alberta's species at risk program

Status of the Hare-footed Locoweed (*Oxytropis lagopus* var. *conjugans*) in Alberta

Alberta Wildlife Status Report No. 69

Alberta Conservation Association

Alberta Government

Status of the Hare-footed Locoweed (*Oxytropis lagopus* var. *conjugans*) in Alberta

Prepared for:
Alberta Environment and Sustainable Resource Development (ESRD)
Alberta Conservation Association (ACA)

Prepared by:
Cheryl E. Bradley

This report has been reviewed, revised, and edited prior to publication.
It is an ESRD/ACA working document that will be revised and updated periodically.

Alberta Wildlife Status Report No. 69

September 2012

Published By:

Alberta Government

Alberta Conservation Association

ISBN No. 978-1-4601-0465-1 (On-line Edition)
ISSN: 1206-4912 (Printed Edition)
ISSN: 1499-4682 (On-line Edition)

Series Editors: Sue Peters, Robin Gutsell, and Shevenell Webb
Cover illustration: Brian Huffman
Maps: Velma Hudson

For copies of this report, visit our web site at:
http://srd.alberta.ca/FishWildlife/SpeciesAtRisk/ (click on "Detailed Status"), or
http://www.ab-conservation.com/go/default/index.cfm/publications/conservation-reports/
(click on "Alberta Wildlife Status Reports")

OR

Contact:
Information Centre – Publications
Alberta Environment and Sustainable Resource Development
Main Floor, Great West Life Building
9920 - 108 Street
Edmonton, Alberta, Canada T5K 2M4
Telephone: (780) 310-3773 or 1-877-944-0313
Email: ESRD.Info-Centre@gov.ab.ca

This publication may be cited as:

Alberta Environment and Sustainable Resource Development and Alberta Conservation Association. 2012. Status of the Hare-footed Locoweed (*Oxytropis lagopus* var. *conjugans*) in Alberta. Alberta Environment and Sustainable Resource Development. Alberta Wildlife Status Report No. 69. Edmonton, AB. 31 pp.

PREFACE

Every five years, Alberta Environment and Sustainable Resource Development reviews the general status of wildlife species in Alberta. These overviews, which have been conducted in 1991 (*The Status of Alberta Wildlife*), 1996 (*The Status of Alberta Wildlife*), 2000 (*The General Status of Alberta Wild Species 2000*), 2005 (*The General Status of Alberta Wild Species 2005*), and 2010 (*The General Status of Alberta Wild Species 2010*), assign individual species "ranks" that reflect the perceived level of risk to populations that occur in the province. Such designations are determined from extensive consultations with professional and amateur biologists, and from a variety of readily available sources of population data. A key objective of these reviews is to identify species that may be considered for more detailed status determinations.

The Alberta Wildlife Status Report Series is an extension of the general status exercise, and provides comprehensive current summaries of the biological status of selected wildlife species in Alberta. Priority is given to species that are *At Risk* or *May Be At Risk* in the province, that are of uncertain status (*Undetermined*), or that are considered to be at risk at a national level by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Reports in this series are published and distributed by Alberta Conservation Association and Alberta Environment and Sustainable Resource Development. They are intended to provide detailed and up-to-date information that will be useful to resource professionals for managing populations of species and their habitats in the province. The reports are also designed to provide current information that will assist Alberta's Endangered Species Conservation Committee in identifying species that may be formally designated as *Endangered* or *Threatened* under Alberta's *Wildlife Act*. To achieve these goals, the reports have been authored and/or reviewed by individuals with unique local expertise in the biology and management of each species.

EXECUTIVE SUMMARY

Hare-footed locoweed (*Oxytropis lagopus* var. *conjugans*) is a tufted, low-growing perennial herbaceous plant with silvery hairs and pink, pea-like flowers endemic to southwestern Alberta and western Montana. In Canada, it is listed as *Special Concern*, and provincially it is considered *May Be At Risk* because of a small number of occurrences and restricted distribution. This report provides detailed and up-to-date information, including results of a 2011 survey, to assist provincial assessment of the status of hare-footed locoweed and for use by resource professionals in managing the species and its habitat.

In Alberta, hare-footed locoweed is found within the Foothills Fescue Natural Subregion south of Lethbridge. Its habitat is gravel substrates on headlands of flat-topped unglaciated uplands of the Del Bonita Plateau and of the Milk River Ridge, as well as on post-glacial river terraces. These specialized habitats are discontinuous and widely separated. Eleven extant subpopulations and one historical subpopulation are recognized. Each extant subpopulation is between 1 km and 4 km from its nearest neighbour; their extent of occurrence is approximately 229 km^2. Area of occupancy calculated by summing occupied 2-km x 2-km squares is 124 km^2. A more biologically relevant area of occupancy, based on survey data, is estimated to be 0.4 km^2 to 0.5 km^2, including consideration that there may be other subpopulations in areas of potentially suitable habitat that have not yet been surveyed.

Currently, only approximately one dozen occurrences of hare-footed locoweed (variety *conjugans*) are known in Montana, suggesting that a significant proportion of the global population may occur in Alberta. Alberta's population of hare-footed locoweed is approximately 120 km north of the nearest known occurrence in Montana.

The provincial population of hare-footed locoweed can be estimated as greater than 36 400 mature individuals, based on recent counts at nine of eleven extant subpopulations. Subpopulation sizes range from 1 individual to approximately 19 400 individuals. The three subpopulations on the Del Bonita Plateau, south of the North Milk River, comprise approximately 84 percent of the provincial population with the remaining 16 percent occurring in eight subpopulations along the Milk River Ridge.

Loss and degradation of habitat for hare-footed locoweed has occurred in Alberta and is expected to continue as a result of cultivation, gravel extraction, oil and gas development, residential development, and construction and use of roads and trails. At least five of the eleven extant subpopulations of hare-footed locoweed are affected by one or more of these human activities including invasion by non-native plant species. Extirpation of the one known historical subpopulation near Cardston is attributed to gravel extraction. Within the extent of occurrence of hare-footed locoweed much of the habitat has been cultivated, contributing to isolation of subpopulations. However, five subpopulations of hare-footed locoweed associated with the Milk River Ridge lie within areas designated for protection by government or private interests. Stewardship of these areas can be expected to mitigate against habitat loss and degradation, provided protection of rare plant species is a management goal.

Efforts to define appropriate strategies for conservation of hare-footed locoweed in Alberta would benefit from research to determine if there is gene flow among subpopulations, and whether the size and connectivity of subpopulations in Alberta is sufficient for survival of the provincial population, especially in light of recent habitat loss and fragmentation.

ACKNOWLEDGEMENTS

The assistance and contributions of several people in the preparation of this report is gratefully acknowledged. My husband Lorne Fitch voluntarily assisted with field work in 2011. Friends and colleagues—Peter Achuff, Cyndi Smith and Earl Stamm—also assisted with field work, as did Lynn Fitzpatrick (Alberta Environment and Sustainable Resource Development [ESRD]), Lorna Allen, Karen Anderson, Joyce Gould and Drajs Vujnovic (all of Tourism, Parks and Recreation [TPR]). Permission from 16 landowners of private land and grazing leaseholders on public land for access to conduct surveys is greatly appreciated, as well as their interest in the project. Lorna Allen, Joyce Gould and Drajs Vujnovic (all of TPR's Alberta Conservation Information Management System [ACIMS]) provided data compiled over decades on occurrences of hare-footed locoweed and worked jointly to define and map subpopulations. Bruce Bennett (Co-chair, Vascular Plant Specialist Subcommittee, Committee on the Status of Endangered Wildlife in Canada) shared estimates of extent of occurrence and area of occupancy for this report. Dr. Stanley Welsh (Brigham Young University Herbarium) sent a valuable reference document, his unpublished revision of North American species of *Oxytropis*. Dr. Welsh also answered my questions about distribution and collections of hare-footed locoweed south of the border, as did Scott Mincemoyer (Montana Natural Heritage Program), Ernie Nelson (Rocky Mountain Herbarium University of Wyoming) and David J. Ode (South Dakota Game, Fish & Parks Department). Dana Bush generously forwarded maps and the results of 2010 surveys by volunteers with Adopt-a-Plant Alberta (APA). Jon Boyle (Range Conservation Service), Dana Blouin (Nature Conservancy Canada) and colleague Reg Ernst clarified information on a reported occurrence of hare-footed locoweed. Tony Brierley (Agriculture and Agri-Food Canada) and Ed Karpuk (ESRD) provided insights into soils formation on the Del Bonita Plateau. This report benefited from reviews by Joyce Gould (ACIMS), Cliff Wallis (Cottonwood Consultants), Robin Gutsell (ESRD), Shevenell Webb (Alberta Conservation Association, ACA) and Sue Peters (ACA).

Preparation of this report was funded by Alberta Conservation Association and Alberta Environment and Sustainable Resource Development.

TABLE OF CONTENTS

TABLE OF CONTENTS continued:

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

Hare-footed locoweed (*Oxytropis lagopus* Nutt.) is a tufted, low-growing perennial herbaceous plant with silvery hairs and pink, pea-like flowers. It is found in southwestern Alberta, western Montana, east-central Idaho, Wyoming and southwestern South Dakota. Only one of three varieties of hare-footed locoweed is reported in Alberta—*Oxytropis lagopus* Nutt. var. *conjugans* Barneby. The variety is endemic to southwestern Alberta and western Montana.

In April 1995, hare-footed locoweed was assigned a status of *Vulnerable** by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), based on the assessment of a status report (Smith 1995). The *Vulnerable* designation was later translated to *Special Concern* (COSEWIC 2011). In Alberta, hare-footed locoweed is considered *May Be At Risk* (Alberta Sustainable Resource Development [ASRD] 2011). The Alberta Conservation Information Management System (ACIMS) ranks hare-footed locoweed as S1 (ACIMS 2011a). These designations reflect the fact that there are a very small number of occurrences of this species and it has a restricted distribution (although it is fairly common where found), and its habitat is threatened by gravel extraction and cultivation of plateau rims (ASRD 2011). There has not previously been a detailed assessment of the status of hare-footed locoweed in Alberta.

This report provides detailed and up-to-date information that will assist provincial assessment of the status of hare-footed locoweed, and will be useful to resource professionals for managing the species and its habitat.

* See Appendix 1 for definitions of selected status designations.

SPECIES TAXONOMY

Hare-footed locoweed (*Oxytropis lagopus* Nutt), also known as haresfoot locoweed, haresfoot crazyweed or hare oxytrope, was first collected and described in 1834 by Thomas Nuttall during his travels with the Wyeth expedition to the sources of the Missouri River. By the mid-1900s, three varieties of the hare-footed locoweed were recognized: *O. lagopus* var. *lagopus*, *O. lagopus* var. *atropurpurea* (Rydb.) Barneby, and *O. lagopus* var. *conjugans* Barneby (Barneby 1952). A recent revision to the treatment of North American species of the genus *Oxytropis,* prepared for the *Flora of North America*, confirms the delineation of hare-footed locoweed and its three varieties (Welsh 2001).

The only variety of hare-footed locoweed known to occur in Alberta is *conjugans*. According to Welsh (2001), it differs from the other two varieties in having 5–9 leaflets congested on a leaf axis 5 mm–13 mm long, about equal to the longest leaflet. Variety *atropurpurea* and variety *lagopus* both have 9–17 leaflets that are well-distributed along a leaf axis that is longer than the longest leaflet. These last two varieties are differentiated based on the degree of inflation of the calyx (the usually green outer whorl enclosing the petals) and whether or not the pod ruptures the calyx and is persistent or deciduous with the calyx.

