue to reproduce and persist at these sites as they have historically. Further surveys of similar sand dune complexes may result in the discovery of additional occurrences or populations.

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

Yes. Suitable Western Spiderwort habitat exists at all sites where populations occur and with proper management the species can continue to persist. Fire suppression, altered grazing regimes, and invasion by invasive alien species and/or woody vegetation encroachment may contribute to habitat becoming less suitable over time. Beneficial management practices such as prescribed fire, timed grazing and control of invasive alien species have the potential to maintain and enhance Western Spiderwort habitat.

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

Yes. The main threats to Western Spiderwort recovery are changes in ecological dynamics or natural processes due to an alteration of grazing and/or fire regimes, ultimately contributing to dune stabilization and woody vegetation encroachment, or increased abundance of invasive alien species. Other major threats include habitat loss and degradation as a result of cultivation, industrial and recreational activities, and possibly mortality from overgrazing by wild and domestic ungulates. Threats can be mitigated through beneficial management practices, protection or private stewardship of species and their habitat.

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

Yes. Recovery techniques related to habitat conservation and adaptive habitat management can be implemented, and have already been implemented at some locations. This should reduce the main threats to Western Spiderwort and aid in achieving the population and distribution objectives of maintaining existing populations. A number of locations currently occupied by Western Spiderwort are in areas managed for conservation such as provincial parks, AAFC Community Pastures, or ecologically significant areas. Remaining areas could be secured through stewardship arrangements with public and private landowners.

TABLE OF CONTENTS

1. COSEWIC* SPECIES ASSESSEMENT INFORMATION

Date of Assessment: November 2002

Common Name (population): Western Spiderwort

Scientific Name: *Tradescantia occidentalis*

COSEWIC Status: Threatened

Reason for Designation: A perennial restricted to four disjunct sand dune habitats where the species is at risk from invading leafy spurge, cattle grazing, and dune stabilization.

Canadian Occurrence: Alberta, Saskatchewan and Manitoba

COSEWIC Status History: Designated Threatened in April 1992. Status re-examined and confirmed in November 2002.

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

2. SPECIES STATUS INFORMATION

Western Spiderwort (*Tradescantia occidentalis (*Britt.) Smyth) is native to the interior plains and Colorado plateau of western North America. Globally, the plant is ranked as secure (G5; NatureServe 2010a). In Canada, Western Spiderwort is considered critically imperiled (N1; NatureServe 2010a) and was listed as threatened under the Species at Risk Act (SARA) in 2005. Alberta, Saskatchewan and Manitoba all list the species as critically imperiled (S1; NatureServe 2010a), and as "threatened" under their respective Endangered Species or Wildlife Acts. Western Spiderwort is more common in the United States, where it is considered nationally secure (N5?; NatureServe 2010a); however, it has not been ranked in 17 of the 18 states in which it occurs (SNR or SNA; NatureServe 2010a). No information is available on the abundance of Western Spiderwort in the United States. It is not known precisely what percent of the species' global distribution and abundance currently is found in Canada, only that it is small and likely between 1 to 5% of the global extent of occurrence[1].

[1] Extent of occurrence, as defined by COSEWIC, is "the area included in a polygon without concave angles that encompasses the geographic distribution of all known populations of a species" (COSEWIC 2010).

3. SPECIES INFORMATION

3.1 Species Description

Western Spiderwort is a perennial herb from the Spiderwort Family (Commelinaceae) whose common name originates from the sticky substance secreted by injured leaves or stems which hardens into a cobweb-like material (Kershaw et al. 2001). It has semi-succulent stems up to 60 cm high, and leaves that are grass-like (Looman and Best 1979). Young plants can resemble grass seedlings. Flowers have three petals ranging in colour from pink to violet with dark-blue being the most common type (Fig. 1; Scoggan 1957, Looman and Best 1979). Flowers are in clusters at the top of stems with each flower lasting about one day, opening in early morning and usually closing by noon (Faden 2000, C. Neufeld pers. obs.). It flowers in late June to mid July, with most mature seed capsules produced by late July (Kershaw et al. 2001).

Figure 1. Flowering Western Spiderwort © *Candace Neufeld*

Reproduction is only by seeds, and plants lack rhizomes for vegetative reproduction (Scoggan 1978, Great Plains Flora Association 1991, Remarchuk 2006).

3.2 Population and Distribution

The range of Western Spiderwort in North America extends east to west from New York to Arizona, and north to south from Saskatchewan to Texas (Fig.2). In Canada, Western Spiderwort is limited to four populations[2] in Alberta, Saskatchewan, and Manitoba (Fig. 3). These are located at the Pakowki Lake Sand Hills in southeastern Alberta, the Elbow Sand Hills in south-central Saskatchewan, and the Routledge and Lauder Sand Hills in Manitoba. Although COSEWIC (Smith 2002) recognized an east and west population within the Lauder Sand Hills, they will be considered as one population for the purposes of this recovery strategy for the

[2] Using the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) definition, a population is defined as "geographically or otherwise distinct group within a wildlife species that has little demographic or genetic exchange with other such groups. Theoretically, populations maintain genetic distinction if there is typically less than one successful breeding immigrant individual or gamete per generation." (COSEWIC 2010). NatureServe considers occurrences within 1 km of each other, or within 3 km if there is less than 1 km of unsuitable habitat between them, to be from the same element occurrence (NatureServe 2010b). For the purposes of the recovery strategy, we will consider the term "element occurrence" equivalent to population. The Canadian population is the total number of mature individuals in Canada.

.

following reasons: they are in the same dune complex; the east and west occurrences are separated by under 1.5 km with approximately 1 km of cultivation and a gravel road separating the suitable dune habitat (NatureServe 2010b); there is a high degree of genetic similarity, indicating there likely is, or has been, genetic exchange between them (Remarchuk 2006); the habitat and threats between the two are similar.

In the three provinces where Western Spiderwort occurs, it has a restricted area of occupancy[3], and restricted extent of occurrence[4] (COSEWIC 2002). Numerous targeted surveys in recent years since the COSEWIC status update (Smith 2002) have greatly increased the known area of occupancy and estimates of population sizes, but the extent of occurrence, number of total populations and threats to habitat remain very similar to what they were prior to the COSEWIC status update. The 1990 COSEWIC assessment estimated 3,500 plants on 5 quarter sections[5] in two provinces (Smith and Bradley 1990) which was updated in the 2002 COSEWIC assessment to 22,000 plants on 19 quarter sections in three provinces with an area of occupancy of < 10 km^2 and an extent of occurrence of approximately 500 km^2 (Smith 2002). As of 2010, the Canadian population was estimated to be over 100,000 plants on 39 quarter sections in 3 provinces with an index area of occupancy [6] of 76 km^2 (Table 1; Environment Canada unpubl.data, Saskatchewan Conservation Data Centre 2010 Element

Figure 2. Range of Western Spiderwort in North America

[3] Area of occupancy is the portion within the 'extent of occurrence', or range of a species, that is actually occupied by the species (COSEWIC 2010). This can also be viewed as the area occupied by each occurrence.
[4] Extent of occurrence, as defined by COSEWIC, is "the area included in a polygon without concave angles that encompasses the geographic distribution of all known populations of a wildlife species" (COSEWIC 2010).
[5] The Dominion Land Survey system (McKercher and Wolfe 1986) is the grid system used in the Prairie Provinces to describe land locations. The provinces are divided into townships and each township is divided into 36 sections. Each section is further divided into four 0.8 km x 0.8 km quarter sections.
[6] The index area of occupancy is calculated by counting the total number of 2 x 2 km grid squares that contain the species (COSEWIC 2010). This count was made by using either the area of occupancy for each occurrence where this had been mapped, or centroid coordinates for those populations lacking more detailed survey work, and is current up to December 2010. Occurrences included in the calculation of index area of occupancy needed to meet the following criteria: occurrences were reported using precise and accurate geographic referencing systems; habitat still exists at the location to support the species; occurrences have been confirmed at the location within the past 25 years. A breakdown of index area of occupancy per population is: Lauder Sand Hills = 20 km^2, Routledge Sand Hills = 12 km^2, Elbow Sand Hills = 32 km^2, Pakowki Sand Hills = 12 km^2.

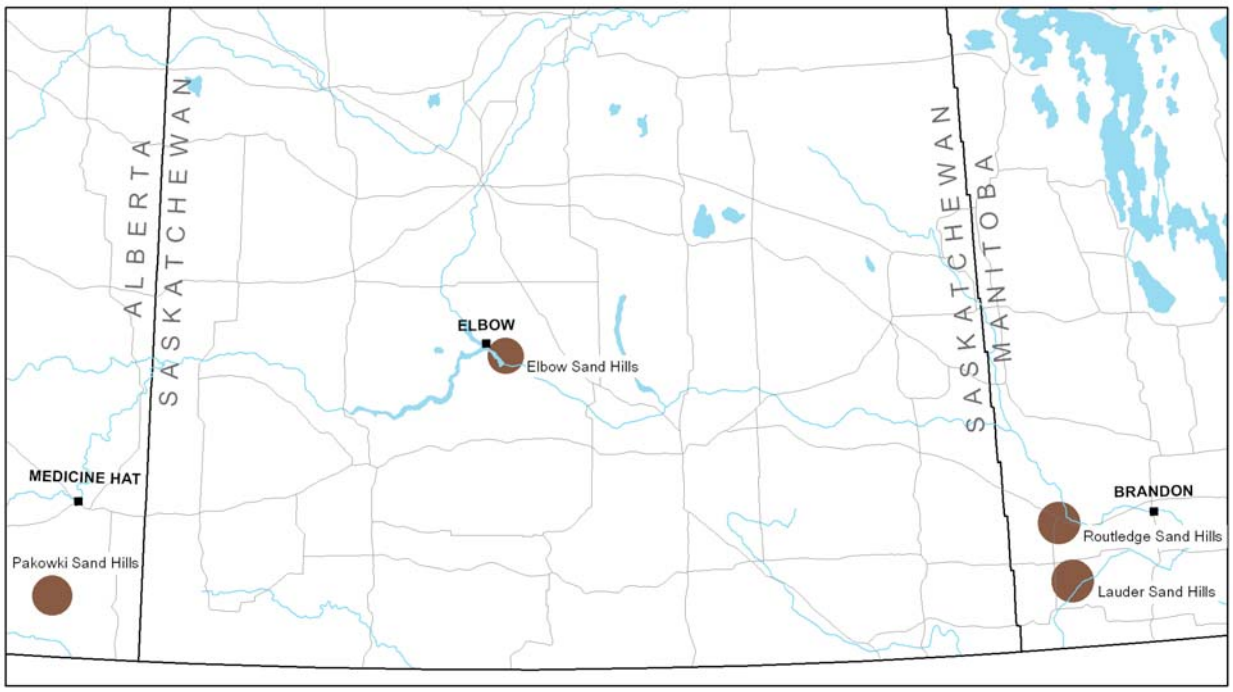


Figure 3. Known range of Western Spiderwort in Canada.

Occurrence data, Alberta Conservation Information Management System 2010 Element Occurrence data, Manitoba Conservation Data Centre 2010 Element Occurrence data).

