

COSEWIC Assessment and Status Report

on the

Slender Mouse-ear-cress *Crucihimalaya virgata*

in Canada



**THREATENED
2022**

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada



COSEPAC
Comité sur la situation
des espèces en péril
au Canada

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

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COSEWIC Assessment Summary

Assessment Summary – December 2022

Common name

Slender Mouse-ear-cress

Scientific name

Crucihimalaya virgata

Status

Threatened

Reason for designation

This prairie plant is globally at risk, and restricted to small areas where its population is declining as a result of threats including invasive species, fire suppression, alteration of grazing regimens, fragmentation by cultivation and conversion to tame pasture, and oil and gas development that, ultimately, results in a decline of habitat quality.

Occurrence

Alberta, Saskatchewan

Status history

Designated Endangered in April 1992. Status re-examined and designated Threatened in May 2000. Status re-examined and confirmed in December 2022.



COSEWIC
Executive Summary

Slender Mouse-ear-cress
Crucihimalaya virgata

Wildlife Species Description and Significance

Slender Mouse-ear-cress is a biennial, short-lived perennial (or sometimes annual) plant, 1–4 decimetres tall, arising from a taproot. Stems are one to several, with multi-branched hairs on the central axis and upper stems.

Aboriginal (Indigenous) Knowledge

All species are significant and are interconnected and interrelated. There is no species-specific ATK in the report.

Distribution

The Canadian distribution of Slender Mouse-ear-cress is restricted to southeastern Alberta and southwestern Saskatchewan. In the United States, it occurs in Montana, eastern Idaho, Wyoming, Colorado, Utah, Nevada, and southeastern California.

Habitat

In Canada, Slender Mouse-ear-cress occurs in open, sandy, short to mid-grass prairies that are dry to vernal moist. This species often establishes on flat prairie or in low prairie depressions. Suitable grassland habitat has declined greatly since the late 19th century, offering limited available habitat, which is often fragmented with reduced connectivity.

Biology

Slender Mouse-ear-cress relies on ephemeral flushes of resources such as moisture and nitrogen for germination and growth. The plant flowers in late May to June, so a crucial time for seed germination and seedling growth is likely late April to early May. Apart from a few field observations, no research has been done on the germination requirements of Slender Mouse-ear-cress. The species' reproductive and growth strategies are largely unknown. Factors, climatic or otherwise, that influence population variation and individual size remain unknown and require further research.

Population Sizes and Trends

The number of mature plants in a subpopulation can vary greatly from year to year, so determining the population size of Slender Mouse-ear-crec can be difficult. Few subpopulations have been surveyed repeatedly using census protocols to make conclusions on population trends; however, a declining trend has been determined for one subpopulation. Five subpopulations have been ranked historical since the last status update in 2000.

In Alberta, there are 12 subpopulations believed to be extant. Using the most recent plant count data for each extant subpopulation, the total population in Alberta would be estimated at 664 individuals; if using the plant count data from the year of highest abundance, it would be estimated at over 4,469 individuals.

In Saskatchewan, there are 20 known extant subpopulations. Using the most recent plant count data for each extant subpopulation, the total population in Saskatchewan would be estimated at 472 individuals; if using the plant count data from the year of highest abundance, it would be estimated at over 4,439 individuals.

Threats and Limiting Factors

The threats to Slender Mouse-ear-crec relate to ecosystem modification from invasive species and grazing regime alteration (which increase competition), drought, cultivation, utility and service lines (including oil and gas pipelines and wells), and fire suppression.

Protection, Status and Ranks

Slender Mouse-ear-crec is listed as Threatened under Schedule 1 of the federal *Species at Risk Act*. This species was first assessed by COSEWIC in 1992, when it was designated Endangered. The status was re-examined and designated Threatened in May 2000 and 2022. Within this species' range in Canada, it is listed as Endangered in Alberta and Threatened in Saskatchewan under each province's respective species at risk legislation.

Globally, this species is ranked as Vulnerable (G3) by NatureServe. It is ranked as Imperilled (N2) in Canada, Imperilled (S2) in Alberta, and Critically Imperilled (S1) in Saskatchewan. The species has not been assessed for the most current IUCN Red list.

TECHNICAL SUMMARY

Crucihimalaya virgata

Slender Mouse-ear-cress

Arabette mince

Range of occurrence in Canada (province/territory/ocean): Alberta, Saskatchewan

Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines (2011) is being used)	3–4 years
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Yes, inferred (based on declines in habitat quality and the overall threat impact)
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations, whichever is longer, up to a maximum of 100 years]	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years or 3 generations, whichever is longer, up to a maximum of 100 years].	Unknown
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years or 3 generations, whichever is longer, up to a maximum of 100 years].	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any period [10 years or 3 generations, whichever is longer, up to a maximum of 100 years], including both the past and the future.	Unknown
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	a. No b. Some causes are suspected. c. No
Are there extreme fluctuations in the number of mature individuals?	No. Although the population undergoes extreme fluctuations, this is offset by the seedbank.

Extent and Occupancy Information

Estimated extent of occurrence (EOO)	24,437 km ²
Index of area of occupancy (IAO) (Always report 2x2 grid value).	a) 272 km ² (488 km ² including historical)

Is the population “severely fragmented” i.e., is >50% of its total area of occupancy in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a) No b) Possibly
Number of “locations”* (use plausible range to reflect uncertainty if appropriate)	>10 (possibly 32)
Is there an [observed, inferred, or projected] decline in extent of occurrence?	No
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	Unknown
Is there an [observed, inferred, or projected] decline in number of subpopulations?	Unknown
Is there an [observed, inferred, or projected] decline in number of “locations”**?	Unknown
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Yes, inferred and projected (according to Habitat Trends)
Are there extreme fluctuations in the number of subpopulations?	No
Are there extreme fluctuations in the number of “locations”**?	No
Are there extreme fluctuations in the extent of occurrence?	No
Are there extreme fluctuations in the index of area of occupancy?	No

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	N Mature Individuals
Alberta Subpopulations (12)	664–4469+
Saskatchewan Subpopulations (20)	472–4,439+
Total	1,136–8,908

Quantitative Analysis

Is the probability of extinction in the wild at least [20% within 20 years or 5 generations, whichever is longer, up to a maximum of 100 years, or 10% within 100 years]?	Not Completed
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* See Definitions and Abbreviations on [COSEWIC website](#) for more information on this term.

Threats (direct, from highest impact to least, as per IUCN Threats Calculator)

Was a threats calculator completed for this species? Yes, in October 2021. Overall threat impact was “medium”

- i. Other ecosystem modifications 7.3 (Medium–Low Impact)
- ii. Droughts 11.2 (Medium–Low Impact)
- iii. Annual & perennial non-timber crops 2.1 (Low Impact)
- iv. Utility & service lines 4.2 (Low Impact)
- v. Fire suppression 7.1 (Low Impact)
- vi. Oil & gas drilling 3.1 (Unknown)

What additional limiting factors are relevant?

1. Slender Mouse-ear-cress relies on ephemeral flushes of resources like moisture and nutrients for germination and growth.

The early growth habitat of Slender Mouse-ear-cress makes the species susceptible to frost damage, which would be most consequential at the flowering stage.

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Vulnerable globally (G3); Possibly vulnerable in Montana (S3?)
Is immigration known or possible?	Possible, but unlikely
Would immigrants be adapted to survive in Canada?	Possibly
Is there sufficient habitat for immigrants in Canada?	Possibly, but limited
Are conditions deteriorating in Canada?+	Yes
Are conditions for the source (i.e., outside) population deteriorating?+	Possibly
Is the Canadian population considered to be a sink?+	No
Is rescue from outside populations likely?	No

Data Sensitive Species

Is this a data sensitive species?	No
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Status History

COSEWIC Status History: Designated Endangered in April 1992. Status re-examined and designated Threatened in May 2000. Status re-examined and confirmed in December 2022.

⁺ See [Table 3](#) (Guidelines for modifying status assessment based on rescue effect).

Status and Reasons for Designation:

Status: Threatened	Alpha-numeric codes: C2a(i)
Reasons for designation: This prairie plant is globally at risk, and restricted to small areas where its population is declining as a result of threats including invasive species, fire suppression, alteration of grazing regimens, fragmentation by cultivation and conversion to tame pasture, and oil and gas development that, ultimately, results in a decline of habitat quality.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Insufficient data to reliably infer, project, or suspect the magnitude of population trends.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. Although the IAO of 272 km ² is below the threshold for Endangered and there is an inferred continuing decline in habitat quality, the population is not believed to be severely fragmented, occurs at more than 10 locations, and does not experience extreme fluctuations.
Criterion C (Small and Declining Number of Mature Individuals): Meets Threatened, C2a(i). The number of mature individuals is 1,136 to 8,908, with fewer than 1,000 in any one subpopulation, and there is an inferred continuing decline in the number of mature individuals.
Criterion D (Very Small or Restricted Population): Not applicable. Estimate of a minimum of 1,136 mature individuals exceeds thresholds for D1, and population is not vulnerable to rapid and substantial decline.
Criterion E (Quantitative Analysis): Not applicable. Analysis not conducted.

PREFACE

Slender Mouse-ear-cress was previously named *Halimolobos virgata*, but based on taxonomy changes, it has been revised to *Crucihimalaya virgata* (German 2005).

Since the last assessment by COSEWIC in 2000, 8 additional subpopulations have been found in Alberta, and 16 additional subpopulations have been found in Saskatchewan. Five subpopulations described in the last assessment are now considered historical. With the newly described subpopulations, this corresponds to a small increase in the extent of occurrence (EOO) from 2000 levels, but still much less than the historical range. Some more individuals have been found, but large fluctuations have been observed between years when sites have been revisited. The increase in individuals found and the index of area of occupancy (IAO) since 2000 is a result of increased survey and inventory work that has been conducted for this species and includes incidental observations from pre-development rare plant surveys. Population trends cannot be evaluated based on the available information. No monitoring studies have been done to understand the taxon's demographic characteristics or population dynamics.

A recovery strategy for Slender Mouse-ear-cress was completed in 2012 with Critical Habitat identified covering 1,372 hectares (Environment Canada 2012). A notification of additional identified Critical Habitat was posted on the SARA Public Registry in July 2015 (Environment Canada 2015). In Alberta, the species was declared Endangered under the provincial *Wildlife Act* in 2011. The Alberta Recovery Plan for Slender Mouse-ear-cress was released in 2021 (Alberta Environment and Parks 2021).



COSEWIC HISTORY

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

COSEWIC MANDATE

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

COSEWIC MEMBERSHIP

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

DEFINITIONS (2022)

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

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

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

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



Environment and
Climate Change Canada
Canadian Wildlife Service

Environnement et
Changement climatique Canada
Service canadien de la faune

Canada

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

COSEWIC Status Report

on the

Slender Mouse-ear-cress *Crucihimalaya virgata*

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2022

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Scientific Name: *Crucihimalaya virgata* (Nuttall) D.A. German & A.L. Ebel

Synonyms: *Arabidopsis stenocarpa* (Rydberg) Rydberg; *Arabidopsis virgata* (Nuttall) Rydberg; *Arabis brebneriana* A. Nelson; *Beringia bursifolia* subsp. *virgata* (Nuttall) R.A. Price, Al-Shehbaz & O’Kane; *Halimolobos virgata* (Nutt.) O.E. Schulz; *Hesperis virgata* (Nuttall) Kuntze; *Pilosella stenocarpa* Rydberg; *Pilosella virgata* (Nuttall) Rydberg; *Sisymbrium virgatum* Nutt.; *Stenophragma virgatum* (Nuttall) Greene; *Transberingia bursifolia* ssp. *Virgata* (Nutt.) Al-Shehbaz & O’Kane; *Transberingia virgata* (Nuttall) N.H. Holmgren

Common names: Slender Mouse-ear-cress, Twiggy Fissurewort, Rod Halimolobos, Slender Halimolobos, Virgate Halimolobos, Stemmy Halimolobos

French Common name: Arabette mince

Family: Brassicaceae; mustard family

Major plant group: Dicot flowering plant

The taxonomy was revised to include Slender Mouse-ear-cress in the genus *Crucihimalaya* based on the re-evaluation of morphological, geographical, and molecular data (German 2005).