Another species of locoweed (*Oxytropis*) with which hare-footed locoweed might be confused is Bessey's locoweed (*Oxytropis besseyi* (Rydberg) Blankinship). Hare-footed locoweed differs from Bessey's locoweed in that it usually has shorter flower stalks and leaves (<10 cm), fewer and broader leaflets, and more densely hairy leaves and calyx (Barneby 1952, Welsh 2001). Hare-footed locoweed also tends to have short blackish hairs mixed in with the long whitish ones on the calyx, giving it a more greyish appearance than Bessey's locoweed, which has only long whitish hairs on

the calyx (Welsh 2001). Bessey's locoweed is reported from southwestern Saskatchewan (Val Marie and Canopus, south of Moose Jaw) and northern Montana (Boivin 1967, University of Montana Herbarium 2011). In his revised treatment of North American species of the genus *Oxytropis*, Welsh (2001) states that the range of Bessey's locoweed variety *besseyi* extends north to southern Alberta. Currently, there are no records of Bessey's locoweed in the database of the Alberta Conservation Information Management System; hence the basis of the report by Welsh is currently being investigated (J. Gould pers. comm.).

DISTRIBUTION

1. Alberta – All reports of hare-footed locoweed in Alberta (and Canada) are south of Lethbridge within the Foothills Fescue Natural Subregion of the Grassland Natural Region. Subpopulations of the provincial population of hare-footed locoweed in Alberta are listed in Table 1 and mapped in Figure 1. For the purposes of this report, "subpopulation" as defined by IUCN (2001) is equated with, and will be used in place of, master element occurrence (EO) as defined by NatureServe (2004). Subpopulations are distinct groups in the population that have little or no genetic exchange (IUCN 2001). In the absence of detailed data on a species' biology and dispersal, master EOs are separated by at least 1 km reflecting NatureServe's default criteria for delimiting plant element occurrences (NatureServe 2004). Master EOs (referred to as subpopulations in this report) for hare-footed locoweed in Alberta have been defined by the Alberta Conservation Information Management System using NatureServe's criteria (ACIMS 2011b).

Eleven subpopulations make up the known extant provincial population. All are located in the Del Bonita Plateau Ecodistrict (Adams et al. 2005). Eight subpopulations are on the edge of unglaciated gravel-capped uplands of the Del Bonita Plateau south of the North Milk River and the Milk River Ridge north of the river. Three subpopulations are on post-glacial gravel terraces of the North Milk River and its tributaries. These occurrences range in elevation from 1240 m to 1410 m. Plants generally occur within a band that is 10 m–20 m wide, along the break in slope in sites where erosion by wind and water has exposed cobbles and reduced vegetation cover.

An historical subpopulation—the first report of the species in Alberta in 1958—was recorded in the Cardston Plain Ecodistrict approximately 3 km southwest of Cardston. Targeted surveys in 1986 and 1993 failed to find hare-footed locoweed at this site, now occupied by a gravel pit and urban development, or in other potentially suitable habitats along the St. Mary River and its tributary Lee Creek near Cardston (Smith 1995, Wallis et al. 1986).

Between 1983 and 2010 several additional occurrences of hare-footed locoweed were reported in Alberta. In 2011, a survey was conducted by C. Bradley of known occurrences of hare-footed locoweed. The 2011 survey was designed to inform the preparation of this provincial status report and results are filed with ACIMS. The area of occupancy of known subpopulations was expanded through the 2011 survey; however, the full extent of three of these subpopulations was not determined because of time and resource constraints. As well, the 2011 survey did not include two occurrences reported in the 1990s that are considered extant, but which lacked precision as to their exact location (Whiskey Gap South and North Milk River Terrace). Subsequent analysis of all survey information filed with ACIMS resulted in the identification of 11 extant subpopulations, two of which had not been previously reported (Whiskey Gap Northeast and Whiskey Gap North) (L. Allen pers. comm.). There may be other subpopulations in sites that have not yet been surveyed. Additional survey would be needed to address these gaps.

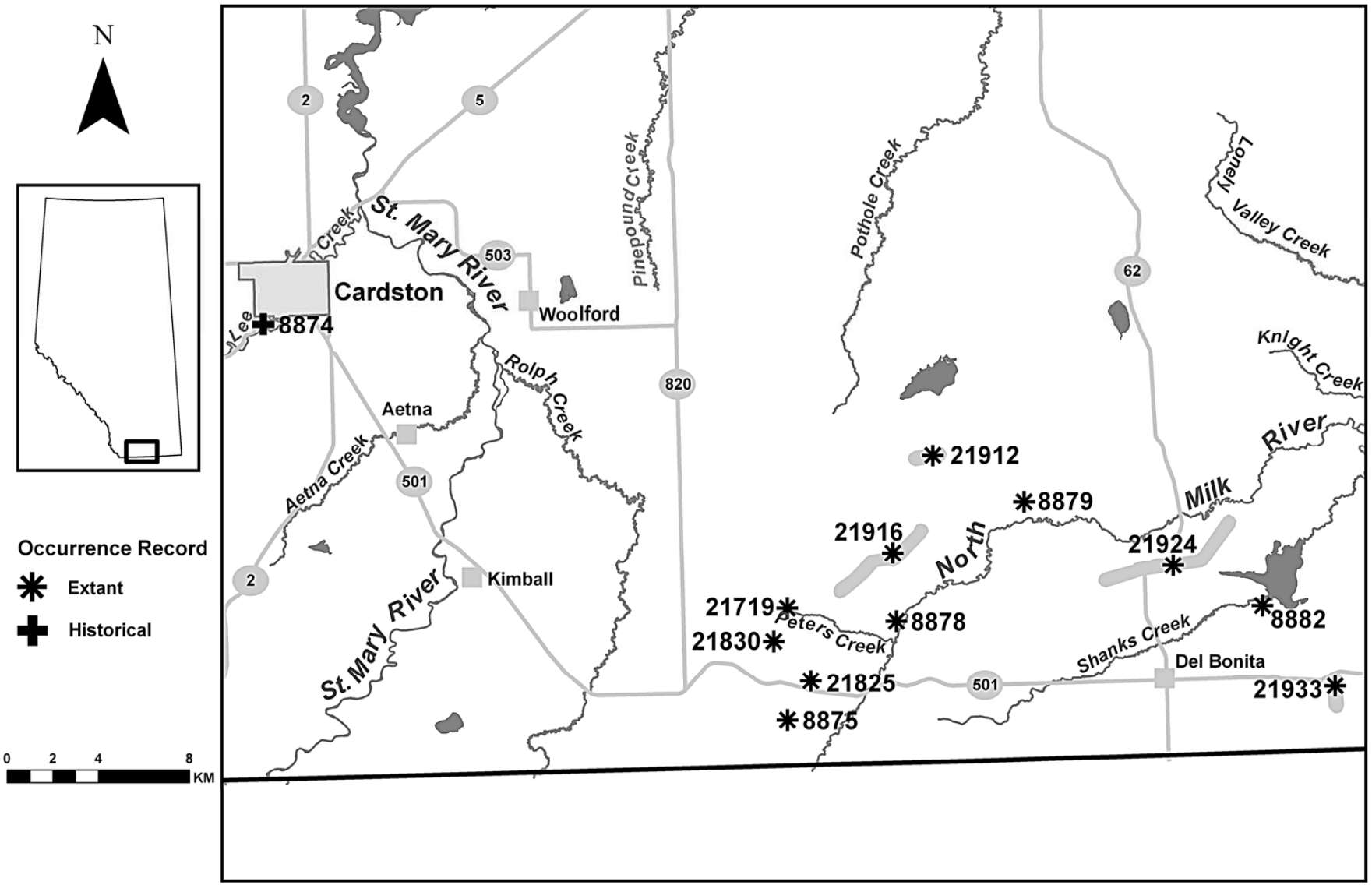

Figure 1. Subpopulations of hare-footed locoweed in Alberta. See Table 1 for information on each record. Note that some records show a shaded area, which includes all sites within that subpopulation but is not wholly occupied.

Table 1. Summary of hare-footed locoweed subpopulations in Alberta. Data are from the Alberta Conservation Information Management System (ACIMS) database of rare plant occurrences. Element occurrence (EO) Rank: H=historical; E=extant. "n/a" indicates data are not available.

Subpopulation Name (Master EO #)[1]	EO Rank	First Obs.	Max. Recorded Pop. (Year)	Most Recent Pop. (Year)	Area Occupied[2] (m^2)	Notes on Level of Survey, Land Tenure, Land Use, Potential Threats, and Level of Overall Threat[3]
Cardston (8874)	H	1958	>1 (1958)	0 (1993)	n/a	Found in 1958, 1966 and 1967 at one site. Not found in 1986 and 1993. Private land. Gravel extraction, urban development, vehicle access. Extirpated.
Whiskey Gap South (8875)	E	1986	>1 (1986)	>1 (1992)	n/a	Found in 1986 and 1992. Additional survey needed to define subpopulation and threats. Private and public land. Livestock grazing.
Whiskey Gap Northeast (21825)	E	2011	1 (2011)	1 (2011)	1	Found in one site in 2011. Private land. Livestock grazing and loitering. High threat.
Whiskey Gap North (21830)	E	2011	340 (2011)	340 (2011)	1220	Found in one site in 2011. Private land. Cultivation, gravel exploration, vehicle access and livestock grazing (corrals). Invasive non-native species. Moderate threat.
Milk River Ridge NCC (21719)	E	2007	838 (2011)	838 (2011)	2150	Found in same site in 2007 and 2011. Land trust property. Livestock grazing. Low threat.
Milk River Ridge (21916)	E	1986	3540 (2011)	3540 (2011)	16 820	Found in several different sites in 1986, 1993, 1996, 1998, 1999, 2002, 2007 and 2011. Provincial protected area and land trust properties as well as private land. Cultivation, gravel extraction, oil and gas development, vehicle access and livestock grazing and loitering. Invasive non-native species. Low threat for a few sites and moderate to high threat for several sites.
Ross Grassland NA North (21912)	E	1983	231 (2011)	231 (2011)	700	Found in same one or two sites in 1983, 1985, 2009 and 2011. Provincial protected area. Livestock grazing. Low threat.
North Milk River Terrace (8878)	E	1996	50 (1996)	50 (1996)	n/a	Found in one site in 1996. Additional survey needed to define subpopulation and threats. Land trust property. Livestock grazing.

Table 1 continued:

Subpopulation Name (Master EO #)[1]	EO Rank	First Obs.	Max. Recorded Pop. (Year)	Most Recent Pop. (Year)	Area Occupied[2] (m2)	Notes on Level of Survey, Land Tenure, Land Use, Potential Threats, and Level of Overall Threat[3]
Sandstone Ranch (8879)	E	1986	937 (2011)	937 (2011)	29 100	Found in one site in 1986, one other in 2010 and several sites in 2011. Full extent of subpopulation not defined. Land trust property. Oil and gas development, vehicle access and livestock grazing. Invasive non-native species. Low threat at a few sites and moderate threat at others.
Shanks Lake West (21924)	E	1986[4]	10 300 (2011)	10 300 (2011)	191 700	Found in four different sites in 1986, 1993, 2001 and 2010 and in several new sites in 2011. Full extent of subpopulation not defined. Private and public land. Cultivation, gravel extraction, residential development, vehicle access and livestock grazing (corrals and loitering). Invasive non-native species. Moderate to high threat for all sites.
Shanks Lake South (8882)	E	1993	1000 (1993)	820 (2011)	11 460	Found in same few sites in 1993 and 2011. Full extent of subpopulation not defined. Private and public land. Cultivation, vehicle access and livestock grazing. Invasive non-native species. Moderate to high threat for all sites.
Del Bonita East (21933)	E	1993	19 400 (2010/11)	19 400 (2010/11)	150 600	Found in one site in 1993, one other in 2010 and both in 2011. Private and public land. Livestock grazing. Low threat at one site and moderate threat at the other.

[1] Subpopulation is equated with master element occurrence (EO) as defined by the Alberta Conservation Information Management System (ACIMS). Master EO# is provided by ACIMS. Subpopulations (or master EOs) are separated by at least 1 km, reflecting NatureServe's default criteria in the absence of detailed data on population biology and dispersal (NatureServe 2004).

[2] Area of occupancy is the total of the estimated or measured area of one or more polygons that encompass plants observed during field survey, generally with gaps of at least 10 metres between polygons.

[3] The assessment of level of threat is subjective, based on field notes and recollection of threats (C. Bradley pers. obs.). It was undertaken at the request of status report reviewers.