To date, there has been inconsistency in methods used for surveying and monitoring Western Spiderwort. In addition, the few available estimates of population abundance are subject to wide variability or questionable accuracy and precision. This makes it difficult to infer any trends from past information that has been collected. Differences and potential sampling error arise in survey or monitoring techniques, search effort, enumeration methods, detectability at time of searching, observer ability, and perhaps inter-annual environmental factors (e.g., Goulet and Kenkel 1997, Peters 2003a and 2003b, Godwin and Thorpe 2004-2007, Remarchuk 2006, Peters et al. 2009). Therefore, due to a lack of standardized and consistent data, current population trends are unknown but there is no evidence for a continuing decline in numbers or area of occupancy. Large increases of population size and area of occupancy between decades to date should not be interpreted as an increase in population size due to biological phenomena, but rather a function of the cumulative search effort undertaken.

Table 1. Summary of known Western Spiderwort populations in Canada[a].

Site	Year First Observed	Recent Pop. Estimate [Year][b]	COSEWIC pop. estimate[g]	Highest Pop. Estimate [Year][b]
MANITOBA				
Routledge Sand Hills	1923	13 402 [2005][c]	9422 [2001]	26 550 [1996][d]
Lauder Sand Hills				
Lauder Sand Hills West	1950	775 [2005][c]	619 [2001][h]	854 [2001]
Lauder Sand Hills East	1995	4 024 [2005][c]	4321 [2002]	19 540 [1996][d]
ALBERTA				
Pakowki Lake Sand Hills	1986	37 195 [2007/08][f]	7450 [2002]	37 195 [2007/08]
SASKATCHEWAN				
Elbow Sand Hills				
AAFC-AESB Elbow Community Pasture	1991	44 000 [2006][c]	42 [1991]	69 000 [2005] [c]
Douglas Provincial Park	2001	4 686 [2009][e]	100 [2002]	4 686 [2009]

[a] Values and occurrences in the table are those known to Environment Canada as of January 2011. Sources: Smith and Bradley 1990, Hohn 1994, Goulet and Kenkel 1997, Hughes 2001, Peters 2003a and 2003b, Godwin and Thorpe 2004-2007, T. Sample (pers. comm.), Remarchuk 2005, Remarchuk 2006, Peters et al. 2009, S. Vinge (pers. comm.), C. Neufeld (unpubl. data), Neufeld 2008, Neufeld 2010, Manitoba Conservation Data Centre element occurrence records (unpubl. data), Alberta Natural Heritage Information Centre element occurrence records (unpubl. data).

[b] Note that population sizes are most often estimates because of distribution over a large area or high numbers of plants in an area. Not all occurrences within a population are enumerated in a year with most surveys. In addition, some surveyors counted individual stems as a unit while others counted clumps of plants as a unit. This makes it impossible to compare population sizes between years. Most populations have been revisited since the last population estimates, but the visits were for the purposes of delimiting area of occupancy, not population counts.

[c] These values are based on counts made along transects, and then extrapolating average density to the area of available suitable habitat on each sand dune. To view methods and standard error associated with the estimates, refer to the documents (Godwin and Thorpe 2004 and 2006, Remarchuk 2006).

[d] Only flowering plants were counted. The count was divided by 0.3 to account for only 1/3 of plants flowering at any time; this may have inflated the estimate (Goulet and Kenkel 1997, Hughes 2001).

[e] Not all occurrences were revisited in this estimate so this is only an estimate of part of the population.

[f] Some occurrences were counted. Population counts for the remainder were extrapolated from patch area based on GPS boundaries, and average population density (Remarchuk 2005, Peters et al. 2009).

[g] From Smith (2002).

[h] There are two different numbers reported for population size for 2001 in the source report (Hughes 2001); COSEWIC reports the population size from the table in the report while the Manitoba Conservation Data Centre reports the population size from the text in the report.

3.3 Needs of the Western Spiderwort

Western Spiderwort inhabits eolian[7] landscape complexes derived from lacustrine or glaciolacustrine deposits comprised of sandy and loamy sandy soils (David 1977). The habitat is in a transitional state between recently disturbed and fully stabilized, but probably tending towards earlier stages of vegetative succession and partial stabilization. Active sand dunes become stabilized with vegetation through natural succession and only remain open or free of woody plants through repeated fire, grazing disturbances and fluctuations in climate (Geological Survey of Canada 2001). Thus, Western Spiderwort needs eolian landscapes with native vegetation subject to fire and grazing disturbance patterns that mimic historical regimes.

[7] Eolian means borne, deposited, produced, or eroded by the wind.

Regionally, in the Pakowki Sand Hills in Alberta, Western Spiderwort is most common in level slacks between dune features that are stabilized by mixed grass prairie vegetation, or along the south-facing edges of partially stabilized or active dunes (Peters 2003a; Remarchuk 2006). In the Elbow Sand Hills in Saskatchewan and the Lauder and Routledge Sand Hills in Manitoba, Western Spiderwort is most common on south and southwest facing slopes of partially stabilized dunes, and less commonly on sandy flats with moderate vegetation (Hohn 1994, Goulet and Kenkel 1997, Hughes 2001, Godwin and Thorpe 2006, Remarchuk 2006). In these landscapes, a scrubby forest cover of Trembling Aspen (*Populus tremuloides*), Chokecherry (*Prunus virginiana*) and, in Manitoba, Bur Oak (*Quercus macrocarpa*), forms a matrix within which the sandy grassland and barren sand patches appear isolated from each other. Historically, it is possible the sand dunes and grassland may have been the dominant land class with the aspen and shrubs being isolated patches within.

A detailed survey by Godwin and Thorpe (2006) in the Elbow Sand Hills in Saskatchewan found preferred Western Spiderwort habitat to be moderate to steep south to southwest facing dune slopes with partial exposures of bare sand and no topsoil or organic material (soil A-horizon). These preferred slopes contained grassland vegetation associated with earlier successional or stable dune environments and had little cover by taller vegetation, including shrubs and trees. This description appears to agree with descriptions provided from the occupied dunes in Alberta and Manitoba as well (Hohn 1994, Goulet and Kenkel 1997, Peters 2003a and 2003b, Remarchuk 2006).

In varying degrees across the Canadian range, Western Spiderwort is found amongst shrubs or beneath an aspen or more open oak canopy but almost always immediately adjacent to other occupied habitat on open slopes (Goulet and Kenkel 1997, Godwin and Thorpe 2006). Potential reasons for establishment and survival in these "secondary" semi-shaded habitats include protection amongst the taller vegetation from grazing pressure, spill-over from abundant seed production of plants on adjacent slopes, or remnant plants from a previously larger occurrence on more sandy, open habitat that is now being stabilized through succession. Occasionally spiderwort plants are observed along sandy game trails within wooded areas which join isolated dune patches. These plants are most likely the result of seed dispersal by grazers. Although some of these occurrences in shrubby or wooded areas are likely more transitory in nature, they may act as dispersers of seed and pollen between occurrences in a population or metapopulation by deer or pollinators. Deer in this region can disperse long distances in short periods, and may be responsible for historical short and long distance colonization of plants in sand dune complexes (Skelton 2010). While it has been suggested that some low shrub cover within the sand dune complex may be important for spiderwort in exposed habitat, complete encroachment of woody vegetation leading to dune stabilization should be avoided (Goulet and Kenkel 1997, Smith 2002); the many physiological adaptations of spiderwort to drought conditions suggest it is better suited to warmer, drier habitats than moist, cool habitats (Remarchuk 2006).

For detailed lists of plant species that have been found growing near Western Spiderwort, refer to Smith (2002) and Remarchuk (2006)[8]. Remarchuk (2006) did not find Western Spiderwort to be associated with any particular plant taxa; slight differences in species composition among

[8] For associated plant lists for each province refer to Goulet and Kenkel (1997) and Hohn (1994) for Manitoba, Godwin and Thorpe (2006) for Saskatchewan, and Peters (2003a and 2003b) and Remarchuk 2005 for Alberta.

populations were attributed to differences in the amount of dune stabilization or slope height among provinces, as well as differences in regional species communities. Godwin and Thorpe (2006) found the most frequently occurring species in Western Spiderwort habitat to be affiliated with early to mid-successional dune habitats or stabilized low-dune grasslands.

Limiting Factors

Western Spiderwort lacks rhizomes for vegetative reproduction (Goulet and Kenkel 1997, Remarchuk 2006); reproduction occurs only by seed. Therefore, Western Spiderwort likely relies on a range of pollinating insects, particularly sweat bees (Smith 2002, Alberta Western Spiderwort Recovery Team 2005). Furthermore, for successful pollination and reproduction, suitable habitat should be sufficiently connected for the dispersal of those insects and any vectors for dispersal of seed. This dispersal of both pollinators and seed is needed to maintain gene flow among occurrences within a population (Remarchuk 2006). Mechanisms for long distance dispersal of Western Spiderwort seed are not known, although plants are frequently grazed. Thus, herbivory may have a role in seed dispersal although no studies have been done. Seed capsules hang in a cluster so most seeds are naturally released close to the parent plant, resulting in a clumped distribution of plants around the parent plant with some seeds dispersed downslope by gravity or runoff (Smith 2002, Remarchuk 2006).

A genetic diversity study was conducted within and among all Canadian populations; the study found populations to be isolated from each other with no genetic flow among them (Remarchuk 2006). There was high genetic similarity within each provincial population potentially indicating a future risk of inbreeding depression if there is a large decline in population numbers; the populations in Alberta and Saskatchewan are large enough that as long as habitat conservation and compatible management occur, inbreeding depression is unlikely to occur (Remarchuk 2006).

4. THREATS

4.1 Threat Assessment

Table 2. Threat Assessment Table

Threat	Level of Concern[a]	Extent[b]	Occurrence[c]	Frequency[d]	Severity[e]	Causal Certainty[f]
Exotic, Invasive or Introduced Species						
Invasive alien species ***Leafy Spurge (Euphorbia esula)*** ***Baby's-breath (Gypsophila paniculata)*** ***Crested Wheatgrass (Agropyron cristatum)***	High Medium	Widespread (Routledge, Lauder, Elbow) Localized (Pakowki, Elbow)	Current Current	Seasonal Seasonal	Moderate Low	High Low-Medium

Threat	Level of Concern[a]	Extent[b]	Occurrence[c]	Frequency[d]	Severity[e]	Causal Certainty[f]
Changes in ecological dynamics or natural processes						
Alteration to, or suppression of, grazing and/or fire regimes	Medium	Widespread (All)	Current	Seasonal	Low-Moderate	Medium
Over-grazing by wild or domestic animals	Low-Medium	Widespread (Lauder, Routledge, Elbow)	Current	Seasonal	Moderate	Low-Medium
Habitat Loss or Degradation						
Cultivation	Medium	Localized (Lauder, Pakowki)	Historic, Current	One-time	Moderate	High
Climate and Natural Disasters						
Prolonged wet climatic periods	Low-Medium	Widespread (All)	Historic, Current	Unknown	Unknown	Medium
Habitat Loss or Degradation						
Sand and Gravel Extraction	Low	Widespread (Lauder, Pakowki)	Unknown, Anticipated	One-time, Recurrent	Unknown	High
Road construction or maintenance	Low	Localized (Elbow, Lauder)	Current, Anticipated	One-time, Seasonal, Recurrent	Low	Medium-High
Oil and Gas Activities	Low	Localized (Pakowki)	Anticipated	Continuous	Low	Medium-High
Disturbance or Harm						
Recreational activities	Low	Localized (Routledge, Lauder)	Current	Seasonal, One-time, Recurrent	Low	High

[a] Level of concern is defined as to whether managing the threat is an overall high, medium, or low concern for recovery of the species, taking into account all of the above factors.
[b] Extent – Defined as widespread, localized, or unknown across the species range.
[c] Occurrence is defined as historic (contributed to decline but no longer affecting the species), current (affecting the species now), imminent (is expected to affect the species very soon), anticipated (may affect the species in the future), or unknown.
[d] Frequency is defined as a one-time occurrence, seasonal (either because the species is migratory or the threat only occurs at certain times of the year), continuous (on-going), recurrent (re-occurs from time to time but not on an annual or seasonal basis), or unknown.
[e] Severity is defined as high (very large population-level effect), moderate, low, or unknown.
[f] Causal certainty is defined as whether the best available knowledge about the threat and its impact on population viability is high (evidence causally links the threat to stresses on population viability), medium (correlation between the threat and population viability, expert opinion, etc), or low (assumed or plausible threat only).