Description of Wildlife Species

Slender Mouse-ear-cress is a biennial or sometimes short-lived perennial, and occasionally an annual, flowering in the first year of growth (cover photo; ASRD and ACA 2009; Naeth *et al.* 2018). Stems are one to several, and 1–4 dm tall (Moss 1983). Slender Mouse-ear-cress flowers from late May to early June. The pods are circular or very slightly compressed in cross-section and are hairless, with the exception of some of the subpopulations in Saskatchewan in which the pods are hairy like the stem (Neufeld pers. obs.); genetic testing may be required to determine whether these are a different species or subspecies. Pods are irregularly biserrate (Moss 1983; ASRD and ACA 2009) and lack margins on wings, thus are most likely shed and land near the parent plants, creating a limited mechanism of dispersal. The plants are densely hairy, covered with greyish forked, multi-branched, and often simple hairs (trichomes; Moss 1983; Smith 1992). The key to the separation of Slender Mouse-ear-cress from other similar species is the presence of more than one type of branched hairs (trichomes), a trait common within the *Crucihimalaya* genus (German 2005). Slender Mouse-ear-cress has more than one type of multi-branched trichomes, with longer straight, simple, or forked hairs, and finer, shorter, freely branching hairs (Smith 2000; ASRD and ACA 2009). Further morphological description can be found in Moss (1983), Smith (2000), and ASRD and ACA (2009).

Population Spatial Structure and Variability

COSEWIC defines population size as the total number of mature individuals of the taxon (COSEWIC 2019). Subpopulations are defined as “geographically or otherwise distinct groups in the population where there is little demographic or genetic exchange” (COSEWIC 2019). For Slender Mouse-ear-cress, the subpopulation definition used is consistent with habitat-based plant element occurrence (EO) delimitation standards and is defined as a group of occurrences that are separated by less than 1 kilometre (km), or if separated by 1 to 3 km, with no break in suitable habitat between them exceeding 1 km; or if separated by 3 to 10 km but connected by linear water flow and having no break in suitable habitat between them exceeding 3 km (NatureServe 2020). There have been no studies on variability within the species.

Designatable Units

There are no recognized subspecies/varieties or discrete/evolutionary significant subpopulations to be recognized as designatable units. The occurrence of Slender Mouse-ear-cress in Canada is considered one designatable unit.

Special Significance

Slender Mouse-ear-cress is of high conservation value because the genetic diversity of peripheral populations is potentially important to the future adaptive capacity of species (Budd *et al.* 2015), and particularly for this species, which has a restricted global range and a Vulnerable global status (NatureServe 2021). In Canada, it is at the northern limit of its range and it occurs in a grassland habitat of high conservation concern in Canada.

ABORIGINAL (INDIGENOUS) KNOWLEDGE

Aboriginal Traditional Knowledge (ATK) is relationship-based. It involves information on ecological relationships between humans and their environment, including characteristics of species, habitats, and locations. Laws and protocols for human relationships with the environment are passed on through teachings and stories, and Indigenous languages, and can be based on long-term observations. Place names provide information about harvesting areas, ecological processes, spiritual significance, or the products of harvest. ATK can identify life history characteristics of a species or distinct differences between similar species.

Cultural Significance to Indigenous Peoples

There is no species-specific ATK in the report. However, Slender Mouse-ear-cress is important to Indigenous Peoples, who recognize the interrelationships of all species within the ecosystem.

DISTRIBUTION

Global Range

The species is a western North American plant found in the United States in Montana, eastern Idaho, Wyoming, Colorado, Utah, Nevada, and southeastern California (Figure 1; ASRD and ACA 2009; NatureServe 2021). The distribution shown in Colorado should be reviewed as it is based on as few as two historical reports (Maxwell pers. comm. 2022).



Figure 1. Distribution of Slender Mouse-ear-cress in North America (from ASRD & ACA 2009).

Canadian Range

In Canada, Slender Mouse-ear-creep is confined to southeastern Alberta and southwestern Saskatchewan (Figure 2). Ongoing fieldwork since 1992 has expanded the known occurrences of Slender Mouse-ear-creep in Canada. Nearly all occurrences (30 of 32) are located within the Mixed Grassland Ecoregion. There are two extant occurrences and one historical occurrence within the Moist Mixed Grassland Ecoregion, and two historical occurrences within the Cypress Upland Ecoregion (Ecological Stratification Working Group 1995; Government of Canada 2017).

Alberta

In Alberta, there have been 16 subpopulations of the species found; of these, 12 are extant, 3 are historical (i.e., (1) a species has not been documented in approximately 20–40 years despite some searching and/or some evidence of significant habitat loss or degradation; (2) a species or ecosystem has been searched for unsuccessfully, but not thoroughly enough to presume that it is no longer present in the jurisdiction), and 1 is extirpated (Table 1; See Hammerson *et al.* 2008; NatureServe 2020). Occurrences were ranked as historical if the subpopulations had not been reconfirmed for 20 or more years. The distribution of Slender Mouse-ear-creep in Alberta is within the watersheds of the Red Deer River (south of Drumheller), and South Saskatchewan River (downstream and northeast of Medicine Hat). Historically, Slender Mouse-ear-creep has been collected from Medicine Hat and the Cypress Hills but not since the late 1890s.

The species has been predominantly associated with the South Saskatchewan River drainage system from the South Saskatchewan / Red Deer River junction south to the Suffield National Wildlife Area. Since the updated status report in 2000, three additional subpopulations have been found within the Red Deer River watershed. This is in addition to the historical Duchess Pasture (Matzhiwin Creek) occurrence. A total of eight subpopulations have been added in Alberta since the updated Status Report (Smith 2000). These additional subpopulations have expanded the range 20 km north of the previously known extent of occurrence. Two subpopulations (Sandy Point, Duchess Pasture) have been ranked historical since the updated status report in 2000.

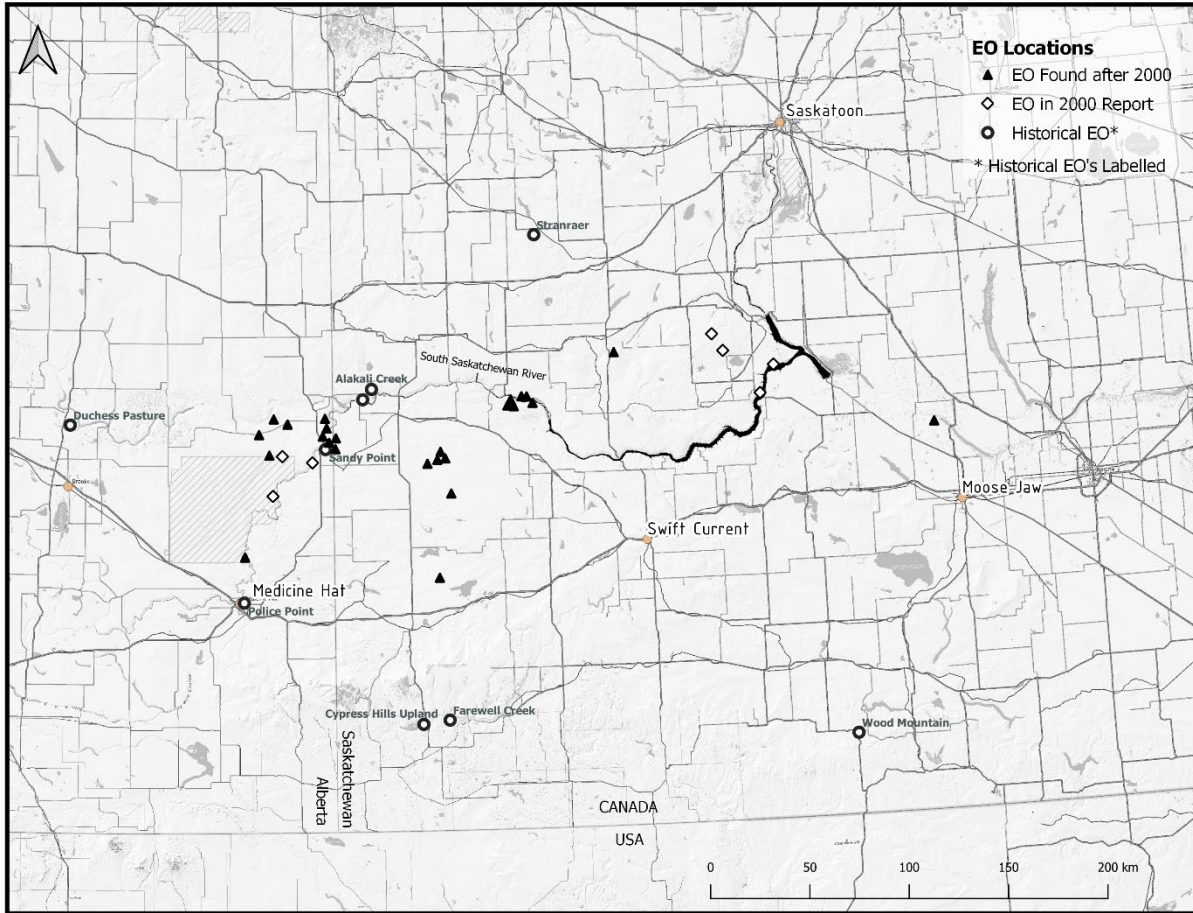


Figure 2. Distribution of Slender Mouse-ear-cress in Alberta and Saskatchewan. Map prepared by Daina Anderson (Tannas Conservation Services Ltd.).

Saskatchewan

In Saskatchewan, there are 26 subpopulations of the species, 20 extant, and 6 historical (**Table 1**). Many of the subpopulations within Saskatchewan have had few revisits, limiting the accuracy of the element occurrence rank. Slender Mouse-ear-cress is restricted to southwestern Saskatchewan, primarily within the South Saskatchewan River watershed, east to Diefenbaker Lake. Outside of the South Saskatchewan River watershed, there is one subpopulation in the North Saskatchewan River, and one in the Upper Qu'Appelle River watersheds. Historically, there were four subpopulations found among the Milk River, Eagle Creek, and Old Wives Lake watersheds.

Of the four subpopulations recorded since 2000, most are within the existing extent documented in Saskatchewan, except for the Marquis subpopulation. Increased survey effort likely explains the increased extent of occurrence in Saskatchewan since the last status report. Three subpopulations (Stranraer, South Saskatchewan River Crossing – N Estuary, and Alakali Creek) have been ranked historical since the updated status report in 2000.

Canada

Overall within Canada, the species exhibits a distribution pattern of disjunct Canadian subpopulations. Increased survey effort, including rare plant surveys associated with development, have increased the known distribution of this species in Canada, although five subpopulations have been ranked historical since the updated status report in 2000. The range of Slender Mouse-ear-cress has retracted greatly, with an increase in occurrences being ranked as historical since the updated status report in 2000 (cover photo; See also Extent of Occurrence and Area of Occupancy Section).

Table 1. Summary of Slender Mouse-ear-cress Subpopulations in Alberta and Saskatchewan

Province	Subpopulation Name (Master EO/EO i.d.) ¹	EO Rank ²	Years Surveyed (Plant Count) ³	Land Tenure, Land Use, Potential Threats
Alberta	Police Point Medicine Hat (8116)	X	1884 (>1) 1991-06-07 (0) 2002 (0)	Land ownership unknown because exact locality uncertain. Residential development and non-native species invasion.
Alberta	Rosedale N of Red Deer R. (18064)	H	1915 (>1)	Unknown.
Alberta	Sandy Point Hwy 41 at S. Sk. R. (8110) ⁴	H*	1978-05-16 (>0) 1991 (0) 1997 (0) 2002 (0) 2005 (0)	Private land used for grazing. Adjacent to public highway. Non-native plant species invasion (Crested Wheatgrass, Yellow Sweet-clover, and Smooth Brome).
Alberta	Linstead Flats CFB Suffield NWA (8109)	E	1995-06-23 (20) 1999 (0) 2005-06-26 (0) 2013-06-15 (1) 2014-05-24 (6) 2015 (0) 2016 (0) 2017-06-08 (2) 2019 (0) 2020 (0) 2021 (0)	National Wildlife Area. Oil and gas activity begun prior to National Wildlife Area designation. Non-native plant species invasion (Crested Wheatgrass).
Alberta	Duchess Pasture Matzhiwin Creek (8117)	H*	1997 (58) 2002 (0) 2005-06-20 (0) 2008-06-16 (0)	Private land, Irrigation District land under grazing lease. Oil and gas activity including large pipeline corridor. Invasion of non-native plant species.