[4] A 1976 collection "3 miles north of Del Bonita" may be from this Shanks Lake West site but there is insufficient label information to be certain.

The extent of occurrence of a population is the area contained within a minimum convex polygon (the smallest polygon in which no internal angle exceeds 180 degrees and which contains all the sites of occurrence) (IUCN 2001). A polygon that encompasses all 11 extant subpopulations of hare-footed locoweed in Alberta is approximately 229 km^2 (B. Bennett pers. comm). A large proportion of the extent of occurrence is unsuitable habitat for hare-footed locoweed.

The area of occupancy is defined as the area within the extent of occurrence known to be occupied by hare-footed locoweed excluding unsuitable or unoccupied habitat (IUCN 2001). An index of area of occupancy for hare-footed locoweed, calculated as per the IUCN standard (IUCN 2001) of summing occupied 2-km x 2-km squares (excluding the historical occurrence) is 124 km^2 (B. Bennett pers. comm.). This measure, however, is less biologically relevant for this species than summing the estimates of area actually occupied by individual occurrences obtained through field survey. Hare-footed locoweed occurs within a very restricted habitat type and much of the habitat in the occupied 2-km x 2-km squares is unsuitable. Furthermore, within occurrences, plants are found in discrete patches and seed pods appear to fall close to the parent plants; hence, areas between patches separated by more than 20 m and that are unsuitable habitat (e.g., upper valley drainages between headlands) are appropriately considered unoccupied. Therefore, a more biologically relevant estimate of area of occupancy is approximately 40 ha (0.4 km^2; the sum of the "Area Occupied" column in Table 1). It is believed that the biological area of occupancy of hare-footed locoweed is somewhat larger than 40 ha, considering that the full extent of three subpopulations is unknown, the area occupied by two subpopulations has yet to be determined, and there may be a few other subpopulations in suitable habitat not yet surveyed within the extent of occurrence. However, even if several additional occurrences are reported, the biological area of occupancy of hare-footed locoweed in Alberta is unlikely to exceed 50 ha (0.5 km^2).

2. Other Areas – Hare-footed locoweed (*Oxytropis lagopus*) occurs on gravelly plains, ridges and slopes in western Montana, east central Idaho, Wyoming and southwestern South Dakota (Figure 2) (Rocky Mountain Herbarium 2008, University of Montana Herbarium 2011, Welsh 2001, S. Welsh pers. comm.). Hare-footed locoweed variety *conjugans*, endemic to Montana and Alberta, grows on stony (gravelly) ridge tops and slopes and river terraces at elevations ranging from 1300 m to 1900 m in western Montana. Variety *lagopus* occurs in western Montana, northwestern Wyoming and east-central Idaho, its northern limit of distribution overlapping with the southern limit of variety *conjugans*. Variety *atropurpurea* occurs in southwestern Montana, Wyoming and southwestern South Dakota (Black Hills); its distribution is separate from variety *conjugans*.

Alberta's population of hare-footed locoweed is at the extreme northern limit of the species' range in North America and disjunct from other known populations. Widely separated occurrences of *O. lagopus* var. *conjugans* lie within a narrow belt east of the Rocky Mountains extending at least 300 km from Alberta's Milk River Ridge into Montana, to the Missouri River in the vicinity of Helena and westward along the Clark Fork at the base of the Garnet Range. The closest known subpopulation of hare-footed locoweed variety *conjugans* in Montana is along the North Fork of the Teton River in the vicinity of the Ear Mountain State Game Refuge, 40 km west of Choteau (University of Montana Herbarium 2011, S. Mincemoyer pers. comm.). Three collections of hare-footed locoweed var *conjugans* were made in this area in the 1970s and 1980s; however, it is not known if this population is still extant (S. Mincemoyer pers. comm.). This subpopulation is approximately 120 km due south of Del Bonita, Alberta.

Figure 2. Distribution of hare-footed locoweed in North America (based on information in Rocky Mountain Herbarium 2008, University of Montana Herbarium 2011, Welsh 2001).

HABITAT

1. Climate – The Del Bonita Plateau Ecodistrict, where all extant populations of hare-footed locoweed occur, is characterized as having a frost-free period of less than 90 days, a mean daily temperature of approximately 4.0°C and mean annual precipitation of approximately 425 mm with 70% of that falling as rain (Adams et al. 2005). Winter temperatures are moderated by strong, westerly chinook winds and there is a high frequency of snowfall in late winter and early spring.

2. Parent Materials and Soils – Flat-lying bedrock of the Del Bonita Plateau south of the North Milk River and higher elevations of the Milk River Ridge north of the North Milk River is capped by gravels up to 5 m thick that were deposited in large fans as the Rocky Mountains formed in the late Tertiary (Jackson et al. 2008, Shetsen 1980, 1987, Stalker 1963). These gravels are quartzitic (derived from silica-based sandstones) and are known as Flaxville gravels. The flat tops of the Del Bonita Plateau and Milk River Ridge are remnants of a vast plain stretching eastward from the Rocky Mountains during late Miocene and Pliocene time. Differential erosion led to lowlands and valleys around and through the plain, creating isolated gravel-capped plateaus. Underlying sandstone bedrock formations are exposed on some ridges and slopes.

During the Pleistocene, the Del Bonita Plateau and higher elevations of the Milk River Ridge extended above the continental ice sheet (Shetsen 1980, Stalker 1963). The gravels on the plateaus, which remained unglaciated, were overlain by silt (loess) up to 2 m thick deposited by strong, cold winds blowing from the retreating ice front over recently deposited calcareous moraine (Brierley et al. 1991, T. Brierley pers. comm.). Subsequent frost action (cryogenic processes) in the periglacial environment lifted the quartzitic gravels into the overlying calcareous loess. Over time, the gravels have become concentrated at the surface as a result of wind and water eroding away finer sediments.

At lower elevations where glaciation occurred there are parent materials of till (nonsorted, unstratified sediment carried by the glacier) and glacio-fluvial deposits (silts, sands and gravels sorted and stratified by glacial meltwaters).

Hare-footed locoweed occurs on headlands along the edges of the plateaus where erosion by wind and water has exposed the Tertiary gravels. Elevations range from 1280 m to 1410 m, except for an outlier of the old Flaxville gravel surface east of Del Bonita that dips to 1240 m. Hare-footed locoweed is found mostly on the plateau surface within 10 m of the plateau edge and also on the upper slopes. These sites have slopes ranging from 0% to 30%.

Hare-footed locoweed also occurs on abandoned gravel terraces of the post-glacial North Milk River with slopes less than 15% and elevations of 1245 m to 1260 m.

Although the Flaxville gravels are predominantly quartzitic, a white crust of calcium carbonate was observed on the underside of the stones at some sites where hare-footed locoweed is found along the Milk River Ridge (E. Karpuk pers. comm.). Some stones deep in the loess may have been partially cemented by calcium carbonate carried downward in solution (T. Brierly pers. comm.). These gravels, when exposed at the surface, are identified by having a whitish calcareous layer on their undersurface. Further investigation would be required to determine if the presence of calcium carbonate on gravels is characteristic of all sites where hare-footed locoweed is found and if it is a significant factor in defining suitable habitat for the species.

Soils of the Del Bonita Plateau Ecodistrict are predominantly Orthic Black Chernozems

characterized as loamy (Adams et al. 2005, Brierley et al. 1991). However, hare-footed locoweed is associated with sites where soils are shallow (< 10 cm surface mantle) over gravel and contain more than 10% cover of gravel or cobbles (5–15 cm diameter) at the surface. The soils are referred to as "gravel" or "shallow to gravel" (Adams et al. 2005). Vegetation is less dense on these sites compared to loamy sites because the water- and nutrient-holding capacity of gravels is low.

Along the plateau edge, hare-footed locoweed is found on all aspects, but most commonly south and west aspects of headlands. East and north aspects commonly have accumulations of wind-blown silt, as they are in the lee of the headlands. The tops of drainages also have accumulations of fine sediment carried by water from the upland. Vegetation is denser in these situations compared to headlands.

At lower elevations on abandoned gravel terraces, hare-footed locoweed is also found only on sites that are wind-scoured and not subject to sediment deposition; hence, vegetation is less dense.

3. Vegetation – Native grasslands in the Del Bonita Plateau Ecodistrict of the Foothills Fescue Natural Subregion are dominated by foothills rough fescue (*Festuca campestris*) and Idaho fescue (*Festuca idahoensis*) (Adams et al. 2005). Hare-footed locoweed is associated with the foothills rough fescue-Idaho fescue herbaceous community, and specifically with open patches that have less than 50% grass and forb cover.

Co-dominant with foothills rough fescue and Idaho fescue on sites where hare-footed locoweed occurs are low sedges (*Carex filifolia, C. obtusata*, *C. pensylvanica, C. stenophylla*) and low cushion plants, including blue phlox (*Phlox alyssifolia*), moss phlox (*Phlox hoodii*), pasture sage (*Artemisia frigida*) and small-leaved everlasting (*Antennaria parvifolia*). Other grasses commonly present are June grass (*Koeleria macrantha*), early bluegrass (*Poa cusickii*), western wheatgrass (*Agropyron smithii*) and western porcupine grass (*Stipa curtiseta*). Other legumes commonly associated with hare-footed locoweed include golden bean (*Thermopsis rhombifolia*) and early yellow locoweed (*Oxytropis sericea*). Viscid locoweed (*Oxytropis borealis* var. *viscida*) commonly occurs in grasslands adjacent to sites where hare-footed locoweed grows, but does not grow in association with hare-footed locoweed (Smith 1995).

A key characteristic of sites supporting hare-footed locoweed is the presence of a continuous ground cover of little club moss (*Selaginella densa*) and lichens (70%–95% cover) interspersed with the exposed gravels (5%–30% cover). There is little to no plant litter because of low site productivity and the erosion by strong winds that carry away dried plant material.

4. Habitat Continuity, Alteration and Fragmentation – It is not known whether subpopulations of hare-footed locoweed in Alberta are relicts of a more continuous distribution prior to, or during, Pleistocene glaciation, or a more recent opportunistic expansion into suitable habitat from a more southerly population of the taxon. Nonetheless, habitats suitable for hare-footed locoweed — plateau headlands and abandoned terraces with gravel substrate — are discontinuous and often widely separated; hence, there is a natural tendency for subpopulations to be isolated one from the other. The degree of isolation has likely increased as a result of widespread landscape change since the early 1900s.

Approximately 70% of the Foothills Fescue Natural Subregion has been converted to non-native vegetation, according to the Grassland Vegetation Inventory, which uses post-2005 colour infrared aerial photography and a minimum mapping unit of 5 ha in area and

50 m in width (Alberta Sustainable Resource Development 2010, Prairie Conservation Forum 2011). Within the extent of occurrence of hare-footed locoweed (229 km^2), most of the fairly level uplands of the Del Bonita plateau (south of the North Milk River) and of the Milk River Ridge (north of the Milk River) as well as terraces and gentle lower slopes in the valleys of the North Milk River, Shanks Creek and west arm of Shanks Lake have been cultivated. In 4 of 11 extant occurrences, some habitat of hare-footed locoweed has been lost to cultivation where fields of annual crop, hay or modified grassland on the uplands extend to the valley edge. The actual area of habitat lost cannot be accurately measured as hare-footed locoweed distribution prior to cultivation is unknown.

Habitat of hare-footed locoweed at known occurrences has been lost and fragmented, not only by cultivation but also other human activities including gravel extraction, oil and gas development, residential development, and construction and use of roads and trails. Surface disturbance from domestic livestock (cattle and bison) loitering on wind-swept plateau sites is also occurring, but the impact of this on long-term survival of hare-footed locoweed is unknown. A common consequence of all these activities is the introduction of non-native plant species, particularly crested wheat grass (*Agropyron cristatum*), and ongoing invasion into native habitat. See the Limiting Factors section for a more detailed discussion of habitat loss and fragmentation.