4.2 Description of threats

Any additional loss of habitat among the known populations of Western Spiderwort would adversely affect the species' survival in Canada (Smith 2002, Remarchuk 2006). Future loss of habitat will most likely be as a result of direct activities like cultivation or oil and gas activities, or through habitat degradation from processes like invasion by invasive alien species and factors affecting dune stabilization (climate, grazing and fire regimes). Threats to Western Spiderwort are not the same across the range, but rather more pervasive in some populations than others. Threats are listed in order of decreasing level of concern.

Invasive Alien Species

Some invasive alien plant species may be relatively unpalatable to livestock and wildlife, or alter fuel properties and fire regimes (Brooks et al. 2004). As a result, an influx of these invasive alien plants could stabilize sand dunes and represent an indirect threat to Western Spiderwort habitat. Direct threats through competition may be posed by invasive alien plants as well which can displace native species, and decrease species diversity or richness through their superior competitive ability and negative effects on ecosystem functioning (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, an invasive Eurasian species, is present at, or near, all Western Spiderwort populations in Saskatchewan and Manitoba (Smith 2002). It reduces the abundance of native species in areas where it occurs, and is capable of turning sites into a stabilized monoculture (Wilson and Belcher 1989). In Manitoba, it was found that 95% of spurge occurrences were associated with human disturbances such as fireguards or vehicle tracks as it was easier for Leafy Spurge to establish in areas with more exposed soil (Wilson and Belcher 1989); active sand dunes may be particularly susceptible to establishment of Leafy Spurge. Crested Wheatgrass has been observed in the Pakowki and Elbow Sand Hills, and Baby's-breath in the Pakowki Sand Hills; long term impacts of these species on Western Spiderwort or its habitat are not known. There is also the potential for Western Spiderwort to be killed, or its habitat negatively altered, by indiscriminate use of herbicides intended to control invasive species.

Alteration to, or suppression of, grazing and/or fire regimes

Western Spiderwort prefers dune slope habitat only partially or recently stabilized (Godwin and Thorpe 2006) and could decline without disturbance that creates partially active to active sand patches (Smith 2002, Godwin and Thorpe 2006). Dunes in the southern Canadian prairies have been stabilizing over the last century through a combination of climate and changes in land-use practices since European settlement (Epp and Townley-Smith 1980, Wallis 1988, Wallis and Wershler 1988, Geological Survey of Canada 2001). Changes in land-use practices contributing to dune stabilization primarily includes eradication of Bison (*Bison bison*), a reduction in the frequency and extent of prairie fires, as well as a more homogenous pattern of grazing (Higgins et al. 1989, Frank et al. 1998, Brockway et al. 2002, Samson et al. 2004, Hugenholtz and Wolfe 2005). It is estimated that less than 1% of dunes are still active in the prairies compared with 10-20% a few hundred years ago (Wolfe et al. 2001); rates of stabilization have been estimated at 10-20% per decade over a 40 year period (Manitoba, Wolfe et al. 2000), although the rate may

be as high as 40% per decade over a 50 year period (Middle Sand Hills, Bender et al. 2005) or 30-90% since the 1940's (Wallis 1988). In the absence of natural disturbances like grazing and fire which interact with cycles of drought and disrupt vegetation growth, natural succession can stabilize and cover sand dunes with vegetation (Potvin and Harrison 1984, Hulett et al. 1966). The stabilization of open sand patches may result in reduced colonization or spread of Western Spiderwort in new and existing areas, respectively, through seed dispersal.

Prairie plants evolved with the ecological processes like fire and grazing. Historically, natural disturbances occurred frequently, randomly, and at different scales and magnitudes across the landscape, and have contributed to plant community composition and structure, and the overall ecological integrity of the prairie (Daubenmire 1968, White 1979, Lesica and Cooper 1999). It is possible that, historically, fires in the summer or fall created lush vegetation the following spring which attracted large herds of grazing animals like bison (Higgins 1986, Vinton et al. 1993) and resulted in reactivation of sand dunes. A combination of fire and grazing likely destabilizes sand dunes and disrupts vegetative succession more effectively than either disturbance independently (Lesica and Cooper 1999). Dunes have been stabilizing in some areas where there have been repeated fires but little grazing, while in other areas dunes have stabilized where there has been grazing but few fires (Wallis and Wershler 1988). Historically, the stabilization of active dunes was thought to be good conservation practice and land managers attempted to stabilize dunes by extinguishing fires, actively reseeding, altering grazing patterns, and placing objects, such as tires or bales, on blowouts (David 1977, Wallis and Wershler 1988). It is only recently that people have realized the benefits of having active dunes for wildlife.

Cultivation

In general, remaining sand dune areas that support Western Spiderwort are not considered high quality land for agriculture due to low soil moisture, low soil fertility, and high risk of wind erosion (Geological Survey of Canada 2001). Nevertheless, these areas are surrounded by Mixed Prairie grasslands which are commonly converted for cultivation resulting in sand dunes becoming islands in a landscape dominated by crops (Neufeld and Henderson pers. obs.). In addition, within sand dune complexes where there is relatively level topography it is possible to irrigate those soils for potato, sugar beet, and corn production (Neufeld, pers. obs.). Much of the Pakowki Sand Hills in Alberta contain nearly level sand plains between dune features. Sand dune complexes in Alberta and Manitoba with similar landscapes have already been converted to irrigated crops (Neufeld and Henderson, pers. obs.); the relative threat is likely limited by economics of irrigation infrastructure development and water supply. Historical conversion of native sandy grassland habitats to cultivated cropland likely contributed to the loss of historical spiderwort habitat as well as to habitat fragmentation. Cultivation will permanently result in habitat loss for which there is no mitigation (Alberta Western Spiderwort Recovery Team 2004).

Prolonged Wet Climatic Periods

Climate historically has played an important role in the stability of dunes as it can impact the vegetation cover on the dunes through periods of drought or moisture, exposing more or less of the sand to wind erosion (Thorpe et al. 2001, Wolfe et al. 2001). An increase in wet climatic cycles over the last 100-150 years, despite short periods of drought, has increased vegetation growth and dune stabilization (Wolfe et al. 1995, Vance and Wolfe 1996, Wolfe et al. 2000,

Wolfe et al. 2001). Recent climate change models and predictions for the prairie sand dunes in Canada predict eventual reactivation of some dune crests due to increased aridity and temperatures, despite increased precipitation in winter and spring (Thorpe et al. 2001, Wolfe et al. 2001). However, due to the uncertainty surrounding these models, it is difficult to evaluate the impact climate change will have on inhabitants of dune ecosystems and impacts may vary depending on the land use. Therefore, conservation of this unique habitat and its species through proper management should be the focus to ensure the sand dunes and species inhabiting them are maintained.

Over-grazing by domestic livestock and wildlife

Western Spiderwort evolved with ungulate grazing as a natural disturbance, and therefore should tolerate some amount of grazing pressure. However, it is possible that the timing, duration, location and diet selection of cattle and ungulates today is unlike what occurred naturally with ungulates prior to European settlement. Grazing may benefit Western Spiderwort habitat by decreasing vegetation cover, increasing soil disturbance and reactivating more stabilized sand dunes (Lesica and Cooper 1999, Hugenholtz and Wolfe 2005). Conversely, heavy grazing may be harmful if plants are trampled or repeatedly grazed during the sensitive flowering period and not allowed to set seed, as this could affect fitness and productivity. In Saskatchewan, deer herbivory reduced flowering by nearly half in 3 out of 4 years (Godwin and Thorpe 2007). In Manitoba, herbivory by both deer and cattle was directly observed, and significant differences in flowering were observed between cattle grazing and exclusion areas (Goulet and Kenkel 1997). Plants resprout following herbivory and thus long-term survival of parent plants may not be affected by occasional grazing (Hohn 1994, Goulet and Kendel 1997). However, Remarchuk (2006) observed more non-reproductive stems on grazed Western Spiderwort plants. Also, Western Spiderwort occurred at significantly lower frequencies in a 50-year moderately-grazed sand dune pasture versus the adjacent ungrazed dunes in Oklahoma (4.6% versus 18.9% frequency, respectively; Sims et al. 1995).

Other Threats

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. Currently, there are active borrow pits near the Lauder Sand Hills population, and sand has been removed from a dune at Pakowki recently and in the past. Although there are no occurrences under immediate threat from large-scale extraction, with the continued need for aggregate it is possible these sand dunes also will be considered as sources.

Western Spiderwort occurs along a few right-of-ways in Manitoba and Saskatchewan. Road maintenance or upgrading activities, such as road widening or repair, mowing and herbicide applications intended to control weeds and woody vegetation are potential threats to these occurrences.

Oil and gas activities have been considered for the Pakowki Sand Hills in the past and they may pose a future threat to the Alberta and Manitoba populations (Hohn 1994, Smith 2002,

Remarchuk 2005 and 2006); currently only the Pakowki location has any existing wells within 1 km of Western Spiderwort occurrences.

Recreational use of motorized or recreational vehicles (e.g., dune bikes, snowmobiles, all-terrain vehicles, 4 x 4 trucks) is occurring in Manitoba. In the Lauder Sand Hills, part of the dunes is used as a motocross race track. Some damage has been observed in the Routledge Sand Hills from snowmobiles or dune bikes (Goulet and Kenkel 1997, Krause-Danielson and Friesen 2009). The removal of western spiderwort plants for use in gardens may have occurred in the past at Routledge (Goulet and Kenkel 1997), but is now prohibited under the provincial Endangered Species Act.

5. POPULATION AND DISTRIBUTION OBJECTIVES

Substantial increases in the abundance, occurrence and distribution of Western Spiderwort in Canada are unlikely given that the suitable habitat for the species is limited in extent and highly fragmented with large extents of unsuitable habitat between populations, and the Canadian populations exist at the northern limit of the species' range. Because of these factors, even if threats are reduced or mitigated, it is possible its status will always remain as threatened. Considering habitat loss and degradation (mainly due to invasive species encroachment and changes in fire and grazing regimes) are likely the greatest threats to Western Spiderwort, recovery should focus on maintaining, and if possible increase, existing populations over the long term and reversing or preventing further declines in quality of habitat through beneficial management practices and stewardship arrangements.

Therefore, population and distribution objectives for Western Spiderwort are to:

Maintain and, if possible, increase the current estimated distribution of the existing naturally occurring populations and to similarly maintain and, if possible, increase the distribution of any newly-discovered naturally occurring populations.

Specifically, for each population[9]:

1. Lauder Sand Hills Population: Maintain mature individuals in at least 6 quarter sections.
2. Routledge Sand Hills Population: Maintain mature individuals in at least 7 quarter sections.