Province	Subpopulation Name (Master EO/EO i.d.) ¹	EO Rank ²	Years Surveyed (Plant Count) ³	Land Tenure, Land Use, Potential Threats
Alberta	Remount Pasture SE N Boundary CFB Suffield (22479) ⁵	E	1997 (>216) 1999 (0) 2002 (0) 2004-06 (1317) 2008-07-02 (>25) 2009-05-22 (0) 2010-05-21 (0) 2014-07 (2)	AB public land in Special Areas Community Pasture. Oil and gas activity including large pipeline corridor. Invasion of non-native plant species.
Alberta	S Sk. R. pipeline crossing W of McNeill (8113) ³	E	1997 (>100) 1999 (0) 2002 (0) 2004 (0) 2013-06-16 (2) 2014-06-26 (>2)	AB public land under grazing lease. Oil and gas activity including large pipeline corridor.
Alberta	McNeill 1 (8112)	E	2004-06&09 (199) 2007-07 (251) 2008-06 (>59) 2009-05-21 (5) 2010-05-19 (139) 2011-05 (4) 2013-06-11 (56) 2016-05-18 (636)	AB public land under grazing lease and private land used for grazing. Oil and gas activity including large pipeline corridor. Transected by public gravel road.
Alberta	Bindloss W Remount Pasture (22428)	E	2007-05 (228) 2008-06-06 (193) 2009-05&06 (3) 2010-05&06 (20) 2011-05 (42) 2012-05-15 (59) 2013-05-22 (182) 2014-06&07 (12) 2015-05-22 (1766) 2016-05-21 (1201) 2017 (240) 2018-05-30 (8)	AB public land in Special Areas Community Pasture and public land under grazing lease. Oil and gas activity, including large pipeline corridor. Near public highway and old railway.
Alberta	W of Remount Pasture N Boundary CFB Suffield (17811)	E	2008-07-02 (47) 2009-05-22 (2) 2010-05-21 (4) 2011-05-18 (2)	AB public land under grazing lease. Oil and gas activity, including active wellsite. Large power line corridor. Invasion of non-native plant species (Crested Wheatgrass).

Province	Subpopulation Name (Master EO/EO i.d.) ¹	EO Rank ²	Years Surveyed (Plant Count) ³	Land Tenure, Land Use, Potential Threats
Alberta	Remount Pasture NW Cavendish (17814)	E	2008-07-05 (87) 2009-05-22 (0) 2010-05-20 (3) 2011-05-17 (0)	AB public land in Special Areas Community Pasture. Oil and gas activity including active well sites. Old cultivation nearby. Public highway nearby. Invasion of non-native plant species (Crested Wheatgrass).
Alberta	Empress 1 Big Loop S. Sk. R. (17812)	E	2008-07-03 (7) 2009-05-21 (0) 2010-05-20 (0) 2011-05-18 (0)	AB public land under grazing lease. Oil and gas activity including active gas well. Cultivation nearby. New public gravel road construction nearby. Invasion of non-native plant species (Crested Wheatgrass).
Alberta	Empress 2 Big Loop S. Sk. R. (17813)	E	2008-07-03 (15) 2009-05-21 (0) 2010-05-20 (1) 2011-05-18 (0)	AB public land under grazing lease. Oil and gas activity. Cultivation nearby. Invasion of non-native plant species (Crested Wheatgrass and Leafy Spurge).
Alberta	McNeill 2 (Northwest) S. Sk. River overlook (17843)	E	2008-07 (13)	AB public land under grazing lease. Oil and gas activity including large pipeline corridor.
Alberta	Bull Pen CFB Suffield NWA (24397)	E	2013-06-11 (38) 2014-05&06 (460) 2015-06 (170) 2016-06-21 (1) 2017-06 (62) 2019 (0) 2020 (0) 2021 (0)	National Wildlife Area. Oil and gas activity begun prior to NWA designation. Invasion of non-native plant species (Crested Wheatgrass and Leafy Spurge).
Alberta	Bindloss SE (25205)	E	2009-06-24 (>0)	Private land used for grazing, Oil and gas activity, large pipeline corridor.
Saskatchewan	Wood Mountain (16237)	H	1895-06-06 (>0)	Unknown.
Saskatchewan	Farewell Creek (16238)	H	1895-06-26 (>0)	Unknown.
Saskatchewan	Cypress Hills Upland Sucker Creek (16242)	H	1895-07-03 (>0)	Unknown.

Province	Subpopulation Name (Master EO/EO i.d.) ¹	EO Rank ²	Years Surveyed (Plant Count) ³	Land Tenure, Land Use, Potential Threats
Saskatchewan	Macrorie S of Macrorie (984)	E	1974-06-15 (>0) 2005-06 (133) 2008-06-15 (0) 2010-06-15 (2) 2013-07-09 (0) 2014-06-17 (0) 2019 (0)	SK public land. Agricultural grazing lease. Invasion of non-native plant species. Potential for reactivation of old gravel pit.
Saskatchewan	Birsay Camp Can-ta-ka-ye (3741)	E	1974-06-01 (>0) 2002-06 (0) 2004-07 (2) 2005-06-13 (0) 2014-07-03 (9)	Private land / SK public land. Invasion of non-native plant species (Crested Wheatgrass, Smooth Brome, Kentucky Blue Grass).
Saskatchewan	Riverhurst NW side of Lake Diefenbaker (6201)	E	1974-06-09 (>0; frequent) 1981-05-31 (>0; rare) 2005-06-14 (26) 2010-06-15 (0) 2011-06-08 (0) 2019 (0)	SK public land. Agricultural grazing lease. Actively used for grazing. Adjacent to cultivation. Invasion of non-native plant species.
Saskatchewan	Stranraer SW of Stranraer (7616)	H*	1985-05-18 (>0; rare) 2002-06 (0)	SK public land. Agricultural grazing lease. May have been visited in 2004, but no plants found.
Saskatchewan	Lucky Lake NW of Lucky Lake (4474)	E	1990-05-27 (>0; abundant) 1997 (?) 2005-06-15 (1)	Private land. Invasion of non-native plant species (Smooth Brome).
Saskatchewan	South Saskatchewan River crossing (N Estuary) East of Hwy 635/741 (16240)	H*	1997 (2)	SK public land. Agricultural grazing lease.
Saskatchewan	Alkali Creek N of South Saskatchewan River (16241)	H*	1997 (21)	Private land.

Province	Subpopulation Name (Master EO/EO i.d.) ¹	EO Rank ²	Years Surveyed (Plant Count) ³	Land Tenure, Land Use, Potential Threats
Saskatchewan	Great Sandhills – Prairie National Wildlife Area, Unit 20 (14877)	E	2004-06 (140) 2005-06 (271) 2006-06 (>2178) 2007-06 (3678) 2008-06 (1062) 2009 (0) 2011-05/06 (40) 2014-06 (159) 2019-05 (0)	Federal – National Wildlife Area. Existing oil/gas infrastructure within 300 m of EO. Invasion of non-native plant species (Crested Wheatgrass, Smooth Brome, Kentucky Blue Grass).
Saskatchewan	Liebenthal N of Liebenthal (11315)	E	2006-05-25 (142) 2008-summer (207)	Private and SK public land (grazing reserve; Wildlife Habitat Protection Area. Resource development [windmill]). Invasion of non-native plant species. Existing oil/gas infrastructure within 300 m of EO.
Saskatchewan	Great Sandhills – East Fox Valley (13080)	E	2006-06-09 (1)	SK public land. Agricultural grazing lease. Wildlife Habitat Protection Area. Existing oil/gas infrastructure within 300 m of EO.
Saskatchewan	Great Sandhills N (14875)	E	2006-05-25 (>121)	SK public land. Wildlife Habitat Protection Area. Invasion of non-native plant species. Existing oil/gas infrastructure within 300 m of EO.
Saskatchewan	Great Sandhills – Golden Prairie (14999)	E	2006-06-11 (100)	Private land. Existing oil/gas infrastructure within 300 m of EO. Oil and gas development.
Saskatchewan	South Easton 1 (13912)	E	2007-05-27 (6)	SK public land. Agricultural grazing lease. Threats – Grazing. Existing oil/gas infrastructure within 300 m of EO. EO within active PNG disposition.
Saskatchewan	Northeast Lancer (13914)	E	2007-06 (5) 2011-07-19 (1) 2013-07-10 (0) 2017 (0) 2019 (0)	Private land. Rare Plant Rescue Actively used for grazing. Existing oil/gas infrastructure within 300 m of EO. EO within active PNG disposition.

Province	Subpopulation Name (Master EO/EO i.d.) ¹	EO Rank ²	Years Surveyed (Plant Count) ³	Land Tenure, Land Use, Potential Threats
Saskatchewan	South Easton 2 (13915)	E	2007-06-02 (1)	SK public land. Agricultural grazing lease. Existing oil/gas infrastructure within 300 m of EO. EO within active PNG disposition.
Saskatchewan	Lancer (13916)	E	2007-06-05 (8)	Private land. Actively used for grazing. Existing oil/gas infrastructure within 300 m of EO. EO within active PNG disposition.
Saskatchewan	Great Sand Hills – East Liebenthal 2 (14876)	E	2008-summer (5)	SK public land. Wildlife Habitat Protection Area. Existing oil/gas infrastructure within 300 m of EO.
Saskatchewan	Burstall S (15359)	E	2010-06-09 (7) 2011-05-25 (11) 2012-05 (3) 2013-05 (0) 2014-06 (1) 2017 (0) 2019 (0)	Private land. Rare Plant Rescue. Actively used for grazing. Existing oil/gas infrastructure within 300 m of EO.
Saskatchewan	Marquis (15432)	E	2010-05 (15) 2011-05-19 (1) 2012-05-11 (0) 2013-05-16 (0) 2019 (0)	Private land. Rare Plant Rescue. EO occurs within Phase 3 of SK Irrigation Plan (future cultivation a possibility).
Saskatchewan	Lancer N (15923)	E	2011-07-24 (1) 2013-07-10 (0) 2017 (0) 2019 (0)	Private land. Rare Plant Rescue. Actively used for grazing. Existing oil/gas infrastructure within 300 m of EO. EO within active PNG disposition.
Saskatchewan	Lancer E (15946)	E	2011-06/07 (86) 2014-06-20 (>3)	Private land. Reservoir development lands. Existing oil/gas infrastructure within 300 m of EO. Invasion of non-native plant species (Crested Wheatgrass).
Saskatchewan	Burstall S (16239)	E	2011-06 (>14) 2012-05-24 (0) 2014-06-03 (0) 2017 (0) 2019 (0)	Private land. Rare Plant Rescue. Actively used for grazing.

Province	Subpopulation Name (Master EO/EO i.d.) ¹	EO Rank ²	Years Surveyed (Plant Count) ³	Land Tenure, Land Use, Potential Threats
Saskatchewan	Monet Pasture (17148)	E	2014-06-03 (10)	SK public land (Monet PFRA). Agricultural grazing lease. Oil and gas well within 30 m. Threats include invasion of non-native species.