One historical subpopulation of hare-footed locoweed (Cardston) may have been extirpated because of gravel extraction (Smith 1995, Wallis et al. 1986). That subpopulation was first recorded in 1958 and again in 1966 and 1967 by the same surveyor. Surveyors failed to find plants at the site in 1986 and 1993, and noted that gravel extraction was occurring at the site.

Given the pervasiveness of cultivation within the species' extent of occurrence and fragmentation of habitat as a result of human activity within known occurrences, one may reasonably expect that there are areas of the uplands and valley terraces where hare-footed locoweed habitat has been lost over the last several decades, thereby reducing the connectivity among subpopulations.

CONSERVATION BIOLOGY

1. Morphology and Habit – Hare-footed locoweed is a perennial herb in the Pea Family (Fabaceae [Leguminosae]). Plants are silky-hairy and densely tufted, and grow from a taproot with a branched crown. Pinnately-divided leaves grow from the crown, their stalks with silky-hairy, membranous stipules at the base. Pea-like flowers with pinkish-purple or bluish-purple petals are clustered at the top of short, leafless stalks. The base of the petals is surrounded by a calyx with a mix of white and blackish hairs and below that is a shaggy-hairy bract. As the fruit forms, the calyx swells. The oblong, papery pod is tipped with a short beak and projects from the calyx at maturity.

Variety *conjugans,* the only variety of hare-footed locoweed occurring in Alberta, has leaves that are 1 cm–6 cm long with 5–9 leaflets congested on a leaf axis that is 5 mm–13 mm long and about equal to the longest leaflet (Welsh 2001). Flower stalks are 5 cm–15 cm tall. Flowers are 15 mm–19 mm long. Pods are 8 mm–13 mm long and 5 mm thick, and typically fall without the calyx.

A strong taproot and a cushion-like growth form allow hare-footed locoweed to withstand buffeting by strong winds. Dense hair cover on the leaves, flower stalks and calices alleviates desiccation by sun and winds in highly exposed habitats.

2. Longevity and Reproduction – Hare-footed locoweed populations are likely long-lived

with overlapping generations. At least two subpopulations in Alberta, both occurring within a provincial protected area, have been documented as persisting for at least 25 years. Individual plants likely persist for at least several years as do other perennials; however, information is lacking on longevity of individuals, reproductive age and age structure within a population.

In Alberta, hare-footed locoweed has been observed in flower from early May to late June. In the 2011 survey, peak flowering occurred during the last week in May at lower elevation sites near Del Bonita, and the first week in June at higher elevations on the Milk River Ridge. The number of flowering stalks per plant ranged from 1 to 112, with 5 to 15 stalks being most common; 5 to 8 flowers grow on each stalk. Flowers appeared to fade quickly within a few days of opening. One uniquely coloured white-flowered plant was observed east of Del Bonita.

As for other legumes, pollination of hare-footed locoweed is likely accomplished by insects because of the large showy flowers with design features attractive to insects. Two species of bumble bees (*Bombus huntii* and *Bombus nevadensis*) were observed on flowers of hare-footed locoweed in May 1998 within the Ross Grassland Natural Area (Ernst 1998). Both bumble bee species are native to western North America. Bumble bees are known to be pollinators of other *Oxytropis* species (Artyukova et al. 2010, Bauer 1983). Bees are known to mediate gene flow over several kilometres when pushed by the wind (Pasquet et al. 2008); however, dispersal distances for hare-footed locoweed pollinators have not been investigated.

Fruits mature within a few weeks of pollination (Ernst 1998, C. Bradley pers. obs.). Mature pods may split open on the plant with the small seeds being gravity-dispersed only a short distance from the maternal plant. Alternatively, mature pods may separate from the calyx at maturity and be dispersed by wind before splitting open. Dispersal by wind over short distances may result in successful establishment; however, the likelihood of long-distance wind dispersal resulting in small pods landing in suitable habitat is very low, since habitat suitable for establishment of hare-footed locoweed is uncommon and discontinuous. Seed dispersal in hare-footed locoweed has yet to be investigated.

By mid- to late-July, all that is visible of individual plants is a tuft of hairy leaves hugging the ground (C. Bradley pers. obs.). Stalks and fruiting structures have been subject to herbivory or blown away. By this point in their annual life cycle, hare-footed locoweed would be difficult to detect during field survey.

3. Herbivory and Traditional Use – Herbivory of the flowers and seed pods of hare-footed locoweed is known to occur as evidenced by freshly decapitated inflorescence stalks and chewed pods at several sites during field survey (Ernst 1998, J. Gould pers. comm., C. Bradley pers. obs.). Colonies of ground squirrels (Richardson's and thirteen-lined) are established near some subpopulations of hare-footed locoweed (C. Bradley pers. obs.). Ground squirrels may chew open the pods and eat the seeds directly (Ernst 1998), or carry the flowers and pods back to burrows that are dug into the deeper loamy soils away from the plateau edge. Deer may also nip off the flower and fruiting heads of hare-footed locoweed, but this has not been observed. High and persistent levels of herbivory on flowers and seeds may significantly affect dispersal, recruitment and plant density in hare-footed locoweed subpopulations; however, this has not been studied.

Herbivory by domestic livestock on hare-footed locoweed appears to be light to non-existent (Ernst 1998, C. Bradley pers. obs.). It may be that the plants are unpalatable or toxic for livestock,

although this has yet to be investigated. A small proportion of locoweed species in North America, including field locoweed (*Oxytropis campestris*) and early yellow locoweed (*Oxytropis sericea*), both found in Alberta, produce the alkaloid swainsonine that is toxic to livestock when ingested in large quantities (Welsh et al. 2007). Symptoms of swainsonine poisoning—intoxication and neurological disorders—are referred to as locoism; hence, the derivation of the name locoweed. Other locoweeds, however, are considered of value as grazing plants.

Locoweeds have been used in traditional folk medicine in Alberta and elsewhere (Johnson 1987, Li et al. 2011). Chemicals isolated from 28 species of the genus *Oxytropis*, principally flavinoids, alkaloids and saponins, have been shown to have beneficial medicinal properties. It is not known if early inhabitants used hare-footed locoweed for traditional medicine or if such use played a role in the species' dispersal and survival.

4. Soil Interactions **–** It has been suggested that the sites where hare-footed locoweed occurs are limy, with free calcium carbonate at the surface (Bradley 2008, T. Brierley pers. comm., E. Karpuk pers. comm.). Lime increases soil pH and can enhance the uptake of certain beneficial elements by plants and reduce potentially toxic concentrations of others (Brady 1974). Lime also has a stimulating effect on bacteria that fix nitrogen; hence, the growth of legumes with nodules is especially enhanced. It is unknown whether hare-footed locoweed harbours nitrogen-fixing rhizobial root symbionts; however, it might be expected as nodulation has been documented for several other species of *Oxytropis* (Laguerre 1997). The capacity to fix nitrogen could be a factor that allows hare-footed locoweed to survive on sites with unproductive gravel soils; however, this has yet to be investigated.

Hare-footed locoweed's association with a biological soil crust of mosses, lichens and perhaps fungi, bacteria and algae, may benefit species' establishment and survival by helping to hold water, moderating soil temperatures, fixing nitrogen and anchoring the underlying soil in this harsh environment (Crisfield 2011). Alternatively, the biological crust might compete with hare-footed locoweed for nutrients and space. Hare-footed locoweed was observed on some sites where the biological soil crust had been disturbed by loitering cattle and other temporary disturbances (C. Bradley pers. obs.); however, long-term persistence on such sites has not been determined. Further investigation would be required to determine whether or not the biological soil crust contributes to survival of hare-footed locoweed.

POPULATION SIZE AND TRENDS

1. Alberta **–** There are insufficient data to confidently estimate the size of the provincial population of hare-footed locoweed. A survey of 9 of 11 known extant subpopulations in 2011 produced estimates of the number of individual plants. The total of those estimates for nine subpopulations is approximately 36 400 individuals (Table 1). The full extent of occurrence for three of those subpopulations was not determined and two known extant populations were not surveyed. In addition, there may be unidentified subpopulations of hare-footed locoweed since a systematic approach to surveying all potential habitat has not been undertaken.

For hare-footed locoweed, an individual is defined by a root crown and leaves arising from it at the soil surface. This is the most practical and efficient unit for monitoring population size of hare-footed locoweed. There may be viable seeds in the soil that are part of the population but are not readily counted. Mature plants capable of reproduction have one to numerous flower-bearing stalks from a single to multiple-branched root crown, which may in the latter

case appear as a "clump." In 2011, almost all individuals were observed to have flower-bearing stalks, and were hence determined to be mature (C. Bradley pers. obs.). More study is needed to determine how many years are required for a plant to reach maturity and if mature plants consistently produce flowers from year to year.

The number of individuals within the 11 extant subpopulations of hare-footed locoweed, according to reports filed with ACIMS, ranges from 1 to 19 400 (Table 1). The largest subpopulation (19 400 individuals) is found on two plateaus, separated by a 500 m-wide valley, east of Del Bonita and about 1 km north of the U.S. border (Del Bonita East). This subpopulation is at the southeastern limit of the known extent of occurrence of hare-footed locoweed in Alberta. The second largest subpopulation (10 300 individuals) is approximately 8 km north along the edge of a narrow plateau paralleling the west arm of Shanks Lake (Shanks Lake West). There is a much smaller (820 individuals), but less well surveyed, subpopulation about halfway between (Shanks Lake South). These three subpopulations comprise approximately 84% of the known provincial population. The remaining eight subpopulations are associated with the Milk River Ridge north of the North Milk River valley. These subpopulations are considerably smaller in size (1–3540 individuals), and no one subpopulation is separated from its nearest neighbour by more than 3 km or less than 1.5 km.

There are insufficient data to determine trends in population size of hare-footed locoweed. Reliable population estimates for more than two years are available for only one occurrence. At this site within the Ross Grassland Natural Area (part of the Milk River Ridge subpopulation), seven reports by four different observers of hare-footed locoweed have been filed with ACIMS since hare-footed locoweed was first found there in May 1986. Two of the reports do not include a population estimate. For three of the reports that do provide plant counts, the area surveyed is not precisely defined nor is the survey methodology. In the 2011 survey, 1575 plants were counted at the site through systematic survey of a 20 m-wide belt transect (recorded using a hand-held GPS receiver) along the entire plateau edge in the southern portion of the natural area. Other estimates of number of individuals at the site range from approximately 250–300 plants in 1993 and 2007, to 500–1000 plants in 1986, to 3200 plants in 1998. These data suggest a fluctuation in population size that exceeds 10-fold; however, a more systematic approach to survey is required to confirm such a conclusion.

In Alberta, 1 of 12 known subpopulations of hare-footed locoweed has been eradicated, perhaps by gravel extraction. The location of the historical subpopulation near Lee Creek in the glaciated Cardston Plain is approximately 25 km northwest of the closest known extant subpopulation on the unglaciated Milk River Ridge and 210 m lower in elevation. There is speculation that the Cardston subpopulation may have been introduced (Smith 1995, Wallis et al. 1986); however, this has not been confirmed and may never be.

There is evidence that area of occupancy and quality of habitat of hare-footed locoweed has declined or is at risk of decline within 5 of 11 extant subpopulations as a result of cultivation, gravel extraction, oil and gas development, residential development, and construction and use of roads and trails (Table 1). A common consequence of all these activities is introduction of non-native plant species, particularly crested wheat grass, and ongoing invasion into native habitat. An approach to estimating the amount of habitat lost or degraded within known subpopulations may be to overlay a GIS layer of known distribution of hare-footed locoweed with air photo images and appropriate layers of the Grassland Vegetation Inventory interpreting range site type, vegetation and land use (Alberta

Sustainable Resource Development 2010). Surface disturbances within subpopulations and/or within 50 m of the plateau edge in suitable habitat for hare-footed locoweed could then be interpreted as resulting in loss or degradation of habitat. Such an analysis has not been undertaken.

2. Other Areas - Collections of hare-footed locoweed variety *conjugans* in the University of Montana herbarium indicate there are approximately a dozen subpopulations in that state (University of Montana Herbarium 2011). Survey focused on hare-footed locoweed has not been conducted in Montana, although the need for this has been identified (S. Mincemoyer pers. comm.). Given the lack of data on population size of hare-footed locoweed in Montana, the proportion of the global population of variety *conjugans* occurring in Alberta cannot be confidently estimated, although it is expected to be significant.