[9] Occurrences included in the current estimated distribution (quarter section) needed to meet the following criteria: occurrences were reported using precise and accurate geographic referencing systems; habitat still exists at the location to support the species; occurrences have been confirmed at the location within the past 25 years. As some of the occurrences within populations have only recently been discovered, complete area of occupancy data at the square metre scale is only available for some occurrences. Additionally, where area of occupancy has been measured in multiple years at an occurrence, it appears to fluctuate naturally from year to year, sometimes joining or splitting adjacent occurrences. Western Spiderwort populations may also act as metapopulations with colonizations and extinctions occurring dynamically within a dune system. These factors make it difficult to use a count of occurrences for population objectives or a measure of area in m^2 for distribution objectives. It may be useful for determining natural range of variation and trends, however.

3. Elbow Sand Hills Population: Maintain mature individuals in at least 18 quarter sections.
4. Pakowki Sand Hills Population: Maintain mature individuals in at least 8 quarter sections.

Rationale:

At this time, it is not feasible to define quantitative population objectives for a species for which there are no accurate estimates of population size, long-term data on population trends, or understanding of the range of natural variability for the populations. Once consistent and accurate baseline data are obtained, and a reliable monitoring program is established, quantitative population objectives may be able to be defined.

A decrease in the distribution of Western Spiderwort could reflect a loss of both habitat and individuals. Maintaining the species distribution at the current levels will help ensure the extent of occurrence and index area of occupancy are maintained, preventing the species from being evaluated as "declining" in future COSEWIC assessments, as per the COSEWIC criteria in either category A, "decline in total number of mature individuals", or category B, "small distribution range and decline or fluctuation" (COSEWIC 2010). Therefore, until reliable and accurate population estimates are available, establishing distribution objectives is a more meaningful approach for recovery planning purposes for this species.

6. BROAD STRATEGIES AND GENERAL APPROACHES TO MEET OBJECTIVES

6.1 Actions Already Completed or Underway

Alberta has formed a provincial recovery team and created a maintenance and recovery plan for 2005-2010 (Alberta Western Spiderwort Recovery Team 2004). Recent recovery actions in the Pakowki Lake Sand Hills have focused on survey and monitoring, invasive species control, as well as education and awareness (Fish and Wildlife Division 2010). In Saskatchewan, surveys are being conducted by numerous agencies in the Elbow Sand Hills, both on Agriculture and Agri-Food Canada – Agri-Environment Services Branch (AAFC-AESB) land and within Douglas Provincial Park; these surveys are mainly to locate new occurrences and delineate the area of occupancy of occurrences. AAFC-AESB has started to develop management guidelines and decision support tools for pasture land managers (E. Svendsen, pers. comm.). Leafy Spurge monitoring and control has been ongoing since 1991 using an integrated pest management approach, including sheep grazing. Saskatchewan Tourism, Parks, Culture and Sport is starting a multi-year adaptive and integrated management program for western spiderwort habitat using prescribed burning, integrated pest management for invasive exotic species such as Leafy Spurge, and grazing (R. Wright, pers. comm.). In Manitoba, there have been efforts to delimit the area of occupancy of all occurrences, and the recent initiation of a monitoring program to monitor responses to different management techniques in an effort to reduce spurge and woody vegetation encroachment (Hamel and Foster 2005, Foster and Reimer 2007, Foster 2008, Krause-Danielson and Friesen 2009, J. Greenall, pers. comm., P. Westhorpe, pers. comm.).

6.2 Strategic Direction for Recovery

Research and management approaches recommended to address threats as well as key information needs for successful recovery planning are outlined in Table 3.

Table 3. Recovery Planning Table

Threat or Limitation	Priority	General Description of Research and Management Approaches
Broad Strategy: Inventory and Monitoring		
Knowledge gaps related to trends in population, distribution and habitat; all threats	High	• Using consistent survey guidelines (Henderson 2009), confirm and/or determine area of occupancy for all occurrences. • Determine trends and range of natural variation for population size and area of occupancy. • Determine long-term impacts of threats and management practices on populations and habitat quality.
	Low	• Coordinate inventory and monitoring activities through the Recovery Team to ensure effective and efficient use of funds and labour. • Develop models (e.g., habitat suitability and/or species distribution models) to predict priority search areas for new populations; validate with surveys
Broad Strategy: Adaptive Habitat Management		
All threats **except** Prolonged Wet Climatic Periods	High	• Develop, implement and monitor population or location specific beneficial management practices (BMP) using adaptive habitat management (prescribed burns, brush control, invasive species control, grazing) to improve habitat as applicable to each population. • Integrate habitat management with that for other dune specialist species (Appendix C) and evaluate effectiveness of other habitat restoration/management projects in dunes. • Engage and partner with existing organizations, land owners and land managers to implement appropriate habitat management strategies at each population.
Broad Strategy: Habitat Conservation and Stewardship		
All threats **except** Prolonged Wet Climatic Periods	Medium	• Engage private landowners and broker stewardship or conservation arrangements; encourage implementation of BMPs and/or participation in habitat management. • Educate public and land users to minimize habitat deterioration through recreational use. • Secure surface/subsurface resources (where possible) to control access and prevent new developments. • Communicate activity set-back distance guidelines for disturbances to appropriate regulatory agencies. • Monitor compliance with, and success of, BMPs and stewardship arrangements.

Table 3. Recovery Planning Table continued.

Threat or Limitation	Priority	General Description of Research and Management Approaches
Broad Strategy: Research		
All threats; Knowledge gaps related to impact of threats and plant ecology	Medium-High	• Develop in-situ or ex-situ experiments and/or studies that will inform and facilitate development of BMPs, conservation and management of critical habitat and an understanding of the species ecological needs.

6.3 Narrative to Support the Recovery Planning Table

Research activities needed to further the recovery of the species are explained below.

Research
Addressing several knowledge gaps through research into impacts of human-related threats, habitat needs, and species' ecology is relevant to the recovery and long-term conservation and management of Western Spiderwort. Research is needed to evaluate the magnitude and direction of threats and mitigation effects on plant fitness, population size, and area of occupancy. In particular ex-situ or in-situ experimental and observational field investigations that could be undertaken, include examining the effects, timing and intensity of grazing, fire, invasive species control, brush control, and idled habitats, or a combination thereof, on Western Spiderwort survival and reproductive output and its habitat quality and availability. Other knowledge gaps requiring research include: aspects of the species' life cycle; the influence of precipitation on dormancy, population health, and population fluctuations; its tolerance for varying conditions (climate, vegetation encroachment, dune stabilization, precipitation); pollination and pollinator limitations. The research findings need to be applied to beneficial management practices developed for the species and may be used to re-evaluate critical habitat.

7. CRITICAL HABITAT

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

7.1 Approach to Identifying Critical Habitat

Identification of critical habitat for Western Spiderwort is based upon the best available occurrence information known to Environment Canada up to the end of 2010, and reflects what is needed to achieve the population and distribution objectives. The approach used for identifying critical habitat for Western Spiderwort is based on a decision tree developed by the

Recovery Team for Plants at Risk in the Prairie Provinces, as guidance for identifying critical habitat for terrestrial and aquatic prairie plant species at risk, and is summarized below.

Primary habitat required by Western Spiderwort consists of moderately sloped, partially stabilized sand dunes with patches of bare sand, as well as more stabilized dune slacks, rolling sand hills and level grasslands in parts of its range (Section 3.3). Although it is possible that areas of shrubs and trees interspersed within the sand dune matrix may also be beneficial by Western Spiderwort as secondary, and perhaps transitory, habitat for reasons described in Section 3.3, occurrences within this type of habitat are likely not critical to the survival of a population. Therefore, only occurrences within primary habitat were considered in the critical habitat identification process.

Primary habitat usually has distinct boundaries and appears as well-defined habitat patches in land cover classification analysis using remote sensing technology[10]. Therefore, because the species occupies well-defined and easily delineated habitat patches, and because the species is a medium-sized perennial, reliably present and easy to detect during the flowering period, critical habitat for Western Spiderwort is identified as the occupied primary habitat patches and all natural landforms, soils and native vegetation within a 300 m distance of each habitat patch[11], as per the criteria in the decision tree. The 300 m distance around the habitat patch represents the minimum distance needed to maintain the habitat required for long term survival of the species. This specific distance is based upon a detailed literature review that examined edge-effects of various land use activities that could affect resource availability for native prairie plants generally, and could contribute to negative population growth.

7.2 Identification of Critical Habitat for Western Spiderwort

Maps showing the location of areas containing critical habitat are provided in Appendix A. The total size of the areas containing critical habitat is 2851 hectares, with 633 hectares identified in Manitoba, 1047 hectares in Saskatchewan, and 1171 hectares in Alberta. This occupies or overlaps into 103 quarter sections of land in the Dominion Land Survey System (28 in Manitoba, 44 in Saskatchewan, 31 in Alberta; Appendix B).

In order to locate critical habitat, only generalized geographic locations at the scale of quarter sections are provided (Appendix B). All jurisdictions and landowners who are controlling

[10] Using object-oriented classification of satellite imagery (2.5 m panchromatic Spot 5 imagery for AB and MB; 2.5 m panchromatic Spot 5 and 10 m multispectral Spot 5 for SK), the landscape was classified into the following land cover classes, or habitat patches: dunes (bare sand), grassland (including vegetated dune slopes), shrub, forest, water and cropland following methods outlined in Lowe 2011. Primary habitat patches used for critical habitat were occupied grassland and dunes patches. Post-visual interpretation of the habitat classification using satellite imagery and higher resolution orthophotos, where available, was used minimally to increase accuracy in boundary delineation.

[11] For the purposes of identifying critical habitat for Western Spiderwort, rivers, and wetlands are not included in the definition of natural landforms and vegetation as the species does not use these habitats. In addition, large barriers like river channels or cultivated fields (e.g., greater than 150 m wide) can create a discontinuity in the natural habitat. These barriers may overwhelm other edge effects at the distal end of critical habitat, or prevent effective dispersal of the plant at the proximal end closest to the occurrence. In these particular cases, some patches of natural vegetation on natural landforms within a distance of 300 m but discontinuous from the habitat occupied by the plants may not be identified as critical habitat.

surface access to the area, or who are currently leasing and using parts of this area, will be provided with geo-referenced spatial data or large-format maps delineating the boundaries of critical habitat displayed in Appendix A, upon request.

7.3 Activities Likely to Result in Destruction of Critical Habitat

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

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

1) Compression, covering, inversion, or excavation/extraction of soil – Examples of compression include the creation or expansion of permanent/temporary structures, trails, roads, repeated motorized traffic, and objects that concentrate livestock activity and alter current patterns of grazing pressure such as spreading bales, building new corrals, or adding more watering sites. Compression can damage soil structure and porosity, or reduce water availability by increasing runoff and decreasing infiltration, such that critical habitat is destroyed. Examples of covering the soil include the creation or expansion of permanent/temporary structures, spreading of solid waste materials, or roadbed construction. Covering the soil prevents solar radiation and water infiltration needed for germination and survival of plants, such that critical habitat is destroyed. Examples of soil inversion and excavation or extraction include new or expanded cultivation, sand and gravel extraction pits, dugouts, road construction, pipeline installation, and stripping of soil for well pads or fireguards. Soil inversion or extraction can alter soil porosity, and thus temperature and moisture regimes, such that vegetation communities change to those dominated by competitive invasive species, and the critical habitat is therefore destroyed.

2) Alteration to hydrological regimes - Examples include temporary or permanent inundation resulting from construction of impoundments downslope or downstream, and accidental or intentional releases of water upslope and upstream. As the seed bank and plants of Western Spiderwort are adapted to semi-arid conditions, flooding or inundation by substances like water or hydrocarbons, even for a short period of time, can be sufficient to alter habitat enough to be unsuitable for survival and re-establishment. Even construction of a road can interrupt or alter overland water flow, altering the conditions of the habitat required for the long-term survival of the species at this occurrence enough to render it unsuitable for growth.