¹Data provided by the Alberta Conservation Information Management System (ACIMS) and the Saskatchewan Conservation Data Centre, and current to the end of 2021; EO IDs correspond with those assigned by the respective data centres; Subpopulation Name matches those used in previous reports to the extent possible and new names given to those subpopulations not previously named (Smith 2000; ASRD and ACA 2009; Environment Canada 2012; Alberta Environment and Parks 2021).

²EO Rank based on guidelines outlined by NatureServe (2020), Element Occurrence (EO) Rank: E=extant; F=failed-to-find; H=historical; X=extirpated. See Hammerson *et al.* (2008) for definitions.

³ – Referred to as “South SK River, W side” in the federal recovery strategy (Environment Canada 2012).

⁴ – Referred to as “South SK River, Hwy 41” in the federal recovery strategy (Environment Canada 2012).

⁵ – EO 8015, 25207 and 25208 now included with EO22479 based on element occurrence definitions, and ACIMS database update.

*EO Rank has changed since updated status report in 2000.

Extent of Occurrence and Area of Occupancy

Extent of occurrence (EOO) of the extant population is 24,437 km², which is a small (5%) increase from the EOO of 23,360 km² at the time of the previous report in 2000, but less than 30% of the EOO if the historical range is considered (83,750 km²). The index of area of occupancy (IAO) is 272 km² (68 squares) for the extant population, which is an increase of 126% in the IAO in 2000, which was 120 km² (30 squares), but a decrease of 55% when the historical range is considered (488 km²; 122 squares). While the EOO has not changed much in area since the last Status Report in 2000, there has been a large increase in the IAO. This increase is presumed to be largely based on increased search efforts both in Alberta and Saskatchewan.

Search Effort

There has been increased search effort for rare vascular plants in southeastern Alberta and southwestern Saskatchewan, but the majority of search efforts have failed to find Slender Mouse-ear-cress (ASRD and ACA 2009; Putz pers. comm. 2022). Slender Mouse-ear-cress is known to exhibit fluctuating population sizes and may not be detected during surveys when present only in the seed bank (Smith 2000; ASRD and ACA 2009). Additionally, based on spring moisture levels, the plant has been reported to be sensitive to desiccation (Low 2016) and may not be detectable if surveys are not timed prior to seed set.

The known distribution may be close to an accurate representation of the actual distribution. The most recently discovered subpopulations have been located within the extent previously described in the last status report update, and largely within the historical extent, with the exception of one recently discovered subpopulation that extends the range slightly further east. There may be unknown extant subpopulations that have not been documented. Searches have been conducted primarily in response to proposals for oil and gas development, especially in Alberta.

All potential habitat has not been surveyed or even identified and delineated; however, significant conservation efforts have been made through the Rare Plant Rescue program (Nature Saskatchewan 2015), which surveys and monitors plant species at risk on private and provincial public lands in SK, with efforts related to Slender Mouse-ear-cress focused in the Great Sandhills area and eastern portion of “South of the Divide” in southwest SK. Since 2003, targeted searches have been conducted on 127 quarter sections, with nine occurrences found. Stewardship agreements have been set up with landowners for some of these occurrences. Significant conservation efforts have also been made through the Rare Plants and Ranchers program (Native Plant Society of Saskatchewan 1998), which collaborates with the Rare Plant Rescue program but does habitat monitoring on private and provincial public lands containing plant species at risk through range health assessments and the creation of adaptive beneficial management plans; program participants include landowners and land managers with Slender Mouse-ear-cress on their lands. In addition, surveys associated with proposed pipelines and other developments have discovered new occurrences of Slender Mouse-ear-cress at sites that have not previously been searched. Canadian Wildlife Service (Environment and Climate Change Canada) have also done extensive surveys for Slender Mouse-ear-cress in AB and SK on private, provincial and federal lands (including in National Wildlife Areas and in previously held PFRA community pastures) in SK and AB between 2004 and present.

Some new occurrences and subpopulations have been discovered as additional suitable habitat is surveyed in years with weather conditions favourable to germination and growth. This report is based on all known occurrences as of 2021. Given that surveys have discovered an increased number of subpopulations, additional sites could be expected within the historical and current distribution and in suitable habitat conditions. Timing of surveys is critically important in confirming the presence of Slender Mouse-ear-cress. Slender Mouse-ear-cress may often be completely dried and without any foliage or flowers by early to mid-June, making it hard to identify, and the growth form could be confused with Small-flowered Rocket (*Erysimum inconspicuum*) (Macdonald 1997). The species has been observed to senesce soon after going to seed, dropping leaves and desiccating quickly, impairing the ability to positively identify individuals. Also, based on observations from frequent monitoring, old stems have not been observed to persist, as the plant often breaks at the base or falls over soon after fruiting (Neufeld, pers. comm. 2022).

HABITAT

Habitat Requirements

Slender Mouse-ear-cress habitat is very similar over the extent of the Canadian range for the species. The typical habitat of Slender Mouse-ear-cress is open, sandy, short to mid-grass prairie that is dry to vernal moist. Slender Mouse-ear-cress is more frequently found on flat prairie (ASRD and ACA 2009; Naeth *et al.* 2020), and often on the edge of low prairie depressions (ASRD and ACA 2009; Nemirsky 2011). The grassland species associated with Slender Mouse-ear-cress sites are often June Grass (*Koeleria macrantha*) / Needle-and-thread Grass (*Hesperostipa comata*) / bluegrass spp. (*Poa* spp.) / wheatgrass spp. (*Elymus/Agropyron/Pascopyrum* spp.). In many cases, Slender Mouse-ear-cress is associated with more robust shrubs or cacti that can provide wind shelter and moisture sinks. Silver Sagebrush (*Artemisia cana*) or Plains Prickly-pear (*Opuntia polyacantha*) are two species often associated with Slender Mouse-ear-cress. On more marginal habitat, rose (*Rosa* spp.) and Western Snowberry (*Symphoricarpos occidentalis*) may also provide similar functions (Smith 2000). Several other species may also be associated (ACIMS 2021; SCDC 2021a).

More recent studies have found Slender Mouse-ear-cress plants are associated with soil conditions on the outer edge of temporary or seasonal depressions with lower vegetation cover, bare soils, and lower litter levels often associated with grazing or light disturbance (Nemirsky 2011). It has also been found to favour habitat with low competition and vegetation cover (Nannt 2014). A 10-year study of Slender Mouse-ear-cress along a pipeline right-of-way found the species to be more associated with sites with low cover but high litter cover. While it was found that pipeline construction had little negative effect on the species growing adjacent to pipeline development over 10 years, demonstrating the species tolerance of light to moderate disturbance (Naeth *et al.* 2020), it has been observed to grow up to, but be absent within, the pipeline right of way (Smith 2000; Neufeld pers. comm. 2022).

Habitat Trends

The trend for suitable habitat throughout this species' Canadian and global ranges has declined significantly and remains under threat. It is estimated that at least 70% of Canada's native prairie has been impacted and an even greater proportion degraded. Agricultural land use and land clearing for cultivation has affected the largest amount of grassland habitat, but other negative influences include industrial development, roads, and urbanization (ESTR Secretariat 2014). Land conversion occurred most significantly between the late 19th and 20th centuries but continues. Increased efforts within Alberta and Saskatchewan have been working to quantify these changes, as most estimates are based on estimates from the 1990s to 2000s (Hammermeister *et al.* 2001). In Alberta, it is estimated that 48% of native cover remains in the Grassland Natural Region (Alberta Prairie Conservation Forum 2019). The largest recent native cover declines have occurred near urban centres and native land cover losses have been greater on private land than on public lands (Alberta Prairie Conservation Forum 2019). In Saskatchewan, recent estimates

have found that 14% of native grasslands remain based on data from 2015, and additional declines of approximately 3% have occurred since 1990 (Sawatzky and Piwowar 2019).

While declines in habitat quantity continue, declines in habitat quality throughout the range of Slender Mouse-ear-cress are also affecting the species. The open grassland habitats occupied by Slender Mouse-ear-cress have largely been impacted by anthropogenic alterations, including agriculture (annual cropping and grazing), oil and gas development, invasion by exotic vascular plant species and, to a more minimal extent, urban development (Smith 2000; ASRD and ACA 2009; Environment Canada 2012; Alberta Environment and Parks 2021); see **Threats**. Invasive species have been observed within the plant communities at many of the known subpopulations, with high prevalence of aggressive graminoid species including Crested Wheatgrass (*Agropyron cristatum*), Smooth Brome (*Bromus inermis*), and Kentucky Bluegrass (*Poa pratensis*).

BIOLOGY

The following is primarily from the status report for Slender Mouse-ear-cress (Smith 2000).

Life Cycle and Reproduction

The reproductive and growth strategies of Slender Mouse-ear-cress are largely unknown. This ephemeral, weak biennial is abundant one year then apparently disappears for one to several years, only to reappear years later in small or expanded occurrences. Although typically biennial, some Slender Mouse-ear-cress plants in the United States produce flowers and seeds in the first year, and some biennials may be able to survive more than two seasons if seed is not produced in the second year (Alberta Sustainable Resource Development 2005). Seed can remain dormant in the soil for numerous years; it is difficult to predict the locality and density of plants in subsequent years (Chambers and MacMahon 1994). Seed production, germination rates and requirements, seed viability, seed dispersal, predation, pollination, and general population dynamics have been identified as knowledge gaps for this taxon (Environment Canada 2012).

Plants may be robust, tall, and well-branched one year then short, and single-stemmed another year. The factors, climatic or otherwise, responsible for population variation and size differences from year to year are largely unknown and require further research. Year-to-year variations are likely tied to available moisture and nitrogen in a given year or, more importantly, winter and spring temperatures (see **Fluctuations and Trends**).

When determining generation length for plants with seed banks, IUCN (2019) recommends using juvenile period + either the half-life of seeds in the seed bank or the median time to germination, whichever is known more precisely. Seed bank half-lives commonly range between <1 and 10 years. The generation time for Slender Mouse-ear-cress is therefore at least 3–4 years and possibly longer.

Physiology and Adaptability

Little is known of the physiology of Slender Mouse-ear-cress. It could be assumed that some adaptability is afforded the plants by their biennial reproductive strategy and ability for seeds to remain dormant for many years.

Dispersal and Movements

Little is known about the dispersal of Slender Mouse-ear-cress; however, dispersal distance is likely somewhat limited because the seeds do not have a structure to aid in dispersal by wind. While still attached to the plant, seed pods split open at maturity, which disperses the seeds mainly near the base of the parent plant (ASRD and ACA 2009). Seeds may be carried further by wind, water, or animals (potentially livestock) (ASRD and ACA 2009), but to what extent is not known.

Unlike most biennial and annual plant species, Slender Mouse-ear-cress may not disperse to new habitable sites quickly, but seeds can remain viable for numerous years until conditions become suitable for seedling establishment at the parent site. Biennials of this nature often produce large numbers of seeds after a local disturbance or unusual climatic event (Harper 1977).

Interspecific Interactions

Little is known about interspecific interactions of Slender Mouse-ear-cress. There are no known specific obligate relationships between Slender Mouse-ear-cress and insects that may use the plant as a food source. The specific method of pollination is also currently unknown and may be insect or wind mediated (self-fertilization may also occur). The species may benefit from moderate grazing by livestock, opening niches for seed establishment, and even though it is not thought to be selectively grazed, it may suffer from direct trampling (see **Threats and Limiting Factors Section**). An unknown Chrysomelidae beetle larva has been noted feeding on leaves, stems, and seed pods of Slender Mouse-ear-cress, although the prevalence and severity are unknown (Neufeld pers. comm. 2022).

POPULATION SIZES AND TRENDS

Data Sources, Methodologies, and Uncertainties

Population sampling effort has varied in frequency and intensity throughout Alberta and Saskatchewan. Survey methods have not been well documented with occurrence data and likely vary greatly between sampling years and observers. The varying documentation of survey methodology makes comparisons of subpopulations less informative.