The proportion of the global population in Alberta is much less significant when one considers all three varieties of hare-footed locoweed. The two varieties of hare-footed locoweed not found in Alberta—variety *lagopus* and variety *atropurpurea*—have been reported from many more sites over a larger area than variety *conjugans* (Figure 2). Herbarium collections indicate more than 70 subpopulations (separated by more than 1 km) of hare-footed locoweed variety *lagopus* in Montana, Wyoming and Idaho and more than 30 subpopulations of hare-footed locoweed variety *atropurpurea* in Wyoming with one subpopulation in southern Montana and one in the Black Hills of South Dakota (Rocky Mountain Herbarium 2008, University of Montana Herbarium 2011, S. Welsh pers. comm.).

LIMITING FACTORS

Limiting factors are major factors that affect habitat quality and availability, reproductive output, or survival of individuals. For this status report, the focus is on limiting factors that have an anthropogenic origin. The effects of limiting factors may be cumulative.

Land ownership, designation and management intent should be considered in assessing the level of threat to a rare plant population by a limiting factor. Five of the 11 extant subpopulations of hare-footed locoweed on the Milk River Ridge are contained within a provincial protected area or on private land that is protected through a conservation land trust (Table 1). One subpopulation (Ross Grassland North) and part of another (Milk River Ridge) are within the Ross Grassland Natural Area, where the management intent is to maintain ecological integrity and preserve key natural and cultural heritage values. Three subpopulations (Milk River Ridge NCC, North Milk River Terrace, Sandstone Ranch) and part of another (Milk River Ridge) are on parcels owned by or under easement to conservation land trusts. These properties are managed to conserve biodiversity and promote ecosystem health through stewardship. Land uses that threaten hare-footed locoweed (i.e., cultivation, gravel exploration and extraction, oil and gas development, residential development, wind energy development, roads and vehicle trails) are less likely to occur in these protected areas.

The three subpopulations of hare-footed locoweed occurring south of the North Milk River are located on both private land and public land (Table 1). In the absence of legal protection for habitat of hare-footed locoweed, all subpopulations are at some degree of risk. Protection of hare-footed locoweed is more likely to be a component of management on public land, where conservation of biodiversity is a management intent, compared to private land without any conservation designation. On public land, habitat for hare-footed locoweed is less likely to be at risk from cultivation, residential development or wind energy development, and livestock grazing is managed

by defining an ecologically-sustainable carrying capacity and conducting periodic inspections to ensure range health is maintained. Other land-use activities that may negatively affect hare-footed locoweed do occur on public land, including oil and gas development, gravel extraction, access trail development and livestock corrals. Provided there is a protective notation and requirement for rare plant survey prior to any surface disturbance, these threats can be avoided or minimized.

With respect to the consideration of land ownership and management intent in assessing threat of limiting factors, a parcel of public land immediately adjacent to or containing known habitat for hare-footed locoweed in the Shanks Lake West occurrence was recently considered for transfer to Cardston County. Hare-footed locoweed habitat occurs at the top of the steep slope of the North Milk River valley at the southeast corner of the quarter section. The parcel was retained as public land for environmental reasons. Had the parcel been transferred to the municipality it was at risk of being privatized. Hare-footed locoweed habitat would have been at more risk of being adversely affected by heavy grazing pressure, cultivation, gravel extraction, residential development and trail development as currently occurs on other privately-owned parcels in the Shanks Lake West occurrence. This is an example demonstrating the importance of environmental considerations in public land sale decisions.

1. Loss and Degradation of Habitat - Loss of native grasslands within the extent of occurrence of hare-footed locoweed has affected and continues to affect habitat quality and availability. Since the late 1900s, approximately 70% of the Foothills Fescue Natural Subregion has been converted to non-native vegetation (Alberta Sustainable Resource Development 2010, Prairie Conservation Forum 2011). Restoration of foothills rough fescue grasslands, once disturbed, is notably difficult (Bradley 2009, Desserud 2006, Kestrel Research Inc. and Gramineae Services Ltd. 2011, Willms 2008).

Much of the hare-footed locoweed's 229-km^2 extent of occurrence has been cultivated, including the fairly level uplands of the Del Bonita plateau (south of the North Milk River) and the Milk River Ridge (north of the Milk River), as well as terraces and gentle lower slopes in the valleys of the North Milk River, Shanks Creek and west arm of Shanks Lake. The fields are generally very stony, as evidenced by large piles of hand-picked stones. Cultivation occurs to within a few metres of the plateau edge in many places. In some places, hare-footed locoweed habitat has likely been completely lost, although the extent of the loss is difficult to determine. Some fields are still actively cultivated while others have been returned to permanent cover. Return to permanent cover involves planting a cover crop that may include plant species such as crested wheat grass that invades native grassland. The result may be an indirect adverse effect on hare-footed locoweed subpopulations.

In four known subpopulations, cultivation has occurred in suitable habitat (Table 1, 2). Hare-footed locoweed persists in narrow bands (less than 10 m wide) of native grassland between cultivated fields on the upland and the upper valley slopes. Besides cultivation, other human land-use activities that have led to habitat loss and fragmentation of hare-footed locoweed habitat include gravel extraction, oil and gas development, residential development, and construction and use of roads and trails (Table 1). Hare-footed locoweed habitat is adversely affected by one or more of these land-use activities in 5 of the 11 extant occurrences (Table 1, 2).

In five subpopulations invasion by non-native plant species, primarily crested wheat grass, has occurred and is likely to continue to occur as a result of human land-use activities (Table

Table 2. Land uses and the number of extant subpopulations affected by the activity. A subpopulation may be affected by more than one land use activity.

Land Use Activity	Number of Subpopulations Affected (n=11)
vehicle access (trails and roads)	5
cultivation	4
gravel exploration and extraction	3
oil and gas development	2
residential development	1

1). Crested wheat grass is long-lived (15 to 20 years), drought-tolerant and has an extensive root system (Henderson and Naeth 2005, Operation Grassland Community 2011). It spreads primarily via seed, but may also spread via rhizomes (underground stems). Crested wheat grass is reported to spread by seed into native grasslands at rates up to 0.8 m/year (Henderson 2007, Henderson and Naeth 2005). It may form monotypic stands and inhibit growth of native species. Early detection of crested wheat grass and control of new infestations into native prairie is recommended (Operation Grassland Community 2011). Similarly, vigilance is required to ensure other invasive non-native plants able to establish in gravels, such as spotted knapweed (*Centaurea stoebe* ssp. *micranthos*), do not get a foothold.

Gravel extraction may have led to extirpation of the one known historical subpopulation of hare-footed locoweed near Cardston (Smith 1995). A gravel pit in hare-footed locoweed habitat within the Ross Grassland Natural Area (Milk River Ridge) was halted in 1986 (Smith 1995) and a project to restore the native rough fescue grassland community was implemented in 1997 (Willms 2008). Hare-footed locoweed is growing near, but not on, the reclaimed site (C. Bradley pers. obs.). There is a large active gravel mining operation on the plateau north of Shanks Lake that is impacting habitat for hare-footed locoweed and expanding further into the plant's habitat.

An operating gas well is situated in habitat for hare-footed locoweed within one subpopulation (Sandstone Ranch) and an abandoned well site was noted within 100 m of another occurrence (Milk River Ridge) (C. Bradley pers. obs.). The former appears to have been constructed using minimum disturbance techniques, whereas the latter has resulted in introduction of invasive non-native species (crested wheat grass). Oil and gas exploration and development activity has recently dramatically increased in the Del Bonita area (C. Bradley pers. obs., Wells 2010). Light oil has been found in the Bakken (Exshaw) shale formation underlying the Plateau. Extracting the oil requires horizontal drilling and multi-stage fracturing technology. The implications of this activity with respect to loss or fragmentation of habitat for hare-footed locoweed have not yet been assessed.

Vehicle roads and trails run through hare-footed locoweed habitat at several sites within five extant subpopulations. Hare-footed locoweed is not growing on the travel tracks or graded road beds, but in some places plants were observed in the disturbed gravels along the edges of these vehicle access routes (C. Bradley pers. obs.). Whether there is long-term survival of plants and successful regeneration in these disturbed

sites is a matter for further study. There is a risk of non-native plant species invasion as a result of introduction of propagules by vehicles traveling on these routes. An overall adverse effect is predicted.

The entire extent of occurrence of hare-footed locoweed in Alberta is included in the Chief Mountain Cumulative Effects Study Area (Silvatech Consulting Ltd. 2011). Thirty percent of the study area is native grassland. Modeling predicts the following trends in environmental impacts resulting from growth in human activity over the next 50 years:

- The area in native grassland is projected to decrease by 3% (8000 ha), 80% of this loss as a result of invasion by non-native plants and 20% by the placement of infrastructure such as roads and houses.
- The total area occupied by invasive plants is forecast to increase by 48% in native grasslands, the rate of increase being greatest during the next 15 years, as a result of activity in the hydrocarbon sector.
- Area of tame pasture will increase by 15% because of the unintentional degradation of native grassland by invasive plant species and direct conversion of native grasslands.
- Edge density resulting from linear features such as roads, pipelines, powerlines, and seismic lines is projected to rise from about 1.5 km per km^2 to approximately 2.25 km per km^2 throughout the study region.

In habitat for hare-footed locoweed, adverse impacts from human activity are likely to follow these predicted trends unless specific measures are taken to prevent or mitigate them.

2. Altered Grazing Regime - Hare-footed locoweed evolved with large grazers. For millennia, bison (*Bison bison*), mule deer (*Odocoileus hemionus*), elk (*Cervus canadensis*) and pronghorn (*Antilocapra americana*) roamed through the rough fescue grasslands of the Del Bonita Plateau and Milk River Ridge. Herbivores ranged freely through the vast open prairie and grazing patterns were climatically and seasonally defined. Beginning in the late 1800s, bison were replaced by domestic livestock and European settlement has resulted in enclosed pastures where management dictates pattern, timing and intensity of grazing.

Rough fescue grasslands, the plant community type in which hare-footed locoweed occurs, are sensitive to heavy grazing pressure during the growing season. The response of foothills rough fescue grasslands to four different summer stocking rates ranging from light (2 .0 acres per animal or cow-calf pair per month [ac/AUM]) to very heavy (0.5 ac/AUM) was studied over four decades at the Stavely research substation of Agriculture and Agri-Food Canada. With very heavy and heavy grazing stocking rates, rough fescue was largely eliminated after five years, weedy species established and forage production declined by 50 percent (Dormaar and Willms 1998, Willms et al. 1985). There was a corresponding decline in soil organic matter, loss of soil structure, increased surface sealing and reduced infiltration rates (Dormaar and Willms 1998, Naeth et al. 1990). Light stocking rates (more than 2 ac/AUM) are recommended as ecologically sustainable in foothills rough fescue grassland communities (Adams et al. 2005).

Although rough fescue grasslands can be readily damaged by heavy grazing pressure in summer, they are very tolerant of winter grazing (Willms and Rode 1998). It is likely that rough fescue grasslands evolved under a regime of winter grazing. The stiff erect leaves of rough fescue are available to grazers through the snow. Heavy grazing of winter range, however, also has a “drying out” effect that may affect suitability of habitat for hare-footed locoweed (Adams et al. 2005).

Loitering of livestock (cattle, horses and bison) in habitat of hare-footed locoweed was observed

at several sites within three subpopulations in 2011 (Whiskey Gap NE, Milk River Ridge, Shanks Lake West) (C. Bradley pers. obs.). Livestock may seek out wind-blown sites to be free of biting insects. In addition, livestock corrals have been constructed within or near hare-footed locoweed habitat within two subpopulations (Whisky Gap North and Shanks Lake West) that may result in loitering (C. Bradley pers. obs.). Where cattle loiter, hoof action has destroyed the biological crust and exposed the finer sands and silts on the surface to erosion and the soil to drying winds and sun (C. Bradley pers. obs.). There is also visible build up of manure. Vascular plant cover is noticeably reduced compared to adjacent vegetation. Hare-footed locoweed continues to grow in these sites, suggesting it is unpalatable to livestock; however, its long-term survival is likely to be adversely affected under persistent heavy livestock use.