3) Indiscriminate application of fertilizers or pesticides – Examples of both herbicide and fertilizer effects that change the habitat include altering soil water and nutrient availability such that species composition or the surrounding community changes. These changes in addition to the altered interspecific competition that results from them could render the habitat unsuitable for the species at risk. Additional examples are the single or

repeated use of broad-spectrum insecticides that may negatively affect pollinators, an essential part of critical habitat, such that the functioning of critical habitat may be negatively impacted.

4) Spreading of wastes – Examples include spreading of materials such as manure, drilling mud, and septic fluids. These have the potential to negatively alter soil resource availability, species compositions, and increase surrounding competitor plants effectively destroying the critical habitat. Unlike covering the soil, these liquid or semi-liquid materials can infiltrate the surface in the short-term, but leave little long-term evidence at the surface that could point to the cause of negative changes observed thereafter.

5) Deliberate introduction or promotion of invasive alien species – Examples of deliberate introduction include intentional dumping or spreading of feed bales containing viable seed of invasive alien species, or seeding invasive alien species within critical habitat. Examples of deliberate promotion include use of uncleaned motorized recreational vehicles on existing race courses, where many of the vehicles arrive contaminated from off-site use and represent significant dispersal vectors for invasive alien species. Once established, these invasive alien species can alter soil resource availability and directly compete with species at risk, such that population declines occur. This effectively destroys the critical habitat. Critical habitat may be destroyed by Leafy Spurge and Baby's-breath (all *Gypsophila* species) which were discussed in Section 4.2, as well as any other prohibited or noxious prohibited weeds. It may also be destroyed by the following species which are not restricted by any legislation due to their economic value: Smooth or Awnless Brome (*Bromus inermis*), Crested Wheatgrass, Yellow Sweet Clover (*Melilotus officinalis*), White Sweet Clover (*Melilotus alba*). This form of destruction is often a cumulative effect resulting from the first four examples of critical habitat destruction.

While the human activities listed above can destroy critical habitat, there are a number of activities that can be beneficial to Western Spiderwort and its habitat. These activities are described in Appendix D.

8. MEASURING PROGRESS

The performance indicators presented below provide a way to define and measure progress toward achieving the population and distribution objectives. Progress towards meeting the population and distribution objectives must be reported within five years after this recovery strategy is finalized. Success of recovery strategy implementation will be measured against the following indicators:

- All four currently existing populations and any new ones discovered by 2018 are maintained, at a minimum, at their current estimated distributions.
- Specifically: the Lauder Sand Hills population is maintained in at least 6 quarter sections; the Routledge Sand Hills population is maintained in at least 7 quarter sections, the Elbow Sand Hills population is maintained in at least 18 quarter sections; and the Pakowki Sand Hills population is maintained in at least 8 quarter sections.

9. STATEMENT ON ACTION PLANS

One or more action plan(s) for Western Spiderwort will be completed by 2017. Action plans will be completed with guidance from this recovery strategy and the Recovery Team. Separate action plans may be required for each population identified in Table 1 or developed on a provincial basis. A multi-species or ecosystem-based action plan would benefit multiple species at risk inhabiting sand dune ecosystems.

10. REFERENCES

Alberta Western Spiderwort Recovery Team. 2004. Maintenance and recovery plan for Western Spiderwort in Alberta 2005-2010. Alberta Sustainable Resource Development, Fish and Wildlife Division, Alberta Species at Risk Recovery Plan No.9, Edmonton, Alberta.18 pp.

Bakker, J., and S. Wilson. 2001. Competitive abilities of introduced and native grasses. Plant Ecology 157: 117-125.

Bender, D.J., Gummer, D.L., Robertson, S., Teucher, A., Knaga, P., Baird, E. and E. Jochum. 2005. Conservation management of Ord's kangaroo rats and sandy habitats of the Middle and Hills of Alberta. Report for Canadian Forces Base Suffield, Medicine Hat, Alberta. 33 pp.

Brockway, D.G., R.G. Gatewood, and R.B. Paris. 2002. Restoring fire as an ecological process in shortgrass prairie ecosystems: initial effects of prescribed burning during the dormant and growing seasons. Journal of Ecological Management 65: 135-152.

Brooks, M.L., D'Antonio, C.M., Richardson, D.M., Grace, J.B., Keeley, J.E., DiTomaso, J.M., Hobbs, R.J., Pellant, M. and D. Pyke. 2004. Effects of invasive alien plants on fire regimes. Bioscience 54: 677-688.

Christian, J.M., and S.D. Wilson. 1999. Long-term ecosystem impacts of an introduced grass in the Northern Great Plains. Ecology 80: 2397-2047.

COSEWIC. 2002. COSEWIC assessment and update status report on the Western Spiderwort *Tradescantia occidentalis* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa.

COSEWIC. 2005. Wildlife Species Assessment: Original criteria and definitions used in the assessment of species from October 1999 to May 2001. Website: http://www.cosewic.gc.ca/eng/sct0/original_criteria_e.cfm [accessed May 2010].

COSEWIC. 2010. Wildlife Species Assessment: COSEWIC's Assessment Process and Criteria, Updated August 2010. Website: http://www.cosewic.gc.ca/eng/sct0/assessment_process_e.cfm#tbl6 [accessed May 2010].

Daubenmire, R. 1968. Ecology of fire in grasslands. Advances in Ecological Research 5:209-266.

David, P. P. 1977. Sand dune occurrences of Canada: a theme and resource inventory study of eolian landforms of Canada. Contract no. 74-230. Indian and Northern Affairs Canada, National Parks Branch, Ottawa.

Epp, H.T. and L. Townley-Smith (Eds.). 1980. The Great Sand Hills of Saskatchewan: Policy,

Planning and Research Branch, Saskatchewan Environment, Saskatoon, SK. 156 pp.

Faden, R. 2000. 207. Commelinaceae R. Brown – Spiderwort family. *In* Flora of North America: North of Mexico. *Edited by* Flora of North America Editorial Committee. Oxford University Press, Oxford, NY. Pp. 170-197. Website: http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=10212 [accessed Oct. 2009).

Fish and Wildlife Division. 2010. Alberta Species at Risk Programs and Projects 2008-2010. Alberta Sustainable Resource Development, Fish and Wildlife Division, Alberta Species at Risk Report No. 137, Edmonton, AB. 68 pp.

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, MB.

Foster, C. and Reimer, E. 2007. Rare plant surveys by the Manitoba Conservation Data Centre, 2006. MS Report 07-01. Manitoba Conservation Data Centre, Winnipeg, MB.

Frank, D.A., McNaughton, S.J. and B.F. Tracy. 1998. The ecology of the Earth's grazing ecosystems. Bioscience 48: 513-521.

Geological Survey of Canada. 2001. Sand dune and climate change studies in the Prairie provinces. Geological Survey of Canada, Ottawa.

Godwin, B. and J. Thorpe. 2004. PFRA Rare Plant Inventory Pilot Project. Agriculture and Agri-Food Canada and Saskatchewan Research Council, SRC Publication No. 11673-1E04.

Godwin, B. and J. Thorpe. 2005. Plant species at risk survey of four PFRA pastures, 2004. Agriculture and Agri-Food Canada and Saskatchewan Research Council, SRC Publication No. 11874-1E05.

Godwin, B. and J. Thorpe. 2006. Plant species at risk surveys in Elbow, Dundurn and Rudy-Rosedale PFRA pastures, 2005. Agriculture and Agri-Food Canada and Saskatchewan Research Council, SRC Publication No. 11997-1E06.

Godwin, B. and J. Thorpe. 2007. Targeted surveys for plant species at risk in Elbow, Dundurn and Rudy-Rosedale AAFC-PFRA pastures, 2006. Agriculture and Agri-Food Canada and Saskatchewan Research Council, SRC Publication No. 11997-1E07.

Goulet, S. and N. Kenkel. 1997. Habitat survey and management proposal for Manitoba populations of Western Spiderwort (*Tradescantia occidentalis*). Department of Botany, University of Manitoba. Winnipeg, MB. 89 pp.

Government of Canada. 2009. *Species at Risk Act* Policies, Overarching Policy Framework (draft). *Species at Risk Act* Policy and Guidelines Series, Environment Canada, Ottawa. 38 pp.

Great Plains Flora Association. 1986. Flora of the Great Plains. University Press of Kansas, Kansas.

Hamel, C. and C. Foster. 2005. Rare species surveys and stewardship activities of the Mantioba Conservation Data Center, 2004. MS Report 05-01. Manitoba Conservation Data Centre, Winnipeg, MB.

Henderson, D.C. 2005. Ecology and Management of Crested Wheatgrass Invasion. Ph.D. Thesis, University of Alberta, Edmonton, Alberta. 137 pp.

Henderson, D.C. 2011. Set-back distance and timing restriction guidelines for prairie plant species at risk. Environment Canada, Prairie and Northern Region, Canadian Wildlife Service. Edmonton AB. Website: http://www.registrelep-sararegistry.gc.ca/document/dspDocument_e.cfm?documentID=2314 [accessed Nov. 4, 2011].

Henderson, D.C. and M.A. Naeth. 2005. Multi-scale impacts of Crested Wheatgrass invasion in mixed-grass prairie. Biological Invasions 7: 639-650.

Higgins, K.F. 1986. Interpretation and compendium of historical fire accounts in the Northern Great Plains. U.S. Fish & Wildlife Service, Resource Publication 161. 39 pp.

Higgins, K.F., A.D. Kruse and J. L. Piehl. 1989. Effects of fire in the Northern Great Plains. U.S. Fish and Wildlife Service and Cooperative Extension Service, South Dakota State University, Brookings, South Dakota. Extension Circular 761. Jamestown, ND: Northern Prairie Wildlife Research Center Online. Available at: http://www.npwrc.usgs.gov/resource/habitat/fire/index.htm. (accessed October 20, 2007).

Hohn, S. 1994. The habitat requirements and management implications for the Western Spiderwort (*Tradescantia occidentalis*). Critical Wildlife Habitat Program.

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.

Hulett, G.K., R.T. Coupland and R. L. Dix. 1966. The vegetation of dune sand areas within the grassland region of Saskatchewan. Canadian Journal of Botany 44: 1307-1331.

Jordan, N.R., Larson, D.L. and S.C. Huerd. 2008. Soil modification by invasive plants: effects on native and invasive species of mixed-grass prairies. Biological Invasions 10: 177-190.

Kershaw, L., Gould, J., Johnson, D. and J. Lancaster. 2001. Rare Vascular Plants of Alberta. University of Alberta Press and Natural Resources Canada, Canadian Forestry Service, Northern Forestry Centre, Edmonton, AB. 484 pp.

Kochy, M. and Wilson, S.D. 2001. Nitrogen deposition and forest expansion in the northern Great Plains. Journal of Ecology. 89: 807-817.

Krause-Danielsen, A. and C. Friesen. 2009. Rare plant surveys and stewardship activities by the Manitoba Conservation Data Centre, 2008. Report No. 2008-04. Manitoba Conservation Data Centre, Winnipeg, MB.

Kronberg, S. L., Muntifering, R.B., Ayers, E.L. and C. B. Marlow. 1993. Cattle avoidance of Leafy Spurge: a case of conditioned aversion. Journal of Range Management 46: 364-366.