More recently, new occurrences and subpopulations have been detected through rare plant surveys associated with pipeline pre-disturbance surveys. These surveys will have followed the rare plant survey guidance from each province (Henderson 2009; ANPC 2012;

Saskatchewan Ministry of Environment 2015). Prior to these protocols, meandering searches were likely targeting microhabitats thought to be suitable for the focal species; protocols now focus on standardized surveys, focusing on systematic, repeatable, often randomized placed transects that are stratified or unstratified, meant to present unbiased information about the presence or absence of the species. Known subpopulations and suitable habitat have also been searched by the Canadian Wildlife Service (Environment and Climate Change Canada) since 2004, consistently following standardized protocols (Henderson 2009); these standardized protocols are reflected in the provincial rare plant protocols. The Canadian Wildlife Service also conducts monitoring in subpopulations found on federal lands. Land stewardship and land management initiatives in Saskatchewan like Rare Plant Rescue and Rare Plants and Ranchers have also followed these same standardized guidelines when conducting surveys or monitoring since 2008.

Abundance

Population counts for each element occurrence are assumed to represent mature individuals unless otherwise stated in the notes for each subpopulation. Population numbers presented may be an overestimate based on this assumption. Two population numbers are presented, the sum of the highest count for each extant occurrence regardless of year, and also the population count for the most recent extant occurrence. As the number of mature plants in a subpopulation can vary greatly year to year for Slender Mouse-ear-cress, the highest count for each occurrence represents the most extreme variation. However, the highest count for each occurrence may neglect to show recent population trends. Determining population size is difficult for many small subpopulations that are influenced by different factors affecting abundance. In Alberta, there are 12 subpopulations believed to be extant (Table 1). In 2009, the provincial population of Slender Mouse-ear-cress was estimated at 3,000–7,000 individuals from the 9 known extant subpopulations at the time (ASRD and ACA 2009). This estimate took into account the available habitat around the subpopulations, most of which had not been adequately searched for Slender Mouse-ear-cress. Using the most recent plant count data for each extant subpopulation, the total population in Alberta is estimated to be 664 individuals; if using the plant count data from the year of highest abundance, it is estimated to be over 4,469 individuals (Table 1). This estimate includes an additional 3 subpopulations located since the estimate from 2009. There was additional search effort within the range in the years since 2009, yet the population size estimate has not increased from the estimate provided at that time. This estimate does not include plants that may occur in unsearched suitable habitat around extant occurrences as it did in 2009.

In Saskatchewan, Slender Mouse-ear-cress is known from 20 extant subpopulations (Table 1). In 2009, the provincial population was estimated at 4,150–4,400 individuals from the 14 known extant subpopulations at that time (ASRD and ACA 2009). Using the most recent plant count data for each extant subpopulation, the total population in Saskatchewan it is estimated to be 472 individuals; if using the plant count data from the year of highest abundance, it is estimated to be over 4,439 individuals (Table 1). An additional 6 subpopulations were found since 2009.

Fluctuations and Trends

There are insufficient historical and long-term data collected for this species to reliably infer, project, or suspect the magnitude of population trends. In the case of annual and biennial plants, the locality and density of mature plants reflects patterns of seed dispersal in previous years. As the seed may lay dormant for many years, predicting the locality and density of plants in future years is difficult (Environment Canada 2012). Based on the repeat visits that have been completed at extant subpopulations, the extent of Slender Mouse-ear-cress varies temporally, and is not static or predictable. For example, Rare Plant Rescue had conducted 56 monitoring visits at 14 known Slender Mouse-ear-cress subpopulations, and they have found the species three times (Putz pers. Comm. 2022). There are seven subpopulations that have had plant counts ranging from 100 to over 3,000, but in some years have recorded only single digit plant counts (Table 1).

Detection bias is also another factor impacting trends among years (Environment Canada 2012). With Slender Mouse-ear-cress, this may be caused by the interaction of various factors stimulating germination and the search efficiency of people looking for these plants. Naeth *et al.* (2020) observed that warmer winter and spring temperatures were drivers of seed germination and plant establishment, irrespective of spring moisture. Similarly, Lee and Neufeld (2019) documented that spring snowmelt could explain 63% of the variation in the number of plants among years for the subpopulation monitored within the Prairie National Wildlife Area, Unit 20 (EO 14877). However, these findings were not consistent when exploring data for a similar study at the Canadian Forces Base, Suffield, although the occurrence data were quite limited and may have influenced not seeing a similar result (Neufeld pers. comm. 2022). More study is needed on the factors affecting seed germination and plant establishment to further understand yearly population fluctuations. In certain years, more plants have been observed to germinate and form larger patches of plants that are more easily detected and discovered (Smith 2000). In drought years, it is less likely that new occurrences will be discovered, because plants occur as more widely separated and inconspicuous clusters or isolated individuals. These annual fluctuations can also impact the evaluation of subpopulation trends (Bradley and MacDonald 2016). A decreasing linear trend has been observed at one subpopulation at the Prairie Natural Wildlife Area, Unit 20 (EO 14877), with regular monitoring intervals, but so far the trend is not significant and fluctuations within the natural range of variation cannot be ruled out. The natural variation in plant counts varied from zero to over 3,400 plants between 2005 and 2019 (Lee and Neufeld 2019). IUCN Red List Guidelines (IUCN 2022) suggest that the total population includes the seedbank. As such, the population is not considered to undergo extreme fluctuations.

Severe Fragmentation

Although it was considered that Slender Mouse-ear-cress could be severely fragmented based on having 19 of 32 extant subpopulations with plant counts fewer than 50 individuals ever recorded, and 11 with fewer than 10 individuals ever recorded and it is probable that greater than 50% of the total area of occupancy is in habitat patches that likely do not support viable subpopulations. Also, based on the limited information on seed

dispersal, and likely assumptions of limited dispersal ability, it is probable that greater than 50% of the occupied habitat patches are separated by distances larger than the relative dispersal distance of the species. However, most of the mature individuals are concentrated into three large subpopulations (McNeil, Bindloss, and Great Sandhills) that are considered viable and therefore the species is not considered Severely Fragmented when considering application of criterion B and C.

Rescue Effect

The nearest known population outside Canada is in Montana, 10 km south of the border with Alberta (ASRD and ACA 2009). However, the species is rare in the state and last reported in the border area in 1989 and is otherwise only known in southern areas of the state (Maxwell pers. comm. 2022). The probability of rescue from the U.S. is low based on the hypothesis that seed dispersal is likely to be rare over long distances, and the species is also rare in the United States and possibly declining (NatureServe 2021).

THREATS AND LIMITING FACTORS

Threats

Direct threats assessed in this report were organized and evaluated based on the IUCN-CMP (International Union for the Conservation of Nature-Conservation Measures Partnership) unified threats classification system (Salafsky *et al.* 2008; Master *et al.* 2012). Threats are defined as the proximate activities or processes that directly and negatively affect all individuals of the taxon present. Results on the impact, scope, severity, and timing of threats are presented (Appendix 1). The calculated threat impact is High to Medium but the assigned impact was assigned Medium. The threats are listed below according to their calculated level of impact, from highest to lowest.

The threats to Slender Mouse-ear-cress relate ultimately to alteration of habitat, including loss of habitat from changes in land use, such as petroleum exploration and development or urban residential development. Some proximate causes of habitat alteration include decreased or lack of grazing, fire suppression, climate change, and encroachment of invasive vegetation as Slender Mouse-ear-cress appears to require some element of disturbance (Smith 2000; ASRD and ACA 2009; Low 2016).

These threats are discussed in the following sections in decreasing order of importance based on the current state of knowledge. Additional information and description of threats to Slender Mouse-ear-cress can be found in the Alberta Recovery Plan (Alberta Environment and Parks 2021), the Alberta Status Report (ASRD and ACA 2009), and the Federal Recovery Strategy (Environment Canada 2012). Much of the information presented in the following sections on threats and limiting factors is taken from the recovery strategy (Environment Canada 2012).

Natural System Modifications

7.3 Other ecosystem modifications (Medium-Low Impact)

Habitat degradation resulting in increased thatch and increased competition from invasive species, and changes to grazing regimes are one of the most serious and plausible threats to Slender Mouse-ear-cress. The limited, relatively undisturbed native prairie throughout Alberta and Saskatchewan that remains is further vulnerable to invasion by aggressive non-native species, especially agronomic grass species (Natural Regions Committee 2006). Within the Grassland Natural Region, Kentucky Bluegrass, Smooth Brome, Crested Wheatgrass, and Common Timothy (*Phleum pratense*) were non-native species found in plots characterizing native plant communities (Adams *et al.* 2005, 2013). In the current and historical range of Slender Mouse-ear-cress, the most aggressive invasive species are those adapted to dry conditions that can also overtop and exclude other species. These species include Crested Wheatgrass, sweetclover (*Melilotus* spp.), and Alfalfa (*Medicago sativa*), while Kentucky Bluegrass is typically limited to wetter sites. Further invasion by newly arriving invasive species is also a concern as some are even more aggressive and include Downy Brome (*Bromus tectorum*) and Tall Baby's-breath (*Gypsophila paniculata*). All of these species are present regionally to the extant subpopulations. There are 15 extant subpopulations that noted the presence of non-native species as a threat (ACIMS 2021; SCDC 2021a). However, non-native invasive species are likely present within most sites, and the Element Occurrence data does not fully account for the presence of non-native species. There are multiple sites where Crested Wheatgrass, Kentucky Bluegrass, and Leafy Spurge (*Euphorbia virgata*) could threaten subpopulations of Slender Mouse-ear-cress in Saskatchewan and Alberta. Slender Mouse-ear-cress has been found growing among Crested Wheatgrass and Kentucky Bluegrass where it has invaded native prairie, as well as among Crested Wheatgrass in a previously cultivated field. Based on monitoring of invasive graminoids at the Prairie Natural Wildlife Area, Unit 20 (EO 14877), Kentucky Bluegrass, Smooth Brome, and Crested Wheatgrass increased in plot cover between 2009 and 2019, with increases of 19%, 4%, and 17%, respectively (Lee and Neufeld 2019). The full long-term impacts of these invasive aliens on Slender Mouse-ear-cress presence are not known and need further study.

Grazing has an integral role in prairie ecosystems and can offset some non-native species impacts; however, grazing levels needs to be managed appropriately to optimize benefits and reduce ecological impacts. There are consequences of grazing being too light or heavy. Grazing has been listed as a threat for many element occurrences, but in many circumstances, the disturbance from grazing may also be maintaining suitable habitat. Alteration to grazing regimes can also threaten Slender Mouse-ear-cress subpopulations. Cattle do not appear to selectively graze Slender Mouse-ear-cress, although incidental grazing and trampling occasionally occur (ACIMS 2021; SCDC 2021a). Light disturbance by cattle or other livestock may assist in opening up small patches of bare soil for seed establishment and in reducing litter and surrounding vegetation to assist in germination and establishment. Slender Mouse-ear-cress is classified as an increaser in range surveys in Wyoming (Alberta Sustainable Resource Development 2005), which indicates that it prospers under a modest grazing regime. It is unknown whether high intensity, long-term grazing that exceeds the carrying capacity of the rangeland would positively or negatively

affect Slender Mouse-ear-cress.

Climate change & severe weather

11.2 Droughts (*Medium-Low Impact*)

There is only speculation about what effects climate change will have on this species. A shift towards a warmer climate may negatively impact Slender Mouse-ear-cress if this results in extended periods of drought. Although Slender Mouse-ear-cress is likely adapted to withstand periodic droughts, it is unknown whether long periods of drought may exceed the longevity of seeds in the seed bank. Seedlings and mature plants may flourish after a sporadic rainfall in spring or fall, but then prematurely die from desiccation in hot, dry summer conditions (Alberta Sustainable Resource Development 2005; ASRD and ACA 2009). Repeated years of this cycle would likely reduce the number of seeds in the seed bank. This impact may already be causing population declines that are difficult to detect without further research.