3. Natural Factors - Hare-footed locoweed variety *conjugans* is endemic to western Montana and southwestern Alberta with a narrow habitat range. This fact alone could place the Alberta population at risk of extinction because of low genetic diversity within the population.

The taxon is naturally a habitat specialist, occurring in a habitat that is rare in the landscape with wide separation between similar habitats. The wind-eroded quartzitic gravel substrates, perhaps also characterized by processes of calcretion and biological crust formation, are of extremely limited distribution along edges of an ancient plateau and abandoned terraces of post-glacial rivers in southern Alberta.

Whether there is gene flow among subpopulations of hare-footed locoweed remains to be determined. Long-distance wind dispersal of mature pods and seeds is unlikely to occur given that suitable habitats are widely separated and very restricted. Bee pollinators, pushed by the wind, could conceivably disperse gametes between subpopulations (Pasquet et al. 2008).

4. Decline in Pollinators - Decline in pollinators may also be a limiting factor for survival of the hare-footed locoweed, as the species is reliant on bumble bees (*Bombus* spp.) for pollination. Dramatic range-wide population declines of some species of bumble bees in North America have been quantified, whereas the range-wide population of other species has been determined to be stable (Cameron et al. 2010, Koch 2011). Climate change, urbanization, agricultural intensification and pathogen pressure have been postulated as the cause for the decline in bumble bees.

STATUS DESIGNATIONS*

1. Alberta – Hare-footed locoweed is considered *May Be At Risk* according to the general status reviews in 2005 and 2010 (ASRD 2007 and 2011). The Alberta Conservation Information Management System ranks hare-footed locoweed as S1 (ACIMS 2011a). These designations reflect the fact that there are a very small number of occurrences and a restricted distribution, although the species is fairly common where found, and habitat is threatened by gravel extraction and cultivation of plateau rims (ASRD 2011).

2. Other Areas – In April 1995, hare-footed locoweed was assigned a status of *Vulnerable* by the Committee on the Status of Endangered Wildlife in Canada, based on the assessment of a national status report (Smith 1995). The *Vulnerable* designation was later translated to *Special Concern* (COSEWIC 2011). The reasons for this designation are its highly restricted range and the conclusion that it is common where found, but potentially subject to

* See Appendix 1 for definitions of selected status designations.

further losses from gravel extraction, expansion of agriculture and grazing (COSEWIC 2011).

In Montana, hare-footed locoweed has a state rank of S3 (potentially at risk). The reason for this designation is that the species is scattered across a wide area of the state, but is nowhere common within its habitats, and it is a regional endemic species with three regionally endemic varieties (Montana Natural Heritage Program [MNHP] 2011a and b).

Oxytropis lagopus var. *conjugans* is a *Species of Concern* in Montana, a designation given to native taxa that are at risk as a result of declining population trends, threats to their habitats, restricted distribution, and/or other factors (MNHP 2011a and b). The two other varieties of hare-footed locoweed occurring in Montana—*Oxytropis lagopus* var. *atropurpurea* and *O. lagopus* var. *lagopus*—are designated as *Status Under Review*, indicating that because of a lack of information they do not have a status rank, but may warrant future consideration as *Species of Concern* (MNHP 2011a and b).

Hare-footed locoweed is ranked G4G5 (Apparently Secure to Secure) on a global scale with an intraspecific rank of T3 (Vulnerable) appended to the global rank for *Oxytropis lagopus* var. *conjugans*. The T3 rank indicates the variety is at moderate risk of extinction or elimination because of a restricted range, relatively few populations, recent and widespread declines, or other factors (NatureServe 2011).

RECENT MANAGEMENT AND RESEARCH IN ALBERTA

No management or research activities focused on hare-footed locoweed have been undertaken in Alberta. Protection of hare-footed locoweed and its habitat is being specifically considered, however, as part of management planning for some properties in which the species occurs.

Nature Conservancy Canada (NCC) owns, or holds conservation easements for, five properties on which hare-footed locoweed occurs. As part of management planning of the properties, NCC with assistance from Alberta Conservation Association has acquired baseline data in the form of wildlife, vegetation (including rare plants) and range resource inventories. Range and riparian health assessments have also been conducted. This information is used to assist NCC with long-term stewardship of the properties, including protecting rare plants.

With the establishment of the Ross Grassland Natural Area in 1997, a management plan was developed and implemented. The plan limits vehicle access to protect the area's ecological integrity. In 1997, a trial project was undertaken by Alberta Environment and Cardston County to reclaim an abandoned gravel pit in hare-footed locoweed habitat (Willms 2008). A thin layer of stored topsoil was spread over the gravels and locally-harvested seed of rough fescue, Idaho fescue and other native species was spread. Many of these species have successfully established, although the native community has not yet been fully restored. The site is periodically inspected for progress in restoring a native rough fescue plant community.

SYNTHESIS

In Alberta, hare-footed locoweed is found within the Foothills Fescue Natural Subregion south of Lethbridge. Its restricted habitat is gravel substrates on headlands of flat-topped unglaciated uplands of the Del Bonita Plateau and of the Milk River Ridge (south and north, respectively, of the North Milk River), as well as on post-glacial river terraces. Suitable habitat is discontinuous and widely separated. Eleven extant hare-footed locoweed subpopulations are recognized in Alberta, and one historical occurrence near Cardston. A significant proportion of the global population likely occurs

in Alberta. The provincial population of hare-footed locoweed can be estimated as greater than 36 400 mature individuals, based on recent counts at nine of eleven extant subpopulations. Subpopulation sizes range from 1 individual to 19 400 individuals. Alberta's population of hare-footed locoweed is at the extreme northern limit of the species' range in North America and approximately 120 km north of the nearest known occurrence in Montana.

Loss and degradation of habitat for hare-footed locoweed has occurred, and is expected to continue to occur, as a result of cultivation, gravel extraction, oil and gas development, residential development, and construction and use of roads and trails. Five of the 11 extant subpopulations of hare-footed locoweed are affected by one or more of these human activities. Gravel extraction may have led to extirpation of the one known historical subpopulation of hare-footed locoweed near Cardston. Invasion by crested wheat grass is also occurring. Heavy use by cattle at some sites requires investigation regarding implications for survival and regeneration of hare-footed locoweed.

Five subpopulations of hare-footed locoweed associated with the Milk River Ridge lie within areas designated for protection by government or private interests. Stewardship of these areas can be expected to mitigate against habitat loss and degradation, provided protection of rare plant species is a management goal.

Efforts to define appropriate strategies for conservation of hare-footed locoweed in Alberta would benefit from research to determine if there is gene flow among subpopulations of hare-footed locoweed and whether the size and connectivity of subpopulations in Alberta is sufficient for survival of the provincial population, especially in light of recent habitat loss and fragmentation. Genetic research could also help to clarify species taxonomy, including the genetic similarity of the three varieties of hare-footed locoweed in North America and to define strategies for conservation as has been done for other locoweed species (Artyukova et al. 2010, Chung et al. 2004, Jorgensen et al. 2003, Schonswetter et al. 2004). The development of a conservation strategy for hare-footed locoweed would also benefit from further study of its biology to determine: if the presence of calcium carbonate on gravels is a significant factor in defining suitable habitat for the species; whether or not the biological soil crust contributes to survival of hare-footed locoweed; how many years is required for a plant to reach maturity and if mature plants consistently produce flowers from year to year; and whether there is long-term survival of plants and successful regeneration in disturbed sites. Confidence in the distribution and population estimate for Alberta would benefit from a systematic approach to survey the two subpopulations not yet surveyed in 2011 and of other potentially suitable habitat.

LITERATURE CITED

Adams B.W., R. Ehlert, D. Mosey and R.L. McNeil. 2005. Rangeland Plant Communities and Range Health Assessment Guidelines for the Foothills Fescue Natural Subregion of Alberta; Second Approximation. Rangeland Management Branch, Public Lands Division, Alberta Sustainable Resource Development, Lethbridge. Pub. No. T/044. 97 pp.

Alberta Conservation Information Management System (ACIMS) (Formerly Alberta Natural Heritage Information Centre). 2007. Explanation of Ranks. Alberta Tourism, Parks, Recreation and Culture. URL: http://tprc.alberta.ca/parks/heritageinfocentre/animals/definitions [Updated: 1 October 2007].

Alberta Conservation Information Management System (ACIMS). 2011a. List of Tracked and Watched Elements - May, 2011 version. Alberta Tourism Parks and Recreation, Parks Division, Edmonton Alberta. URL: http://tpr.alberta.ca/parks/heritageinfocentre/DataRequests/docs/List_of_All_Elements_MAY_2011.xls

Alberta Conservation Information Management System (ACIMS). 2011b. Element occurrence records for hare-footed locoweed (*Oxytropis lagopus*) and update mapping notes (September 16, 2011).

Alberta Environmental Protection. 1996. The status of Alberta wildlife. Alberta Environmental Protection, Natural Resources Service, Wildlife Management Division. Edmonton, AB. 44 pp.

Alberta Forestry, Lands and Wildlife. 1991. The status of Alberta wildlife. Alberta Forestry, Lands and Wildlife, Fish and Wildlife Division. Edmonton, AB. 49 pp.

Alberta Sustainable Resource Development. 2001. The general status of Alberta wild species 2000. Alberta Sustainable Resource Development, Fish and Wildlife Service. Edmonton, AB. 46 pp.

Alberta Sustainable Resource Development. 2007. The General Status of Alberta Wild Species 2005. URL: http://srd.alberta.ca/fishwildlife/wildspecies/ [Updated January 2007].

Alberta Sustainable Resource Development. 2010. Grassland Vegetation Inventory Specifications 5th edition, July 2010. Edmonton. 90 pp.

Alberta Sustainable Resource Development. 2011. The General Status of Alberta Wild Species 2010. URL: http://www.srd.alberta.ca/FishWildlife/SpeciesAtRisk/GeneralStatusOfAlbertaWildSpecies/

Artyukova E.V., M.M. Kozyrenko, A.B. Kholina and Y.N. Zhuravlev. 2010. High chloroplast haplotype diversity in the endemic legume *Oxytropis chankaensis* may result from independent polyploidization events. Genetica. 2011 Feb;139(2):221-32. Epub 2010 Dec 16. URL: http://ibss.febras.ru/files/00009927.pdf

Barneby R.C. 1952. A revision of the North American species of *Oxytropis* DC. Proceedings of the California Academy of Sciences IV. 27:177–312.

Bauer, P. J. 1983. Bumblebee pollination relationships on the Beartooth Plateau tundra of southern Montana. American Journal of Botany. 70(1):134–144.

Boivin, B. 1967. Flora of the Prairie Provinces: A Handbook to the Flora of the Provinces of Manitoba, Saskatchewan and Alberta. Provancheria 2, Memoires de l'Herbier Louis-Marie, Faculte d'Agriculture, Universite Laval. 202 pp.

Bradley, C. 2008. Milk River Ridge plant survey: a shared experience. Iris 56 (January 2008):1–6. The Alberta Native Plant Council Newsletter.

Bradley, C. 2009. Handle with Care: The 'hard' evidence for conserving rough fescue grasslands. Hard Grass Advocate 2 (1):11–13. Foothills Restoration Forum Newsletter.

Brady, N.C. 1974. The Nature and Properties of Soils. 8th Edition. MacMillan Publishing Co., Inc. New York. xvi + 639 pp.

Brierley, J.A., A.T. Rodvang, and W.W. Pettapiece. 1991. Soil Survey of the Municipal District of Cardston, (M.D. No. 6), Alberta. Alberta Institute of Pedology Report No. S-86-48. Land Resource Research Contribution No. 87-62. Agriculture Canada, Edmonton. ix + 86 pp plus maps.