Lamont, S. 2004. Personal communication. Botanist, Saskatchewan Conservation Data Centre, Saskatchewan Environment. Regina, Saskatchewan.

Lesica, P. and S. V. Cooper. 1999. Succession and disturbance in sandhills vegetation: constructing models for managing biological diversity. Conservation Biology 13:293-302.

Looman, J. and K.F. Best. 1979. Budd's Flora of the Canadian Prairie Provinces. Research Branch, Agriculture Canada, Publication 1662. Ottawa, Ontario.

Lowe, S. 2011. Spatial Habitat Modeling for a Threatened Plant in a Prairie Sand Dune Landscape. M.Sc. Thesis, University of Saskatchewan, Saskatoon, SK. 104 pp.

McKercher, R. B., and B. Wolfe. 1986. Understanding Western Canada's Dominion Land Survey System. Division of Extension and Community Relations report, University of Saskatchewan, Saskatoon, SK. 26 pp.

NatureServe. 2010a. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Website: http://www.natureserve.org/explorer [accessed: May 2011].

NatureServe. 2010b. Habitat-based Plant Element Occurrence Delimitation Guidance, 1 October 2001. Version 7.1. NatureServe, Arlington, Virginia. Website: www.natureserve.org/explorer/decision_tree.htm [accessed: May 2011].

Neufeld, C. 2008. Survey for Western Spiderwort (*Tradescantia occidentalis*) Elbow PFRA Community Pasture, July 7-18, 2008. Environment Canada report to Agriculture and Agri-Food Canada, ROE 4557:925-7E2-11. Saskatoon, SK.

Neufeld, C. 2010. Survey for Western Spiderwort (*Tradescantia occidentalis*) Elbow PFRA Community Pasture, July 6-16, 2009. Environment Canada report to Agriculture and Agri-Food Canada, ROE 4557:925-7E2-11. Saskatoon, SK.

Pachkowski, J. 2002. Bio-control of Leafy Spurge in Support of Recovery of Species at Risk Year II: 2002 Field Research Results. Rural Development Institute Brandon University, Brandon, MB.

Pachkowski, J. 2003. Bio-control of Leafy Spurge in Support of Recovery of Species at Risk Year III: 2003 Field Research Results. Rural Development Institute Brandon University, Brandon, MB.

Peters, S. 2003a. Inventory of Western Spiderwort (*Tradescantia occidentalis*) in Alberta, 2002. Alberta Sustainable Resource Development, Fish and Wildlife Division, Alberta Species At Risk Report No. 61. Edmonton, AB. 27 pp.

Peters, S. 2003b. Inventory of Western Spiderwort (*Tradescantia occidentalis*) in Alberta, 2003. Addendum to Species at Risk Report No. 61: Inventory of Western Spiderwort (*Tradescantia occidentalis*) in Alberta, 2002. Alberta Sustainable Resource Development, Fish and Wildlife Division, Alberta Species At Risk Report No. 61. Edmonton, AB. 17 pp.

Peters, S., Benders, D., and L. Matthias. 2009. Adopt-a-plant Alberta: Implementing Recovery Actions for Western Spiderwort (Tradescantia occidentalis), 2007-2008. Alberta Sustainable Resource Development, Fish and Wildlife Division. Alberta Species at Risk Report No. 128. Edmonton, AB. 27 pp.

Potvin, M.A. and A.T. Harrison. 1984. Vegetation and litter changes of a Nebraska sandhills prairie protected from grazing. Journal of Range Management. 37: 55-58.

Reader, R.J., S.D. Wilson, J.W. Belcher, I. Wisheu, P.A. Keddy, D. Tilman, E.C. Morris, J.B. Grace, J.B. McGraw, H. Olff, R. Turkington, E. Klein, Y. Leung, B. Shipley, R. vanHulst, M.E. Johansson, C. Nilsson, J. Gurevitch, K. Grigulis and B.E. Beisner. 1994. Plant competition in relation to neighbor biomass: an intercontinental study with *Poa pratensis*. Ecology 75: 1753-1760.

Reimer, E. and C. Hamel. 2002. Rare Species Surveys of the Manitoba Conservation Data Centre, 2001. MS02-02. Manitoba Conservation Data Centre, Winnipeg, MB. 35 pp.

Remarchuk, K.J. 2005. Western Spiderwort (*Tradescantia occidentalis*) inventory in Alberta, 2005. Alberta Sustainable Resource Development, Fish and Wildlife Division, Alberta Species at Risk Report No. 102. Edmonton, AB. 13 pp.

Remarchuk, K.J. 2006. Demography and Genetic Diversity in *Tradescantia occidentalis*. M.Sc. Thesis, University of Saskatchewan, Saskatoon, SK. 136 pp.

Samson, F.B., Knopf, F.L. and W.R. Ostlie. 2004. Great Plains ecosystems: Past, present, and future. Wildlife Society Bulletin 32:6-15.

Scoggan, H.J. 1957. Flora of Manitoba. National Museum of Canada, Ottawa, ON.

Scoggan, H.J. 1978. The Flora of Canada. National Museum of Canada, Ottawa, ON.

Sims, P.L., Berg, W.A. and J.A. Bradford. 1995. Vegetation of sandhills under grazed and ungrazed conditions. *In*: Proceedings of the Fourteenth North American Prairie Conference: Prairie Biodiversity. *Edited by:* D.C. Hartnett. Kansas State University, Manhattan, Kansas. Pp 129-135.

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. 2002. Update COSEWIC status report on the Western Spiderwort *Tradescantia occidentalis* in Canada, in COSEWIC assessment and update status report on the Western Spiderwort *Tradescantia occidentalis* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-25 pp.

Smith, B. and C. Bradley. 1990. Status report on endangered wildlife in Canada – Western Spiderwort (*Tradescantia occidentalis* (Britt.) Smyth). Committee on the Status of Wildlife in Canada, Ottawa, ON. 52 pp.

Thorpe, J. and B. Godwin. 1992. Regional vegetation management plan for Douglas Provincial Park and Elbow PFRA Pasture. Plant Ecology Section, Saskatchewan Research Council. SRC Publication No. E-2520-1-E-92.

Thorpe, J., Wolfe, S., Campbell, J., Leblanc, J. and R. Molder. 2001. An ecoregion approach for evaluating land use management and climate change adaptation strategies on sand dune areas in the Prairie Provinces. Publication 11368-1E01. Saskatchewan Research Council, Saskatoon, SK. 284 pp.

Trammell, M. A. and J. L. Butler. 1995. Effects of exotic plants on native ungulate use of habitat. Journal of Wildlife Management 59: 808-816.

United States Department of Agriculture (USDA) Natural Resources Conservation Service. 2011. Plants database - Plants Profile for *Tripterocalyx micranthus* (Small-flowered Sand-verbena). Available at: http://plants.usda.gov/java/profile?symbol=TRMI6 (accessed May 2011).

Vance, R. E. and S. A. Wolfe. 1996. Geological indicators of water resources in semi-arid environments: southwestern interior of Canada. In Geoindicators: assessing rapid environmental changes in earth systems (Berger, A. R. and W. J. Iams, Eds.). A. A. Balkema, Rotterdam, pp. 251-263.

Vinton, M.A., Hannett, D.C., Finck, E.J., and J.M. Briggs. 1993. Interactive effects of fire, bison (Bison bison) grazing and plant community composition in tallgrass prairie. American Midland Naturalist 129: 10-18.

Walker, J.W., Kronberg, S.L., Al-Rowaily, S.L. and N.E. West. 1994. Comparison of sheep and goat preferences for Leafy Spurge. Journal of Range Management 47: 429-434.

Wallis, C.A. 1988. The unsung benefits of wind erosion – stabilizing sand dunes spell trouble for rare plants. Iris Newsletter 3: 1-2.

Wallis, C. and C. Wershler. 1988. Rare wildlife and plant conservation studies in sandhill and sand plain habitats of southern Alberta. Prepared for Alberta Forestry, Lands and Wildlife, Alberta Recreation and Parks, World Wildlife Fund Canada. Edmonton.

White, P. S. 1979. Pattern, process, and natural disturbance in vegetation. Botanical Review 45: 229-299.

Wilson, S.D. 1989. The suppression of native prairie by alien species introduced for revegetation. Landscape and Urban Planning 17: 113-119.

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.

Wolfe, S. A. 1997. Impact of increased aridity on sand dunes activity in the Canadian Prairies. Journal of Arid Environments 36:421-432.

Wolfe, S.A., D.J. Huntley, and J. Ollerhead. 1995. Recent and late Holocene sand dune activity in southwestern Saskatchewan. *In* Current research 1995-B. Geological Survey of Canada. Pp. 131-140.

Wolfe, S.A., D.R. Muhs, P.P. David, and J.P. McGeehin. 2000. Chronology and geochemistry of late Holocene eolian deposits in the Brandon Sand Hills, Manitoba, Canada. Quaternary International 67:61-74.

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. Canadian Journal of Earth Sciences 38:105-117.