Agriculture & aquaculture

2.1 Annual & perennial non-timber crops (*Low Impact*)

The remaining native prairie in Alberta and Saskatchewan is fragmented by cultivation and conversion to tame pasture. Most remnant patches are small and isolated from other suitable habitat patches. This threatens the natural patterns of seed dispersal and gene flow within former subpopulations and between extant subpopulations. As well, irrigation and the use of some chemicals (e.g., herbicides, fertilizers, pesticides) on adjacent cultivated areas have the potential to alter the habitat on the native prairie (e.g., change species composition, canopy cover, hydrology, and soil stability; and degrade pollinator populations).

Cultivation has reduced overall habitat availability, population size, and genetic diversity of this species to the point where full recovery to its historical range is no longer possible (ECCC 2012). Cultivation continues to expand in the Prairies, and can expand to previously unsuitable habitat with irrigation projects. The Saskatchewan Water Security Agency is proposing to expand irrigation projects around Lake Diefenbaker in Saskatchewan. There are three element occurrences within different phases of the irrigation plan that could be under threat of cultivation within the next 10 years.

Transportation & Service Corridors

4.2 Utility & service lines (*Low Impact*)

Oil and gas activities are listed as threats to 26 extant subpopulations of Slender Mouse-ear-crec, greater than 80% of extant element occurrences (ACIMS 2021; SCDC 2021a). The ongoing maintenance and potential for detrimental spills continue to be a threat across most of the subpopulations.

Oil and gas activities post-installation include ongoing production and transportation, abandonment, and reclamation. The specific threats posed to plant species at risk can vary depending upon the type of petroleum resources extracted. In the Prairie Ecozone, the two most common petroleum resources extracted are crude oil and natural gas (Environment Canada 2012; Alberta Environment and Parks 2021). Related maintenance activities including ongoing use of access roads and well pads, driving overland with trucks >1 tonne, drilling activities, and spraying of adjacent lands with waste drilling fluids, which all have the potential to directly and indirectly impact Slender Mouse-ear-crec.

Natural system modifications

7.1 *Fire and fire suppression* (Low Impact)

Prairie plants evolved with the ecological processes of fire and grazing which were important for maintaining ecosystem function. Since widespread settlement in the Prairies, fire has largely been reduced within these systems. Alteration of natural fire regimes results in increased thatch and vegetation encroachment, reducing habitat for Slender Mouse-ear-crec. Fire would open up habitats for the species. Cattle grazing can help reduce the threat of fire suppression. Cattle grazing does not apparently affect the survival of this species as most subpopulations are found within actively grazed pastures.

Limiting Factors

Slender Mouse-ear-crec relies on ephemeral flushes of resources like moisture and nutrients for germination and growth. It is probable that seedlings will desiccate if not enough moisture is received in critical growing periods, and seeds may fail to germinate during these times (Alberta Sustainable Resource Development 2005; ASRD and ACA 2009). Because the plants flower in late May to June (Smith 1992), a crucial time for the germination of seeds and/or growth of seedlings might be late April to early May (Nannt 2014; Low 2016). At a few sites, Slender Mouse-ear-crec was found in relatively large numbers after receiving normal levels of precipitation in May, following a drought year. Other than these few field observations, no research has been done on the germination requirements of Slender Mouse-ear-crec, or on the time of year that seeds germinate and seedlings are produced. The early growth habitat of Slender Mouse-ear-crec makes the species susceptible to frost damage, which would be most consequential at the flowering stage. A killing frost would have the potential to deplete the seed bank if plants were unable to produce viable seeds. Evidence of frost damage has been observed during the

flowering/fruitleting stage, although plants continue to flower and produce viable pods (Neufeld pers. comm. 2022).

It was thought that Slender Mouse-ear-cress was not able to become re-established on cultivated soil (Smith 2000). However, the species was observed on a previously cultivated pasture seeded to Crested Wheatgrass (Godwin and Thorpe 2004). Absences of Slender Mouse-ear-cress on other cultivated lands may be from dispersal distance limitations, or lack of adequate time since cultivation to develop conditions suitable for seed germination and growth. There are numerous cases of pipeline rights-of-way adjacent to Slender Mouse-ear-cress subpopulations where plants grow up to the edge of, but not within, the pipeline right-of-way (Smith 2000). This suggests that the disturbance has made the area unsuitable for Slender Mouse-ear-cress, or possibly buried seeds too deep for seedling emergence. However, more recent research studies at two pipeline rights-of-way in Alberta have found occurrences within or immediately adjacent to the pipeline trench (Nannt 2014; Low 2016). The positive results of more recent studies may also be evidence of improved construction methods, with improved reclamation and soil handling during installation (Neufeld pers. comm. 2022).

Number of Locations

The highest ranked threats were “Other Ecosystem Modifications” and “Drought.” Both these threats were evaluated to be pervasive in scope, moderate to slight in severity, and high in timing due to a continuing threat (Appendix 1). Local land management and geographically distinct areas were considered when defining the number of locations. There are 32 extant subpopulations based on the known and potential threats for each subpopulation (Table 1). Nearly all of the subpopulations are located within the mixed grassland ecoregion and a few subpopulations are located within the adjacent moist mixed grassland ecoregion. Without detailed information on local land management (e.g., grazing lease holder, grazing management), it was determined that ecoregions may be the most appropriate regions to define ecologically distinct areas. Thirty-two locations are considered as a minimum across the range of Slender Mouse-ear-cress. The number of locations exceeds 10, which is the threshold for meeting criteria for Threatened. While the threat of drought could act across multiple subpopulations, climatic events can be local, regional, or multi-jurisdictional. With the high uncertainty around climatic events, it is difficult to evaluate and define the number of locations based on this threat (IUCN Standards and Petitions Committee 2019).

PROTECTION, STATUS, AND RANKS

Legal Protection and Status

Slender Mouse-ear-cress is afforded some level of protection on Federal lands as a Threatened species listed under Schedule 1 of the federal *Species at Risk Act*. A federal recovery strategy for Slender Mouse-ear-cress was completed in 2012, with Critical Habitat identified covering 1,372 hectares (Environment Canada 2012). Additional identified Critical

Habitat was published on the SARA Public Registry in July 2015, and includes the subpopulations on the Canadian Forces Base Suffield National Wildlife Area and Prairie National Wildlife Area, Unit 20 (Environment Canada 2015).

Slender Mouse-ear-creep was declared Threatened in Saskatchewan under Part V of *The Wildlife Act* in 1999. In Alberta, the species was declared Endangered under the provincial *Wildlife Act* in 2011. The Alberta Recovery Plan for Slender Mouse-ear-creep was released in 2021 (Alberta Environment and Parks 2021).

Non-Legal Status and Ranks

COSEWIC assessed Slender Mouse-ear-creep as Endangered in April 1992 (Smith 1992). The status was re-examined and assessed as Threatened in May 2000 (Smith 2000). Slender Mouse-ear-creep has a NatureServe rank of Critically Imperilled (S1) in Saskatchewan (SCDC 2021b) and Imperilled (S2) in Alberta (ACIMS 2021). The Canadian national rank is Imperilled (N2; NatureServe 2021). In the United States, the national rank is Vulnerable (N3; NatureServe 2021). The species is not listed federally in the United States. Within its range in the U.S., the status is not ranked (SNR) in Idaho and Nevada. It is ranked as Vulnerable (S3) in Wyoming and Possibly Vulnerable (S3?) in Montana. In California and Colorado, the species is ranked as Imperilled (S2). In Utah, Slender Mouse-ear-creep is ranked as Critically Imperilled (S1; NatureServe 2021). Globally, Slender Mouse-ear-creep is ranked as Vulnerable (G3), last reviewed in 2016 (NatureServe 2021). The species has not been assessed by the International Union for the Conservation of Nature (IUCN 2022).

Habitat Protection and Ownership

In Canada, Slender Mouse-ear-creep is found on lands with a variety of ownership, including federal, provincial, and privately owned lands. About 53% of Slender Mouse-ear-creep subpopulations are found on provincial lands, where most are leased for grazing. Federal lands in CFB Suffield and Prairie National Wildlife Area, Unit 20 account for another 15% of subpopulations. Privately owned lands account for 31%. The land ownership proportions do not correspond with the same proportion of mature individuals. Of the total for the most recent plant counts, 16% are on public land, 18% are on federal lands, and 10% are on private lands. One subpopulation occurs on both private and public land, and accounts for 55% of the most recent plant count total.

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INFORMATION SOURCES

Adams, B.W., L. Poulin-Klein, D. Moisey, and R.L. McNeil. 2005. Range plant communities and range health assessment guidelines for the Dry Mixedgrass Natural Subregion of Alberta. First approximation. Alberta Sustainable Resource Development, Range Management Branch, Public Lands and Forests Division, Lethbridge, Alberta.

- Adams, B.W., J. Richman, L. Poulin-Klein, K. France, D. Moisey, and R.L. McNeil. 2013. Rangeland plant communities and range health assessment guidelines for the Mixedgrass Natural Subregion of Alberta. Second Approximation. Lethbridge, Alberta. 85 pp.
- Alberta Conservation Information Management System (ACIMS). 2021. Element Occurrence Data – Slender Mouse-ear-cress. Alberta Environment and Parks, Edmonton, Alberta.
- Alberta Environment and Parks. 2021. Alberta Slender Mouse-ear-cress recovery plan. Number 39. Edmonton, Alberta. 31 pp.
- Alberta Native Plant Council (ANPC). 2012. Guidelines for rare vascular plant surveys in Alberta 2012 Update. Alberta Native Plant Council, Edmonton, Alberta. Website: <https://anpc.ab.ca/wp-content/uploads/2015/01/Guidelines-For-Rare-Plant-Surveys-in-AB-2012-Update.pdf> [accessed March 2019].
- Alberta Prairie Conservation Forum. 2019. State of the Prairie: Technical Report. 13 pp. Available online: https://www.albertapcf.org/rsu_docs/ar2018-2019.pdf
- Alberta Sustainable Resource Development. 2005. Status of the Slender Mouse-ear-cress (*Halimolobos virgata*) in Alberta. Edmonton, Alberta.
- ASRD and ACA. 2009. Status of the Slender Mouse-ear-cress (*Halimolobos virgata* or *Transberingia bursifolia* subsp. *virgata*) in Alberta: Update 2009. No. 55. Alberta Sustainable Resource Development, Edmonton, Alberta.
- Bradley, C.E., and I. MacDonald. 2016. Status of the Slender Mouse-ear-cress (*Halimolobos virgata* or *Transberingia bursifolia* subsp. *virgata*) in Alberta, No. 55: update 2009.
- Budd, C., E. Zimmer, and J.R. Freeland. 2015. Conservation genetics of *Magnolia acuminata*, an endangered species in Canada: Can genetic diversity be maintained in fragmented, peripheral populations? *Conservation Genetics* 16:1359–1373.
- Chambers, J.C., and J.A. MacMahon. 1994. A day in the life of a seed: movements and fates of seeds and their implications for natural and managed systems. *Annual Review of Ecology and Systematics*. 25:263–292. Available online: <https://doi.org/10.1146/annurev.es.25.110194.001403>
- COSEWIC. 2019. Instructions for the preparation of COSEWIC status reports. 36 pp. Available online: https://cosewic.ca/images/cosewic/pdf/Instructions-for-status-report-writers-Nov2019_EN.pdf [accessed November 2020].
- , Ecological Stratification Working Group. 1995. A national ecological framework for Canada. Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research and Environment Canada, State of the Environment Directorate, Ecozone Analyses Branch, Ottawa/Hull. Report, 125 pp and national map at 1:7,500,000 scale.