Cameron, S.A, J.D. Lozier, J.P. Strange, J.B. Koch, N. Cordes, L.F. Solter, and T.L. Griswold. 2010. Patterns of widespread decline in North American bumble bees. PNAS Early Edition online. 6 pp. URL www.pnas.org/lookup/suppl/doi:10.1073/pnas.1014743108. [Date accessed: 31 October 2011.

Chung, M., G. Gelembiuk, and T.J. Givnish. 2004. Population genetics and phylogeography of endangered *Oxytropis campestris* var. *chartacea* and relatives: artic-alpine disjuncts in eastern North America. Molecular Ecology 13:3657-3673.

COSEWIC. 2010. Definitions and Abbreviations. Committee on the Status of Endangered Wildlife in Canada. URL: http://www.cosewic.gc.ca [Updated April 2010].

COSEWIC. 2011. Database. Committee on the Status of Endangered Wildlife in Canada. URL: http://www.cosewic.gc.ca/eng/sct1/searchdetail_e.cfm [Last Updated May 2010. Date Accessed 18 September 2011]

Crisfield, V. 2011. Organisms underfoot! The importance of biological soil crusts. Iris 65 (April 2011): 7. Alberta Native Plant Council Newsletter.

Desserud, P.A. 2006. Restoration of rough fescue grassland on pipelines in southwestern Alberta. M.E.D. thesis. Faculty of Environmental Design, University of Calgary. 208pp.

Dormaar, J.F., and W.D. Willms. 1998. Effects of forty-four years of grazing on fescue grassland soils. J. Range. Manage. 51:122–126.

Ernst, R. 1998. Ross Grassland Natural Area: Results of 1998 Rare Plant Survey. Report for Lethbridge Naturalists Society, Alberta Parks and Public Lands. iii + 30 pp.

Henderson D. 2007. Crested Wheatgrass Invasion: Influence of Prevailing Winds and Grazing at Suffield National Wildlife Area. Environment Canada –

Canadian Wildlife Service. Saskatoon, SK. 36 pp.

Henderson, D.C., and M.A. Naeth. 2005. Multi-scale impacts of crested wheatgrass invasion in mixed-grass prairie. Biological Invasions 7(4):639–650.

IUCN. 2001. IUCN Red List Categories and Criteria: Version 3.1. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK. Ii + 30 pp.

Jackson, L.E. Jr., E.R. Leboe, E.C. Little, P.J. Holme, S.R. Hicock, K. Shimamura, and F.E.N. Nelson. 2008. Quaternary stratigraphy and geology of the Rocky Mountain Foothills, southwestern Alberta. Geological Survey of Canada, Bulletin 583. 61 pp.

Johnson, A. 1987. Plants and the Blackfoot. Lethbridge Historical Society Occasional Paper No. 15. City of Lethbridge. 68 pp.

Jorgensen, J.L., I. Stehlik, C. Brochmann, and E. Conti. 2003. Implications of ITS sequences and RAPD markers for the taxonomy and biogeography of the *Oxytropis campestris* and *O. arctica* (Fabaceae) complexes in Alaska. American Journal of Botany 90(10):1470–1480.

Kestrel Research Inc. and Gramineae Services Ltd. 2011. Long term recovery of native prairie from industrial disturbance: Express Pipeline revegetation monitoring project 2010. Prepared for Kinder Morgan Canada, TransCanada PipeLines, ConocoPhillips Canada and ASRD Public Lands Division. xviii + 345 pp.

Koch, J.B. 2011.The decline and conservation status of North American bumble bees. M.Sc. Thesis. Utah State University, Logan, Utah. *All Graduate Theses and Dissertations*. Paper 1015. x + 133 pp. URL: http://digitalcommons.usu.edu/etd/1015 [Date Accessed: 31 October 2011]

Laguerre, G. 1997. Genetic diversity of rhizobial symbionts isolated from legume species within the genera *Astragalus*, *Oxytropis*, and *Onobrychis*. Applied and Environmental Microbiology. 63: 4748–4758.

Li, M.X., Z.H. Lan, L.L. Wei, W.J. Zhang, R.X. Zhang, and P.J. Zheng. 2011. Phytochemical and biological studies of plants from the genus *Oxytropis*. Records of Natural Products 6:1:1–20.

Montana Natural Heritage Program. 2011a. Species of Concern. URL: http://mtnhp.org/SpeciesOfConcern./ [Date Accessed: 18 September 2011]

Montana Natural Heritage Program. 2011b. Montana Field Guide. URL: http://fieldguide.mt.gov/displaySpecies.aspx?family=Fabaceae [Date Accessed: 18 September 2011].

Naeth, M.A., D.J. Pluth, D.S. Chanasyk, A.W. Bailey, and A.W. Fedkenheuer. 1990. Soil compacting impacts of grazing in mixed prairie and fescue grassland ecosystems of Alberta. Can. J. Soil Sci. 70:157–167.

National Research Council. 1995. Science and the Endangered Species Act. National Academy Press, Washington, DC. 271 pp.

NatureServe. 2004. A habitat-based strategy for delimiting plant element occurrences:

guidance from the 2004 working group. 15 pp. URL: www.natureserve.org/library/deliminting_plant_eos_Oct_2004.pdf

NatureServe. 2011. NatureServe Conservation Status. NatureServe Explorer: an online encyclopedia of life [web application] Version 7.1. Arlington, Virginia, USA: NatureServe. URL: http://www.natureserve.org/explorer/ranking.htm#globalstatus [Last Updated: February 2011. Date Accessed: 17 September 2011]

Operation Grassland Community. 2011. Managing crested wheatgrass in native grassland. The Landowner's Toolkit Series pamphlet. Operation Grassland Community, Edmonton. URL: http://www.ogcpsp.com/ogc/pdfs/fact_sheets/OGCWheatgrass.pdf [Date Accessed: 29 October 2011]

Pasquet, R.S., A. Peltier, M.B. Hufford, E. Oudin, J. Sulnier, L. Paul, J.T. Knudsen, H.R. Herren and P. Gepts. 2008. Long-distance pollen flow assessment through evaluation of pollinator foraging range suggests transgene escape distances. PNAS 105(36):13456-13461. URL: www.pnas.org_cgi_doi_10.1073_pnas.0806040105 [Date Accessed: 1 November 2011]

Prairie Conservation Forum. 2011. Alberta Prairie Conservation Action Plan: 2011-2015. Published by the Prairie Conservation Forum, Lethbridge. 28 pp.

Rocky Mountain Herbarium. 2008. RM Herbarium Specimen Database. University of Wyoming, Laramie. URL: http://www.rmh.uwyo.edu/data/search.php [Date Accessed: 14 August 2011].

Schonswetter, P., A. Tribsch, and H. Niklfeld. 2004. Amplified fragment length polymorphism (AFLP) reveals no genetic divergence of the eastern alpine endemic *Oxytropis campestris* subsp. *tiroliensis* (Fabaceae) from widespread subsp. *campestris*. Plant Syst. Evol. (2004). Published online: February 3, 2004.

Shetsen, I. 1980. Sand and gravel resources of the Lethbridge area. Earth Sciences Report 1981–4, Alberta Research Council, Edmonton. 41 pp and map.

Shetsen I. 1987. Map of Quaternary Geology, Southern Alberta. Alberta Research Council. Scale 1:500,000.

Silvatech Consulting Ltd. 2011. Chief Mountain cumulative effects study: Assessing the footprint of human activity in southwest Alberta. Cardston County and Chief Mountain Landowners Information Network. 24 pp. URL: http://www.watertonbiosphere.com/uploads/biosphere-resources_16_255886894.pdf [Date Accessed: 31 October 2011]

Smith, B. 1995. Status report on the hare-footed locoweed, *Oxytropis lagopus*, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 24 pp.

Stalker, A. 1963. Quaternary stratigraphy in southern Alberta, Canada. Geological Survey Paper No. 62–34. 52 pp.

University of Montana Herbarium. 2011. Montana Vascular Plant Database. URL: http://herbarium.dbs.umt.edu/database/Default.aspx [Date Accessed: 14 August 2011]

Wallis, C., C. Bradley, M. Fairbarns, J. Packer, and C. Wershler. 1986. Pilot rare plant monitoring program in the Oldman Regional Plan area of southwestern Alberta. Forestry, Lands and Wildlife. Edmonton. x + 203 pp.

Wells, P. 2010. Led by the Alberta Bakken/ Exshaw, new shale oil plays are emerging. Nickle's Daily Oil Bulletin (November 16, 2010). 8 pp.

Welsh, S.L. 2001. Revision of North American Species of *Oxytropis* de Candolle (Leguminosae). Brigham Young University. Provo, Utah. iv + 101 pp.

Welsh, S. L., M. H. Ralphs, K. E. Panter, J. A. Pfister, and L. F. James. 2007. Locoweeds of North America: taxonomy and toxicity. *In* Panter, K. E., T. L. Wierenga, and J. A. Pfister, editors. [eds.]. Poisonous plants: global research and solutions. Wallingford, United Kingdom CABI. p. 20–30.

Willms, J.L. 2008. Rough fescue growing on a reclaimed gravel pit. Hard Grass Advocate 1(1):5-6. Foothills Restoration Forum Newsletter.

Willms, W.D., and L.M. Rode. 1998. Forage selection by cattle on fescue prairie in summer or winter. J. Range Manage. 51:496-500.

Willms, W.D., S. Smoliak, and J.F. Dormaar. 1985. Effects of stocking rate on rough fescue grassland vegetation. J. Range Manage. 38:220–225.

Appendix 1. Definitions of status ranks and legal designations.

A. The General Status of Alberta Wild Species 2010 (after Alberta Sustainable Resource Development 2011)

2010/2005 Rank	1996 Rank	Definitions
At Risk	Red	Any species known to be *At Risk* after formal detailed status assessment and designation as *Endangered* or *Threatened* in Alberta.
May Be At Risk	Blue	Any species that may be at risk of extinction or extirpation, and is therefore a candidate for detailed risk assessment.
Sensitive	Yellow	Any species that is not at risk of extinction or extirpation but may require special attention or protection to prevent it from becoming at risk.
Secure	Green	Any species that is not *At Risk, May Be At Risk* or *Sensitive*.
Undetermined	Status Undetermined	Any species for which insufficient information, knowledge or data is available to reliably evaluate its general status.
Not Assessed	n/a	Any species that has not been examined during this exercise.
Exotic/Alien	n/a	Any species that has been introduced as a result of human activities.
Extirpated/Extinct	n/a	Any species no longer thought to be present in Alberta (Extirpated) or no longer believed to be present anywhere in the world (Extinct).
Accidental/Vagrant	n/a	Any species occurring infrequently and unpredictably in Alberta, i.e., outside its usual range.

B. Alberta Species at Risk Formal Status Designations
Species designated as *Endangered* under Alberta's *Wildlife Act* include those listed as *Endangered* or *Threatened* in the Wildlife Regulation (in bold).

Endangered	**A species facing imminent extirpation or extinction.**
Threatened	**A species likely to become endangered if limiting factors are not reversed.**
Species of Special Concern	A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.
Data Deficient	A species for which there is insufficient scientific information to support status designation.

C. Committee on the Status of Endangered Wildlife in Canada (after COSEWIC 2010)

Extinct	A species that no longer exists.
Extirpated	A species that no longer exists in the wild in Canada, but occurs elsewhere.
Endangered	A species facing imminent extirpation or extinction.
Threatened	A species that is likely to become endangered if nothing is done to reverse the factors leading to its extirpation or extinction.
Special Concern	A species that may become threatened or endangered because of a combination of biological characteristics and identified threats.
Not at Risk	A species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient	A category that applies when the available information is insufficient to (a) resolve a wildlife species' eligibility for assessment, or (b) permit an assessment of the wildlife species' risk of extinction.