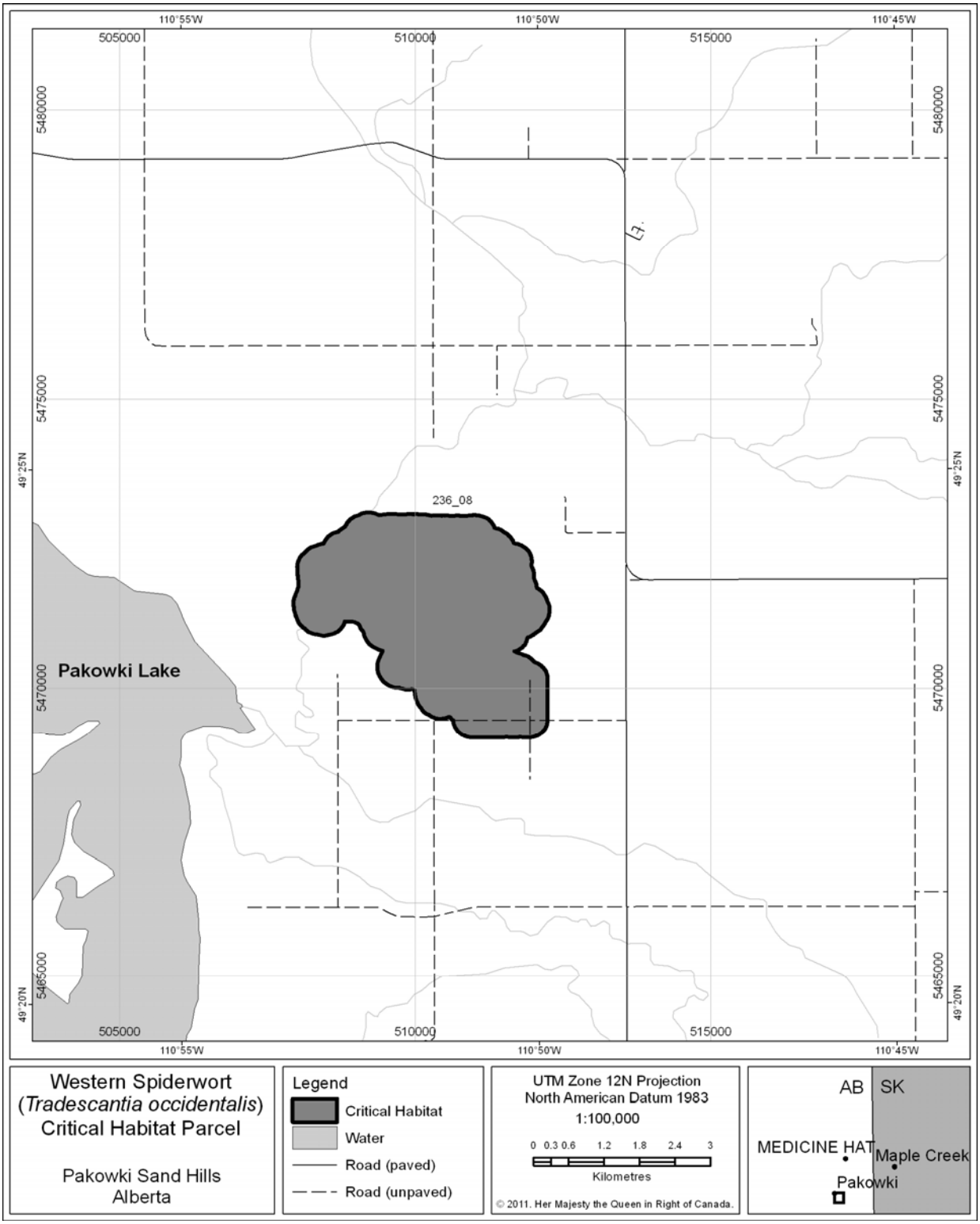
11. RECOVERY TEAM MEMBERS

Current recovery team members:
Candace Neufeld (Environment Canada, recovery team chair)
Jason Greenall (Manitoba Conservation)/ Nicole Firlotte (Manitoba Conservation Data Centre, acting for Jason Greenall)
Fawn Jackson (Canadian Cattlemen's Association)
Sarah Lowe (Environment Canada, recovery team secretary)
Lisa Matthias (Alberta Sustainable Resource Development)
Chris Nykoluk (Agriculture and Agri-Food Canada – Agri-Environment Services Branch)
Jeanette Pepper (Saskatchewan Ministry of Environment)

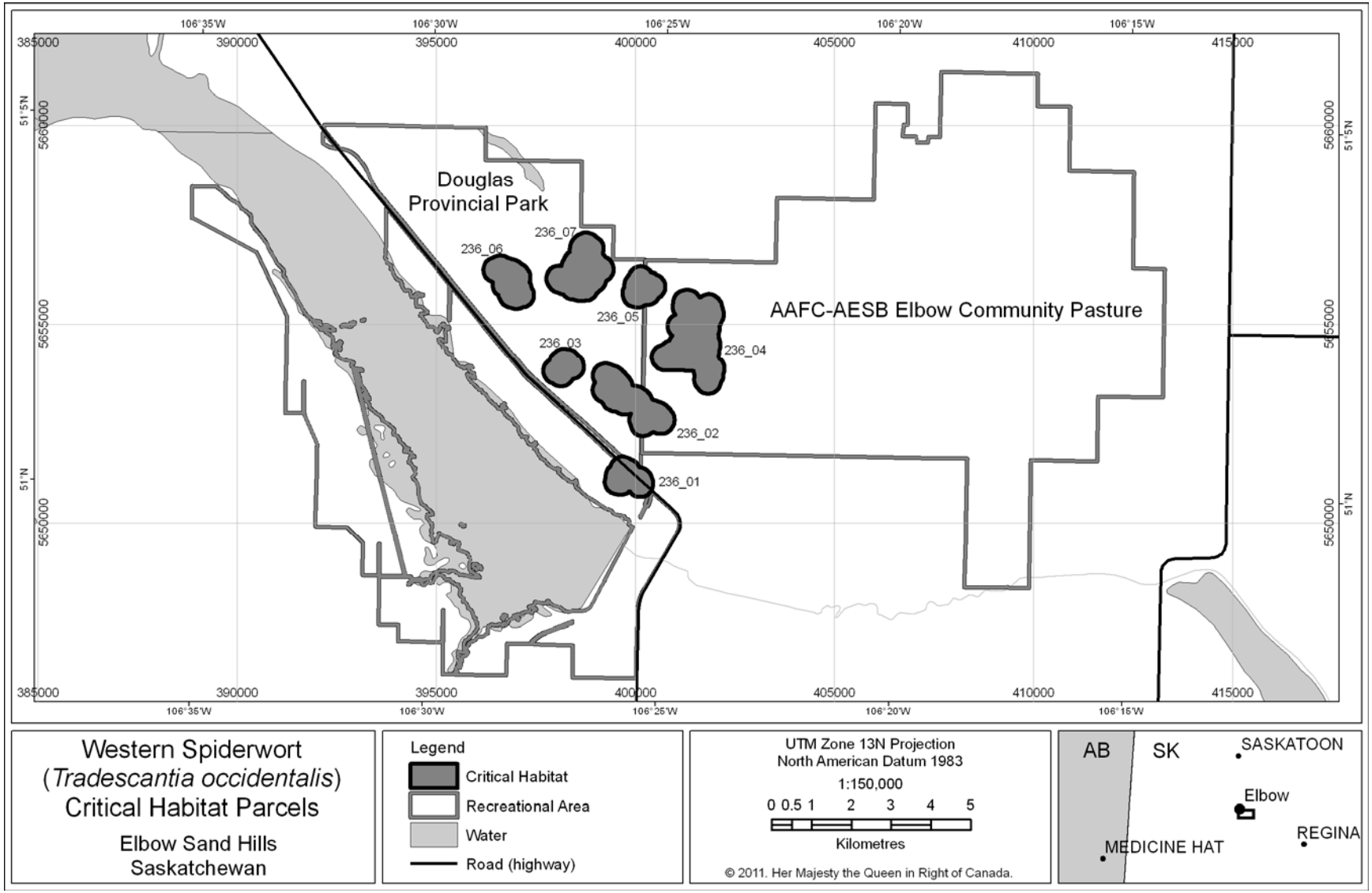
Current recovery team participants:
Joel Nicholson (Alberta Sustainable Resource Development)
Sherry Lynn Punak-Murphy (Department of National Defence, CFB Shilo)
Drew Taylor (Department of National Defence, CFB Suffield)

Past recovery team members/participants:
Cheryl Ann Beckles (Department of National Defence, 17-Wing Detachment Dundurn)
Delaney Boyd (Department of National Defence, CFB Suffield)
Robin Gutsell (Alberta Sustainable Resource Development)
Darcy Henderson (Environment Canada, recovery team chair until August 2010)
Dean Nernberg (Environment Canada, recovery team chair until August 2005)
Sue McAdam (Saskatchewan Ministry of Environment)
Carmen McNabb (Department of National Defence, CFB-Shilo, acting for Sherry Lynn Punak-Murphy)
Dr. Jennifer Rowland (Department of National Defense)
Peggy Strankman (Canadian Cattlemen's Association)

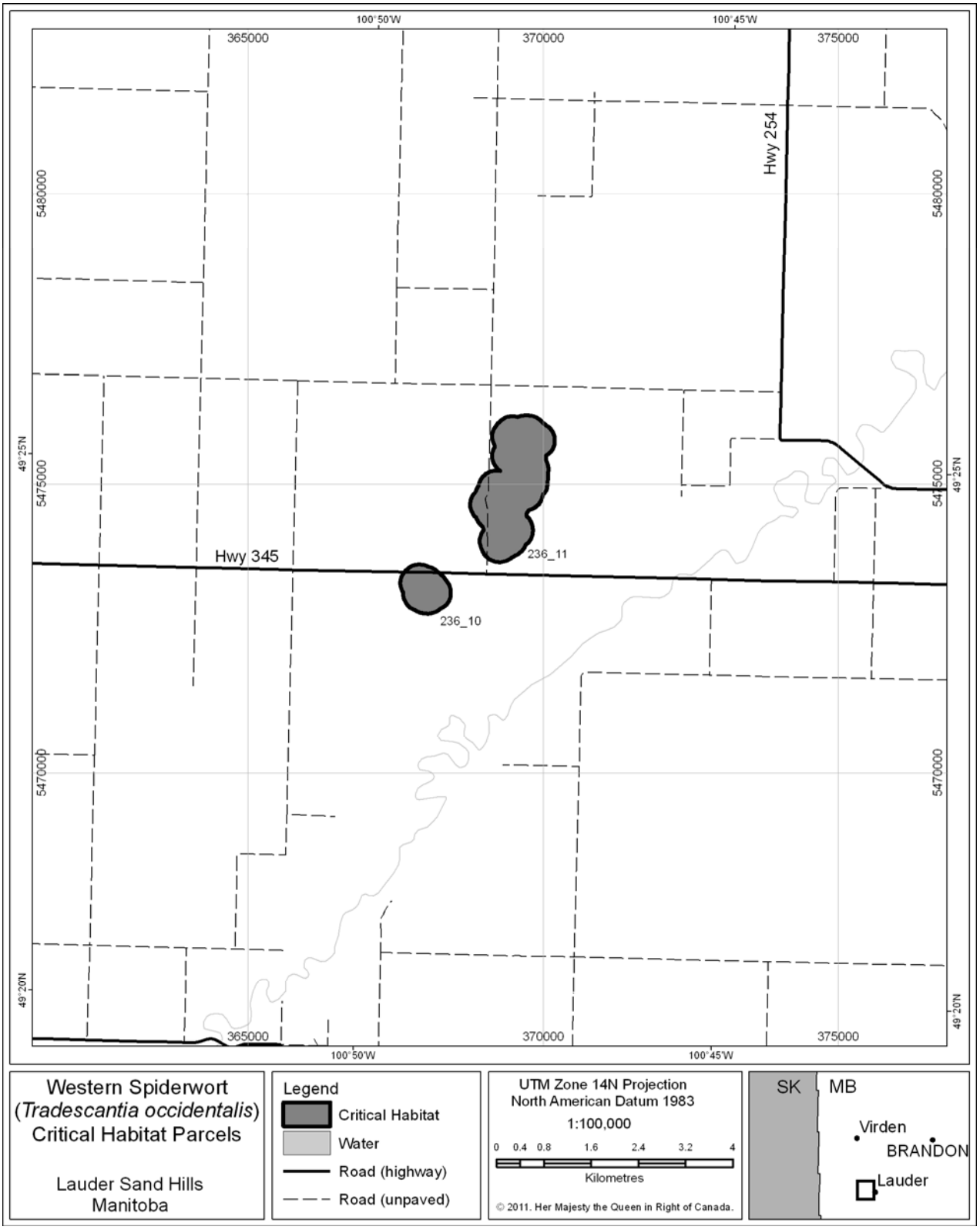
APPENDIX A. Maps of Western Spiderwort Critical Habitat