- Ecosystem Status and Trends Report (ESTR) Secretariat. 2014. Boreal Plains Ecozone + evidence for key findings summary. Canadian Biodiversity: Ecosystem Status and Trends 2010, Evidence for Key Findings Summary Report No. 12. Canadian Councils of Resource Ministers. Ottawa, Ontario. ix + 106 p. Available online: https://publications.gc.ca/site/archivee-archived.html?url=https://publications.gc.ca/collections/collection_2011/ec/En14-26-2010-eng.pdf
- Environment Canada. 2012. Recovery Strategy for the Slender Mouse-ear-cress (*Halimolobos virgata*) in Canada. Environment Canada, Ottawa, Ontario, v+45 pp.
- Environment Canada. 2015. Description of Slender Mouse-ear-cress critical habitat in the Canadian Forces Base Suffield National Wildlife Area and Prairie National Wildlife Area (unit number 20). Canada Gazette. 149(28).
- German, D.A. 2005. Contribution to the taxonomy of *Arabidopsis* s. l. (Cruciferae): the status of *Transberingia* and two new combinations in *Crucihimalaya*. Turczaninowia. 8(4):5–15.
- Godwin, B., and J. Thorpe. 2004. Limited Report: Plant species at risk survey of four PFRA Pastures. Saskatoon, Saskatchewan.
- Government of Canada. 2017. A National Ecological Framework for Canada: GIS Data. CGDI National Frameworks Data; Atlas of Canada 1,000,000 National Frameworks Data.
- Hammermeister, A., D. Gauthier, and K. McGovern. 2001. Saskatchewan's Native Prairie: Statistics of a Vanishing Ecosystem and Dwindling Resource. Saskatoon, Saskatchewan.
- Hammerson, G.A., D. Schweitzer, L. Master, and J. Cordeiro. 2008. Ranking Species Occurrences – a Generic Approach. Arlington, Virginia. Website: https://www.natureserve.org/sites/default/files/eo_rank_specifications-generic_guidelines_and_decision_key_05.08.2020.pdf [accessed September 2022].
- Harper, J.L. 1977. Population Biology of Plants. New York, New York: Academic Press. 892 pp.
- Henderson, D.C. 2009. Occupancy survey guidelines; prairie plant species at risk. Saskatoon, Saskatchewan.
- IUCN Standards and Petitions Committee (IUCN). 2019. Guidelines for using the IUCN Red List Categories and Criteria. Version 14. Standards and Petitions Committee.
- IUCN. 2022. The IUCN Red List of Threatened Species. Version 2022-1. <https://www.iucnredlist.org> [accessed September 2022].
- Lee, S., and C. Neufeld. 2019. Slender Mouse-ear-cress monitoring at National Wildlife Area – Prairie Unit 20: Preliminary report on long-term trends.
- Low, C.H. 2016. Impacts of a six year old pipeline right of way on *Halimolobos virgata* (Nutt.) O.E. Schulz (Slender Mouse Ear Cress), Native Dry Mixedgrass Prairie Uplands, and wetlands. University of Alberta, Edmonton, Alberta.

- Macdonald, I.D. 1997. Vascular plant flora component report. Canadian Forces Base Suffield National Wildlife Area wildlife inventory. Canadian Wildlife Service, Edmonton, Alberta. 209 pp.
- Master, L.L., D. Faber-Langendoen, R. Bittman, G.A. Hammerson, B. Heidel, L. Ramsay, K. Snow, A. Teucher, A. Tomaino, D. Faber-Langendoen, *et al.* 2012. NatureServe Conservation Status Assessments : Factors for Evaluating Species and Ecosystem Risk. Arlington, Virginia.
- Maxwell, B.A. pers. comm. 2022. *Email correspondence with B.A. Bennett, December 2022*. Program Coordinator, Montana Natural Heritage Program.
- Moss, E.H. 1983. Flora of Alberta. Second Edition rev. by J.G. Packer. University of Toronto Press, Toronto, Ontario. 687 pp.
- Naeth, M.A., A.C. Cohen Fernández, F.P.O. Mollard, L. Yao, S.R. Wilkinson, and Z. Jiao. 2018. Enriched topographic microsites for improved native grass and forb establishment in reclamation. The Society for Range Management. Rangeland Ecology and Management. 71(1):12–18. <https://doi.org/10.1016/j.rama.2017.08.004>.
- Naeth, M.A., D.A. Locky, S.R. Wilkinson, C. Leanne, C.H. Low, and M.R. Nannt. 2020. Influence of pipeline and environmental factors on the endangered plant, *Halimolobos virgata* (Nutt.) O.E. Schultz over ten years. Botany 98(12):1–37.
- Nannt, M.R. 2014. Impacts of distance to pipeline disturbance on mixed grass prairie and *Halimolobos virgata* (Nutt.) O.E. Schulz (Slender Mouse Ear Cress). Master of Science thesis, University of Alberta, Edmonton, Alberta. 206 pp.
- Native Plant Society of Saskatchewan. 1998. Guidelines for rare plant surveys. Available online: https://www.npss.sk.ca/docs/2_pdf/NPSS_GuidelinesforRarePlantSurveys.pdf
- Natural Regions Committee. 2006. Natural regions and subregions of Alberta. Compiled by D.J. Downing and W.W. Pettapiece. Government of Alberta. Pub. No. T/852. 254 pp.
- Nature Saskatchewan. 2015. 2014 Report: Habitat stewardship of rare plant species in Saskatchewan. Regina, Saskatchewan.
- NatureServe. 2020. Habitat-based plant element occurrence delimitation guidance. Website: https://www.natureserve.org/sites/default/files/eo_specs-habitat-based_plant_delimitation_guidance_may2020.pdf [accessed April 2021].
- NatureServe. 2021. NatureServe Explorer. Website: https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.130101/Halimolobos_virgata [accessed May 2021].
- Nemirsky, C. 2011. Prairie plant species at risk in southern Alberta: Identification of critical habitat at the microsite level for *Halimolobos virgata* (Nutt.) O.E. Schulz and determination of set back distance between pipeline disturbance and *Halimolobos virgata* and *Cryptantha minima*. Master of Science thesis. University of Alberta, Edmonton, Alberta. 141 pp.

- Neufeld, C., pers. comm. 2022. *Email correspondence to D. Anderson. February 2022.* Grassland Ecologist, Prairie Plant Species at Risk Recovery Team, Canadian Wildlife Service. Saskatoon, Saskatchewan.
- Putz, E. pers. comm. 2022. *Email Correspondence to D. Anderson. February 2022.* Habitat Stewardship Coordinator, Nature Saskatchewan. Regina, Saskatchewan.
- Salafsky, N., D. Salzer, A.J. Stattersfield, C. Hilton-Taylor, R. Neugarten, S.H.M. Butchart, B. Collen, N. Cox, L.L. Master, S. O'Connor, et al. 2008. A standard lexicon for biodiversity conservation: Unified classifications of threats and actions. *Conservation Biology*. 22(4):897–911. <https://doi.org/10.1111/j.1523-1739.2008.00937.x>
- Saskatchewan Conservation Data Centre (SKCDC). 2021a. Element Occurrence Data –Slender Mouse-ear-cress. Saskatchewan Conservation Data Centre.
- Saskatchewan Conservation Data Centre (SKCDC). 2021b. Tracked Taxa List: Vascular Plants. Regina, SK. Website: <http://biodiversity.sk.ca/TaxaList/sk-taxa-vascularplant-track.pdf> [accessed May 2021].
- Saskatchewan Ministry of Environment. 2015. Rare Prairie Plant Survey Protocol. Regina, Saskatchewan.
- Sawatzky, K.D., and J.M. Piwowar. 2019. Changes in prairie grassland extent in Saskatchewan from 1990 to 2015. *Prairie Perspectives: Geographical Essays*. 21:1–8.
- Smith, B. 1992. COSEWIC status report on the Slender Mouse-ear-cress *Halimolobos virgata* in Canada. Ottawa, Ontario. 39 pp.
- Smith, B. 2000. Update COSEWIC status report on the Slender Mouse-ear-cress *Halimolobos virgata* in Canada, in COSEWIC assessment and update status report on the Slender Mouse-ear-cress *Halimolobos virgata* in Canada. Ottawa, Ontario. 1–18 pp.

BIOGRAPHICAL SUMMARY OF REPORT WRITER(S)

Dr. Steven Tannas (PhD) is a Senior Vegetation Ecologist, Reclamation Specialist and Wetland Scientist and a Professional Agrologist (P.Ag.) through the Alberta Institute of Agrologists (AIA). He is the owner of Tannas Conservation Services Ltd. (TCS), a small vegetation specialized environmental consulting company. Dr. Tannas has been working within the environmental industry for the past 20 years. He has extensive experience in reclamation, ecosystem management, rare species surveys, rangeland management, and wetlands.

Kathy Tannas was a noted plant taxonomist and botanist with over 40 years' experience in the field. She was experienced working with plants across western Canada (over 3000 species), with a specialty in identifying rare plants. She was highly experienced in conducting rare species surveys, weed inventories, baseline surveys, range health

assessments, and wetland assessments; and in monitoring plant communities. She taught plant identification courses to professionals and amateurs for over 25 years. She authored a series of plant identification books in 2001 (Common Plants of the Western Rangelands) that are currently used by professionals across the Prairie provinces as a field guide. She received the Alberta Emerald Award for her contributions to the environment and an honorary Agrologist award from the Alberta Institute of Agrologists. Kathy's contributions to this report are honoured in her memory.

Daina Anderson (MSc) is an Intermediate Vegetation and Wetland Ecologist with Tannas Conservation Services Ltd. and a professional biologist. She has over 10 years of field experience, including developing and executing ecological field programs in Alberta, British Columbia, and Ontario. She is specialized in the niche of terrestrial field ecology, conducting vegetation community classification, ecosystem mapping, botanical inventories, wetland delineations and assessments, and species at risk surveys.

COLLECTIONS EXAMINED

No collections of Slender Mouse-ear-cress were examined in the preparation of this report.

Appendix 1: Threats Assessment Worksheet

Species or Ecosystem Scientific Name	Slender Mouse-ear-cress, <i>Crucihimalaya virgata</i>		
Element ID	1057905	Elcode	PDBRA1A040
Date (Ctrl + ";" for today's date):	2021-10-22		
Assessor(s):	Daina Anderson and Steven Tannas (report writers); Bruce Bennett (facilitator, co-chair); Del Meidinger (co-chair); Candace Neufeld, Gina Schalk, Sarah Lee (ECCC); Sarah Vinge-Mazer (SKCDC); Gord Court (Government of Alberta); Varina Crisfield, David Mazzerole, Cary Hamel (VPSSC); Sydney Allen (Secretariat)		
References:			
Overall Threat Impact Calculation Help:		Level 1 Threat Impact Counts	
	Threat Impact		high range
	A	Very High	0
	B	High	0
	C	Medium	2
	D	Low	2
Calculated Overall Threat Impact:		High	Medium
Assigned Overall Threat Impact:		C = Medium	
Impact Adjustment Reasons:		Seems that calculated threat impact is higher than would likely occur over 10 years; based on information from Dave Fraser, high impact equates to a population decline of 22%–70%; medium – decline of 8%–30%; consensus that Medium is reasonable for assigned threat impact as the expected population decline <30%. Grazing may reduce some of the impact of some of the threats.	
Overall Threat Comments		Generation time is 3–4 years (3 generations = 9–12 yrs).	