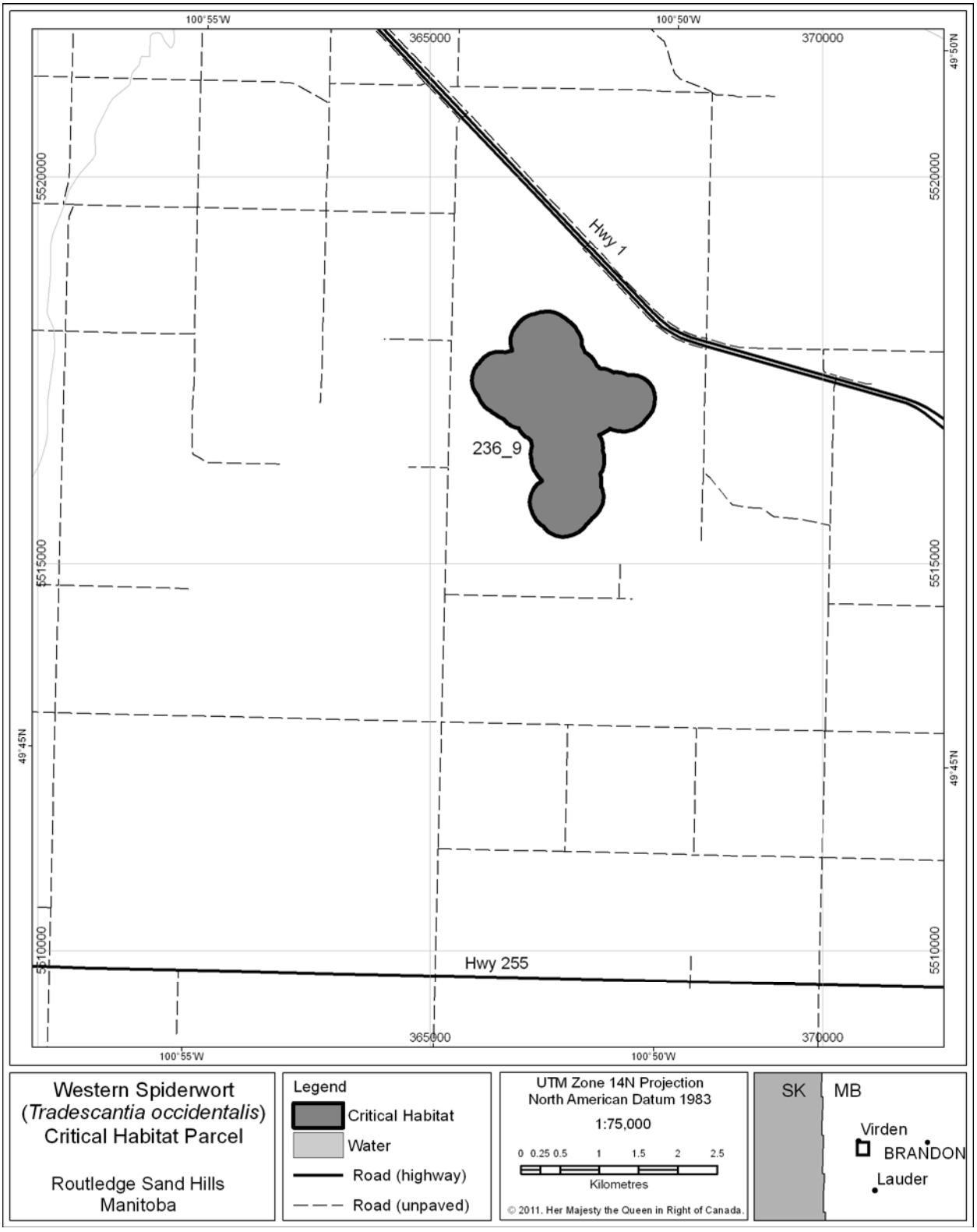
Area containing Western Spiderwort critical habitat for Alberta, Pakowki Lake Sand Dunes. Critical habitat includes natural landforms, soils, and native vegetation, but excludes rivers and waterbodies.



Areas containing Western Spiderwort critical habitat for Saskatchewan, Elbow Sand Hills. Critical habitat includes natural landforms, soils, and native vegetation, but excludes rivers and waterbodies.



Areas containing Western Spiderwort critical habitat for Manitoba, Lauder Sand Dunes. Critical habitat includes natural landforms, soils, and native vegetation, but excludes rivers and waterbodies.



Area containing Western Spiderwort critical habitat for Manitoba, Routledge Sand Dunes. Critical habitat includes natural landforms, soils, and native vegetation, but excludes rivers and waterbodies.

APPENDIX B. Quarter sections in Canada Containing Critical Habitat for Western Spiderwort[12]

SASKATCHEWAN				
Quarter section	**Section**	**Township**	**Range**	**Meridian**
NW	31	23	3	3
SW	31	23	3	3
NE	36	23	4	3
NW	36	23	4	3
SW	36	23	4	3
SE	36	23	4	3
NW	5	24	3	3
SE	6	24	3	3
NW	6	24	3	3
NE	6	24	3	3
SW	6	24	3	3
NW	7	24	3	3
NE	7	24	3	3
SW	7	24	3	3
SE	7	24	3	3
NW	8	24	3	3
SW	8	24	3	3
SW	17	24	3	3
NW	18	24	3	3
SW	18	24	3	3
SE	18	24	3	3
NE	18	24	3	3
SE	1	24	4	3
NE	1	24	4	3
NW	1	24	4	3
SE	11	24	4	3
SW	11	24	4	3
NE	11	24	4	3
SW	12	24	4	3
SE	12	24	4	3
NW	12	24	4	3
NW	13	24	4	3
NE	13	24	4	3
SW	13	24	4	3
SE	13	24	4	3
NE	14	24	4	3
SW	14	24	4	3

[12] Quarter sections identified in this table include those within which are located the boundaries of critical habitat as described in section 7.1 and 7.2. Although all quarter sections included within 300 m of a primary habitat patch are included in this table, not all of them contain natural landform, soil or native vegetation. As such they would not be part of the CH for this species. .

.

SASKATCHEWAN				
Quarter section	**Section**	**Township**	**Range**	**Meridian**
SE	14	24	4	3
NW	14	24	4	3
SE	15	24	4	3
NE	15	24	4	3
SE	22	24	4	3
SE	23	24	4	3
SW	24	24	4	3

ALBERTA				
Quarter section	**Section**	**Township**	**Range**	**Meridian**
NE	11	5	7	4
NW	11	5	7	4
NW	12	5	7	4
NW	13	5	7	4
SW	13	5	7	4
NE	14	5	7	4
NW	14	5	7	4
SE	14	5	7	4
SW	14	5	7	4
NE	15	5	7	4
NW	15	5	7	4
SE	15	5	7	4
SW	15	5	7	4
NE	16	5	7	4
NE	21	5	7	4
SE	21	5	7	4
NE	22	5	7	4
NW	22	5	7	4
SE	22	5	7	4
SW	22	5	7	4
NE	23	5	7	4
NW	23	5	7	4
SE	23	5	7	4
SW	23	5	7	4
NW	24	5	7	4
SW	24	5	7	4
SE	26	5	7	4
SW	26	5	7	4
SE	27	5	7	4
SW	27	5	7	4
SE	28	5	7	4

MANITOBA				
Quarter section	**Section**	**Township**	**Range**	**Meridian**
NE	17	5	25	1
NW	17	5	25	1
SE	20	5	25	1
SW	20	5	25	1
NE	20	5	25	1
SW	21	5	25	1
NW	21	5	25	1
NE	21	5	25	1
NE	28	5	25	1
SE	28	5	25	1
SW	28	5	25	1
NW	28	5	25	1
SE	29	5	25	1
NW	29	9	25	1
SW	29	9	25	1
SE	30	9	25	1
NE	30	9	25	1
SW	31	9	25	1
NW	31	9	25	1
NE	31	9	25	1
SE	31	9	25	1
NE	32	9	25	1
SE	32	9	25	1
SW	32	9	25	1
NW	32	9	25	1
SW	5	10	25	1
SE	6	10	25	1
SW	6	10	25	1

APPENDIX C. EFFECTS ON THE ENVIRONMENT AND OTHER SPECIES

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making.

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

A number of species rely on sand dunes for their survival, including other species at risk (Table 4) and provincially rare species that co-occur with Western Spiderwort. Most, if not all, of these species should benefit from recovery activities and management of threats intended to maintain dune ecosystems for the benefit of Western Spiderwort. The potential for the strategy to inadvertently lead to adverse effects on other species was considered. Some management activities, including prescribed burns and some forms of integrated weed management, have the potential to harm some species, at least in the short term. As a general rule, management actions that incorporate natural disturbance regimes (e.g., fire and grazing) are natural components of prairie ecosystems and should not negatively impact the persistence of other native species particularly if the timing, intensity and frequency mimic natural processes (Samson and Knopf 1994). Recovery activities 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 other recovery teams and organizations working in the dune ecosystem to ensure the most efficient use of resources and to prevent duplication of effort and conflicts with research. The broad strategies described in this recovery strategy are expected to benefit the environment and not entail any significant adverse effects on other species at risk or biodiversity of sand dune ecosystems.

Table 4. Species at risk which co-occur in areas occupied by Western Spiderwort.

Species Name	SARA Designation	Populations
Mammals		
Swift Fox (*Vulpes velox*)	Endangered	Pakowki (AB)
Birds		
Greater Sage Grouse (*Centrocercus urophasianus*)	Endangered	Pakowki (AB)
Loggerhead Shrike (*Lanius ludovicianus*)	Threatened	Pakowki (AB), Elbow (SK), Routledge (MB), Lauder (MB)
Common Nighthawk (*Chordeiles minor*)	Threatened	
Sprague's Pipit (*Anthus spragueii*)	Threatened	
Ferruginous Hawk (*Buteo regalis*)	Threatened	Pakowki (AB)
Reptiles		
Prairie Skink (*Plestiodon septentrionalis*)	Endangered	Lauder (MB)
Invertebrates		

Gold-edged Gem (*Schinia avementis*)	Endangered	Pakowki (AB)
Dusky Dune Moth (*Copablepharon longipenne*)	Endangered	Lauder (MB)
Pale Yellow Dune Moth (*Copablepharon grandis*)	Special Concern	Lauder (MB)
Vascular Plants		
Hairy Prairie-clover (*Dalea villosa* var. *villosa*)	Threatened	Lauder (MB)
Smooth Goosefoot (*Chenopodium subglabrum*)	Threatened	Pakowki (AB), Elbow (SK), Routledge (MB), Lauder (MB)

APPENDIX D. Beneficial Rangeland Management Practices

Western Spiderwort occupies a variety of locations that vary in ecology, land use history, and land tenure in three provinces. For these reasons, it is not possible to propose a general set of beneficial management plans that would be appropriate to encompass all critical habitat. Instead, specific recommendations will be made in one or more action plans or beneficial management plans at scales appropriate for general recommendations and application. At this time only a few general statements can be made regarding on-going activities that benefit Western Spiderwort.

Careful and deliberate application of grazing by one or more classes of livestock may help maintain open sandy habitats needed by Western Spiderwort, much the way wild ungulates would have historically. Management of these livestock requires occasional and randomly dispersed overland access on-foot, on-horseback, by all terrain vehicle, or on existing trails by vehicles up to 1 tonne. In light of these facts, no changes are recommended at this time to current stocking rates, grazing seasons, classes of livestock, fence, salt, feed or water distribution, or access methods used by property owners of critical habitat. Research is needed to determine if alternative grazing systems could enhance habitat, reproductive output, or dispersal of western spiderwort.

Integrated weed management to control Leafy Spurge, Baby's-breath, and Crested Wheatgrass invasion could directly reduce competition with Western Spiderwort, or indirectly change ungulate grazing behaviour or fuel quality for carrying fire that would otherwise improve habitat for Western Spiderwort. Approaches used to reduce the occurrence and density of invasive alien species on critical habitat need to be dealt with on a site-specific basis or in one or more action plans.

Fires resulting from accidental or deliberate ignition by people will not destroy critical habitat nor harm individual plants under most circumstances. In fact, prescribed burning that are carefully managed and that mimic the timing, frequency and intensity of natural processes can improve habitat by reducing or preventing invasion of woody vegetation, grass litter, insect pests and pathogens.

Environment Canada will work with all of its partners to define and improve best practices for conserving the Western Spiderwort across its range and to incorporate multi-species requirements and management in these sand dune ecosystems.