Threat	Impact (calculated)	Scope (next 10 yrs)	Severity (10 yrs or 3 gen.)	Timing	Comments
1 Residential & commercial development					
1.1 Housing & urban areas					One historical EO within the boundaries of Medicine Hat, but has not been relocated since 1894. Not a threat going forward as most extant sites are on public land or in large remote grazing pastures. Potential threat of a single farm building.
1.2 Commercial & industrial areas					
1.3 Tourism & recreation areas					
2 Agriculture & aquaculture	D Low	Small (1%–10%)	Extreme (71%–100%)	Moderate (Possibly in the short term, < 10 yrs / 3 gen)	

Threat		Impact (calculated)		Scope (next 10 yrs)	Severity (10 yrs or 3 gen.)	Timing	Comments
2.1	Annual & perennial non-timber crops	D	Low	Small (1%–10%)	Extreme (71%–100%)	Moderate (Possibly in the short term, < 10 yrs / 3 gen)	Crop production, cultivation, and conversion to tame forages result in fragmentation of native prairie, the species' suitable habitat. Sandy loam to loam textured soils may continue to be converted, but most of the lands are under provincial and federal management, which limits the ability to convert land from native grassland to annual crop land or tame pasture. Most suitable habitat has likely already been converted. New land conversions are not likely, and most EOs are on federal and provincial lands. In AB, they could convert but not likely due to public uproar over recent proposal to convert an area around Brooks, AB. There can be small conversions, but there are studies done beforehand to ensure a conversion is in the public interest. There are disincentives. Also, habitat is not high-quality agriculture land -- best left as grazing land. In SK, some occurrences are on private land and a new irrigation project could make land conversion feasible – 3 EOs could be affected. In AB, there are 2 or 3 subpopulations that could be converted. Reasonable threat in Saskatchewan based on proposed irrigation project. A National Wildlife Area in SK has been seeded, but SMEC is still occurring in the area, so can survive with some conversion, although not likely at the same levels as in natural vegetation.
2.2	Wood & pulp plantations						
2.3	Livestock farming & ranching		Not a Threat	Pervasive (71%–100%)	Neutral or Potential Benefit	High (Continuing)	SMEC evolved with grazing, but cattle grazing may differ in timing, duration, and locality. Grazing occurs at most EOs. Grazing-caused mortality may occur, but lack of grazing also threatens occurrences. Provincial and federal lands include grazing leases, and grazing reserves have management and oversight to limit over-grazing that will mitigate the risk of severe over-grazing. No severe habitat degradation from grazing has been specifically noted within EO site notes. Most subpopulations are found in actively grazed pastures and cattle do not appear to selectively graze the species, although incidental trampling and grazing occur. In Wyoming, the species is classified as an increaser and may benefit under a modest grazing regime. Patterns of grazing have changed drastically since pre-settlement conditions, but the extent to which this is a threat to the population is not well known. Suffield had grazing until a few years ago – now stopped. Great Sand Hills are grazed. All subpopulations in SK have grazing.
2.4	Marine & freshwater aquaculture						

Threat		Impact (calculated)		Scope (next 10 yrs)	Severity (10 yrs or 3 gen.)	Timing	Comments
3	Energy production & mining	Unknown		Restricted (11%–30%)	Unknown	High (Continuing)	
3.1	Oil & gas drilling	Unknown		Restricted (11%–30%)	Unknown	High (Continuing)	Portions of 24–30 Element Occurrences have oil & gas activities listed as a threat or are nearby a pipeline or well activity. Nine new EOs have been found within the last 10 years from rare plant surveys associated with pipeline development. The activity setback distance guidance of oil and gas activity is 300 m. On public lands in AB and SK, the plant is protected and before any development, a survey is done for a listed species. If the plant is found, development would have to occur at least 300 m away. Scope for new development is low. Includes site expansion, access upgrades, and emergency responses. Emergency actions could override 300-m buffer to species at risk, so there is some risk. Actions could also benefit the species by opening up the soil. A lot of the subpopulations are on river banks and not likely to be impacted. Research out of the University of Alberta has found SMEC has been minimally impacted by right(s)-of-way (ROW). Invasives from poor ROW rehabilitation remain a threat, in addition to fragmenting native grassland. In SK, 5 EOs in active development areas and could potentially be affected by future development. Thirty EOs in Sarah Lee's data have listed oil and gas, but perhaps they include some historical EOs. In AB, there is always potential for more exploration, but right now exploration is on a downward trend in the habitat of this species. The scope of Restricted reflects that only a few EOs have active exploration at this time. That could change at any time. In AB, it is best practice to avoid listed species but there is uncertainty in the quality of surveys that can result in development going ahead. Survey quality issues also a concern in SK as the plant can be difficult to detect at the wrong time of the year or in dry years. SMEC survives well in native vegetation and although site disturbance can help species, it does not increase in highly disturbed sites. Also, evidence that disturbance lessens the plant in areas of native vegetation, e.g., a pipeline RoW in a native veg area. Maintenance is scored under 4.2.
3.2	Mining & quarrying	Not Calculated (outside assessment time frame)		Small (1%–10%)	Slight (1%–10%)	Low (Possibly in the long term, >10 yrs / 3 gen)	Sand and gravel extraction of sand dunes can kill living plants and remove all or portions of the seed bank. This can also lead to invasive species establishment. SMEC is a sandy prairie plant and not a dune plant. The threat is localized at present; future uncertain. There is one EO near a gravel pit in AB. On public lands, if mining were proposed, it would not be allowed near known EOs and would have to be 300 m away. Activities at pits are not allowed to go closer to plants but are allowed to continue. One EO near a closed gravel pit is private land and SMEC is growing up to the edge of the pit. Not sure if it was impacted. Likely not at great risk of being opened again. In SK, would need permit and would need 300-m setback. SMEC is growing on back side and along road trail.

Threat		Impact (calculated)		Scope (next 10 yrs)	Severity (10 yrs or 3 gen.)	Timing	Comments
3.3	Renewable energy						
4	Transportation & service corridors	D	Low	Pervasive (71%–100%)	Slight (1%–10%)	High (Continuing)	
4.1	Roads & railroads						Maintenance of oil and gas roads treated in 4.2. No EOs list new roads as a current threat.
4.2	Utility & service lines	D	Low	Pervasive (71%–100%)	Slight (1%–10%)	High (Continuing)	Maintenance of pipelines and impacts due to a potential pipeline rupture are included; 24–30 of EOs are within 300 m of pipeline infrastructure. Spills may or may not happen but it is possible. Also see 3.1 and 4.1. Increased to Pervasive due to the number of EOs and size of subpopulations at areas with infrastructure. Estimated to be greater than 75% of population.
4.3	Shipping lanes						
4.4	Flight paths						
5	Biological resource use						
5.1	Hunting & collecting terrestrial animals						
5.2	Gathering terrestrial plants						
5.3	Logging & wood harvesting						
5.4	Fishing & harvesting aquatic resources						
6	Human intrusions & disturbance		Negligible	Small (1%–10%)	Negligible (<1%)	High (Continuing)	
6.1	Recreational activities		Negligible	Small (1%–10%)	Negligible (<1%)	High (Continuing)	Twenty-three extant EOs are on public land (federal or provincial), 5 are within the Great Sand Hills area, with the most recreational activity access. ATV or motorbike use has not been documented as a threat. Some benefit from a small amount of disturbance, but high level of disturbance may open up habitats to too much erosion. Recreational activities may be both positive (opening habitat) and negative (trampling). Documentation of recreation as a threat and the associated population decline is unknown.

Threat		Impact (calculated)		Scope (next 10 yrs)	Severity (10 yrs or 3 gen.)	Timing	Comments
6.2	War, civil unrest & military exercises		Negligible	Small (1%–10%)	Negligible (<1%)	Moderate (Possibly in the short term, < 10 yrs / 3 gen)	Heavy tracked machinery and military operations can alter sandy native prairie habitats by altering species composition, compacting soils, reducing vegetation cover, and directly disturbing plants. However, this could also benefit subpopulations by opening up habitat and suppressing competition from other species. Two element occurrences are within CFB Suffield. Both of these EOs are within the National Wildlife Area, which is not subject to regular military activity. CWS-ECCC has monitored the SMEC population within CFB Suffield over the past 10 years. SMEC is likely in training area but very difficult to get access. Much of Suffield is sand plain prairie and SMEC found adjacent to training area. So there may be a larger impact but unknown at present.
6.3	Work & other activities						
7	Natural system modifications	C D	Medium – Low	Pervasive (71%–100%)	Moderate – Slight (1%–30%)	High (Continuing)	
7.1	Fire & fire suppression	D	Low	Pervasive (71%–100%)	Slight (1%–10%)	High (Continuing)	Fire has been reduced in prairie systems since widespread settlement, which has altered ecosystem function. The extent to which this has impacted or continues to impact subpopulations is not well known. Alteration of natural fire regimes results in habitat increase of thatch and vegetation encroachment, reducing the habitat for SMEC. Fire opens up habitat for plant. Fire suppression is the issue in changing habitat quality. Loss of fire is the main issue with habitat change. Frequent fire occurs on Suffield site but scope is still about 75%. Takes a long time for change but would be having an impact. Grazing can help reduce this threat.
7.2	Dams & water management/use						Changes to moisture regimes at a site can impact Slender Mouse-ear-cress growth and survival. Developments that restrict natural flooding, cause unnatural flooding, inhibit channel meandering, or divert water could impact the maintenance and creation of suitable habitat. The creation of Gardiner Dam in Saskatchewan flooded a substantial area where subpopulations were suspected to occur.

Threat		Impact (calculated)		Scope (next 10 yrs)	Severity (10 yrs or 3 gen.)	Timing	Comments
7.3	Other ecosystem modifications	C D	Medium – Low	Pervasive (71%–100%)	Moderate – Slight (1%–30%)	High (Continuing)	Habitat degradation resulting in increased thatch and increased competition from invasive species and changes to grazing regimes are the most serious and plausible threats to SMEC. Eleven EOs (CDC data) have non-native species documented in the vicinity and include Crested Wheatgrass, Flixweed, Common Dandelion, Smooth Brome, Common Lamb's-quarters, Common Kochia, Tumbling Mustard, Field Sow-thistle, Goatsbeard (<i>Tragopogon</i>). The impact of invasives includes modification of habitat characteristics related to amount of litter and bare sand, and competition for resources (light, nutrients, water). A few invasive plants (e.g., Crested Wheatgrass) are allelopathic, which makes habitat less compatible for SMEC. Sarah Lee states 16 EOs with non-native plants in them. There are probably non-natives at all sites, e.g., Kentucky Bluegrass. It is likely that EO data does not account for all EOs with non-native species. Grazing can offset some non-native species impacts. There is some resiliency to grow with non-natives, e.g., Crested Wheatgrass. Grazing levels vary greatly. Can be risk of both too little and too much, e.g., distribution of grazing, or sites with or with little grazing.
8	Invasive & other problematic species & genes						
8.1	Invasive non-native/alien species/diseases						Slender Mouse-ear-cress has been found growing among Crested Wheatgrass and Kentucky Bluegrass that have invaded native prairie. The long-term impact of these species on Slender Mouse-ear-cress survival is not known, but has the potential to outcompete native species. Competition, changes to habitat etc. scored under 7.3
8.2	Problematic native species/diseases						
8.3	Introduced genetic material						
8.4	Problematic species/diseases of unknown origin						
8.5	Viral/prion-induced diseases						
8.6	Diseases of unknown cause						
9	Pollution						
9.1	Domestic & urban waste water						
9.2	Industrial & military effluents						
9.3	Agricultural & forestry effluents						
9.4	Garbage & solid waste						

Threat		Impact (calculated)		Scope (next 10 yrs)	Severity (10 yrs or 3 gen.)	Timing	Comments
9.5	Airborne pollutants						
9.6	Excess energy						
10	Geological events						
10.1	Volcanoes						
10.2	Earthquakes/tsunamis						
10.3	Avalanches/landslides						
11	Climate change & severe weather	C D	Medium – Low	Pervasive (71%–100%)	Moderate – Slight (1%–30%)	High (Continuing)	
11.1	Habitat shifting & alteration						Treated under 7.3.
11.2	Droughts	C D	Medium – Low	Pervasive (71%–100%)	Moderate – Slight (1%–30%)	High (Continuing)	Extended periods of drought due to climate change could negatively impact SMEC subpopulations. The species is likely adapted to some level of drought, but it is not known if extended periods of drought will exceed the longevity of seeds in the seed bank. Sporadic rainfall in the spring or fall could result in healthy flourishing plants that then die prematurely in dry summer conditions. If this cycle repeats in multiple years, the number of seeds in the seed bank would likely be reduced. Could be greater than “slight” severity. Many years with no mature individuals, but seed bank longevity is unknown. This impact may already be causing population declines that are difficult to detect without targeted studies.
11.3	Temperature extremes						
11.4	Storms & flooding						
11.5	Other impacts						

Classification of Threats adopted from IUCN-CMP, Salafsky et al. (2008).