Appendix 1 continued:

D. Heritage Status Ranks: Global (G), National (N), Subnational (S) (after Alberta Conservation Information Management System [formerly Alberta Natural Heritage Information Centre] 2007, NatureServe 2011)

G1/N1/S1	5 or fewer occurrences or only a few remaining individuals. May be especially vulnerable to extirpation because of some factor of its biology.
G2/N2/S2	6 to 20 or fewer occurrences or with many individuals in fewer locations. May be especially vulnerable to extirpation because of some factor of its biology.
G3/N3/S3	21 to 100 occurrences; may be rare and local throughout its range, or in a restricted range (may be abundant in some locations). May be susceptible to extirpation because of large-scale disturbances.
G4/N4/S4	Typically > 100 occurrences. Apparently secure.
G5/N5/S5	Typically > 100 occurrences. Demonstrably secure.
GX/NX/SX	Believed to be extinct or extirpated; historical records only.
GH/NH/SH	Historically known; may be relocated in the future.
G?/N?/S?	Not yet ranked, or rank tentatively assigned.

E. United States Endangered Species Act (after National Research Council 1995)

Endangered	Any species that is in danger of extinction throughout all or a significant portion of its range.
Threatened	Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Appendix 2. Technical Summary

A summary of information contained within this report, and used by the Scientific Subcommittee of Alberta's Endangered Species Conservation Committee for the purpose of status assessment based on International Union for the Conservation of Nature criteria. For definitions of terms used in this technical summary, go to: http://www.iucnredlist.org/technical-documents/categories-and-criteria, and http://www.cosepac.gc.ca/eng/sct2/sct2_6_e.cfm

Genus species: *Oxytropis lagopus* var. *conjugans*
Common name: Hare-footed locoweed
Range of occurrence in Alberta: Within the Foothills Fescue Natural Subregion south of Lethbridge. Its habitat is gravel substrates on headlands of flat-topped unglaciated uplands of the Del Bonita Plateau and of the Milk River Ridge (south and north, respectively, of the North Milk River), as well as on post-glacial river terraces. These specialized habitats are discontinuous and widely separated.

Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time as indicated in the most recent IUCN guidelines is being used)	unknown
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals? Continuing decline in the number of individuals is possible because of decline in habitat quality and threats to habitat. See Population Size and Trends (1. Alberta), pp.12–14, Habitat Continuity, Alteration and Fragmentation, pp. 9–10, and Limiting Factors (1. Loss and Degradation of Habitat), pp. 15–17	possible
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	unknown
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	unknown
Are the causes of the decline clearly reversible and understood and ceased?	n/a
Are there extreme fluctuations in number of mature individuals? Data suggest a fluctuation in population size that exceeds 10-fold; however, a more systematic approach to survey is required to confirm this. See Population Size and Trends in Alberta, p. 13	possible, but needs to be confirmed

Appendix 2 continued:

Extent and Occupancy Information

Estimated extent of occurrence - extant subpopulations only See Distribution in Alberta, p. 6	229 km²
Area of occupancy (AO) (Always report 2-km x 2-km grid value; other values may also be listed if they are clearly indicated). See Distribution in Alberta, p. 6	124 km² [2x2 grid] 0.4-0.5 km^2 [field survey estimates]
Is the total population severely fragmented? Although subpopulations are isolated, it is unknown if more than 50% of the AO is in habitat patches that are too small to support a viable subpopulation. See Habitat Continuity, Alteration and Fragmentation, pp. 9–10	no
Number of locations Single threatening events may be cultivation, gravel extraction, oil and gas development, residential development, wind energy development or road construction. Four subpopulations have more than one threat associated with them, but the resolution needed to determine whether these are separate locations within one subpopulation is not available. See Distribution in Alberta, Table 1 and Figure 1, pp. 2–6	11 locations; the 11 subpopulations are likely all separate locations
Is there an [observed, inferred, or projected] continuing decline in extent of occurrence?	unknown
Is there an [observed, inferred, or projected] continuing decline in index of area of occupancy?	unknown
Is there an [observed, inferred, or projected] continuing decline in number of populations? See Distribution in Alberta, Table 1 and Figure 1, pp. 2–6	one historical subpopulation
Is there an [observed, inferred, or projected] continuing decline in number of locations?	unknown
Is there an [observed, inferred, or projected] continuing decline in [area, extent and/or quality] of habitat? See Habitat Continuity, Alteration and Fragmentation, pp. 9–10, and Limiting Factors (1. Loss and Degradation of Habitat), pp. 15–17	likely, as a result of non-native plant species invasion
Are there extreme fluctuations in number of populations?	unlikely
Are there extreme fluctuations in number of locations?	unlikely
Are there extreme fluctuations in extent of occurrence?	unlikely
Are there extreme fluctuations in index of area of occupancy?	unlikely

Appendix 2 continued:

Number of Mature Individuals (in each population)

Population (See Table 1, pp. 4–5)	**N Mature Individuals**
Whiskey Gap South (8875)	>1
Whiskey Gap Northeast (21825)	>1
Whiskey Gap North (21830)	340
Milk River Ridge NCC (21719)	838
Milk River Ridge (21916)	3540
Ross Grassland NA North (21912)	231
North Milk River Terrace (8878)	50
Sandstone Ranch (8879)	937
Shanks Lake West (21924)	10 300
Shanks Lake South (8882)	820
Del Bonita East (21933)	19 400
Total	> 36 400

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	unknown

Threats (actual or imminent, to populations or habitats)

Single threatening events may be cultivation, gravel extraction, oil and gas development, residential development, wind energy development or road construction. Persistent heavy livestock use may also be a threat.
See Limiting Factors, pp. 14–18

Rescue Effect (immigration from outside Alberta)

Status of outside population(s)? See Status Designations (2. Other Areas), p. 18	Species of Concern in Montana.
Is immigration known or possible? Nearest reported population in Montana is 120 km away. More field survey is needed to confirm this. See Distribution (2. Other Areas), p. 6	unlikely
Would immigrants be adapted to survive in Alberta? See Distribution (2. Other Areas), p. 6, and Limiting Factors (3. Natural Factors), p.18	likely

Appendix 2 continued:

Is there sufficient habitat for immigrants in Alberta?	unknown
Is rescue from outside populations likely? See Distribution (2. Other Areas), p. 6, and Limiting Factors (3. Natural Factors), p.18	no

Current Status (See Status Designations, pp. 18–19)

Provincial: May be At Risk (general status review) National: Special Concern Elsewhere: Species of Concern

Author of Technical Summary: Cheryl Bradley, MSc. P. Biol.

Additional Sources of Information:

List of Titles in This Series
(as of September 2012)

No. 1 Status of the Piping Plover (*Charadrius melodus*) in Alberta, by David R. C. Prescott. 19 pp. (1997)

No. 2 Status of the Wolverine (*Gulo gulo*) in Alberta, by Stephen Petersen. 17 pp. (1997)

No. 3 Status of the Northern Long-eared Bat (*Myotis septentrionalis*) in Alberta, by M. Carolina Caceres and M. J. Pybus. 19 pp. (1997)

No. 3 Update 2009. Status of the Northern Myotis (*Myotis septentrionalis*) in Alberta. Alberta Sustainable Resource Development and Alberta Conservation Association. 34 pp. (2009)

No. 4 Status of the Ord's Kangaroo Rat (*Dipodomys ordii*) in Alberta, by David L. Gummer. 16 pp. (1997)

No. 5 Status of the Eastern Short-horned Lizard (*Phrynosoma douglassii brevirostre*) in Alberta, by Janice D. James, Anthony P. Russell and G. Lawrence Powell. 20 pp. (1997)

No. 5 Update 2004. Status of the Short-horned Lizard (*Phrynosoma hernandesi*) in Alberta. Alberta Sustainable Resource Development. 27 pp. (2004)

No. 6 Status of the Prairie Rattlesnake (*Crotalus viridis viridis*) in Alberta, by Sheri M. Watson and Anthony P. Russell. 26 pp. (1997)

No. 6 Update 2012. Status of the Prairie Rattlesnake (*Crotalus viridis*) in Alberta. Alberta Environment and Sustainable Resource Development and Alberta Conservation Association. 49 pp. (2012)

No. 7 Status of the Swift Fox (*Vulpes velox*) in Alberta, by Susan E. Cotterill. 17 pp. (1997)

No. 8 Status of the Peregrine Falcon (*Falco peregrinus anatum*) in Alberta, by Petra Rowell and David P. Stepnisky. 23 pp. (1997)

No. 9 Status of the Northern Leopard Frog (*Rana pipiens*) in Alberta, by Greg Wagner. 46 pp. (1997)

No. 9 Update 2003. Status of the Northern Leopard Frog (*Rana pipiens*) in Alberta. Alberta Sustainable Resource Development. 61 pp. (2003)

No. 10 Status of the Sprague's Pipit (*Anthus spragueii*) in Alberta, by David R. C. Prescott. 14 pp. (1997)

No. 11 Status of the Burrowing Owl (*Speotyto cunicularia hypugaea*) in Alberta, by Troy I. Wellicome. 21 pp. (1997)

No. 11 Update 2005. Status of the Burrowing Owl (*Athene cunicularia*) in Alberta. Alberta Sustainable Resource Development and Alberta Conservation Association. 28 pp. (2005)

No. 12 Status of the Canadian Toad (*Bufo hemiophrys*) in Alberta, by Ian M. Hamilton, Joann L. Skilnick, Howard Troughton, Anthony P. Russell, and G. Lawrence Powell. 30 pp. (1998)

No. 13 Status of the Sage Grouse (*Centrocercus urophasianus urophasianus*) in Alberta, by Cameron L. Aldridge. 23 pp. (1998)

No. 14 Status of the Great Plains Toad (*Bufo cognatus*) in Alberta, by Janice D. James. 26 pp. (1998)

No. 14 Update 2009. Status of the Great Plains Toad (*Bufo* [*Anaxyrus*] *cognatus*) in Alberta. Alberta Sustainable Resource Development and Alberta Conservation Association. 25 pp. (2009)

No. 15 Status of the Plains Hognose Snake (*Heterodon nasicus nasicus*) in Alberta, by Jonathan Wright and Andrew Didiuk. 26 pp. (1998)

No. 16 Status of the Long-billed Curlew (*Numenius americanus*) in Alberta, by Dorothy P. Hill. 20 pp. (1998)

No. 17 Status of the Columbia Spotted Frog (*Rana luteiventris*) in Alberta, by Janice D. James. 21 pp. (1998)

No. 18 Status of the Ferruginous Hawk (*Buteo regalis*) in Alberta, by Josef K. Schmutz. 18 pp. (1999)

No. 18 Update 2006. Status of the Ferruginous Hawk (*Buteo regalis*) in Alberta. Alberta Sustainable Resource Development and Alberta Conservation Association. 22 pp. (2006)

No. 19 Status of the Red-tailed Chipmunk (*Tamias ruficaudus*) in Alberta, by Ron Bennett. 15 pp. (1999)

No. 20 Status of the Northern Pygmy Owl (*Glaucidium gnoma californicum*) in Alberta, by Kevin C. Hannah. 20 pp. (1999)

No. 21 Status of the Western Blue Flag (*Iris missouriensis*) in Alberta, by Joyce Gould. 22 pp. (1999)

No. 21 Update 2005. Status of the Western Blue Flag (*Iris missouriensis*) in Alberta. Alberta Sustainable Resource Development and Alberta Conservation Association. 29 pp. (2005)

No. 22 Status of the Long-toed Salamander (*Ambystoma macrodactylum*) in Alberta, by Karen L. Graham and G. Lawrence Powell. 19 pp. (1999)

No. 23 Status of the Black-throated Green Warbler (*Dendroica virens*) in Alberta, by Michael R. Norton. 24 pp. (1999)

No. 24 Status of the Loggerhead Shrike (*Lanius ludovicianus*) in Alberta, by David R. C. Prescott and Ronald R. Bjorge. 28 pp. (1999)

No. 25 Status of the Plains Spadefoot (*Spea bombifrons*) in Alberta, by Richard D. Lauzon. 17 pp. (1999)

No. 26 Status of the Trumpeter Swan (*Cygnus buccinator*) in Alberta, by M. Lynne James. 21 pp. (2000)

No. 27 Status of the Pygmy Whitefish (*Prosopium coulteri*) in Alberta, by William C. Mackay. 16 pp. (2000)

No. 27 Update 2011. Status of the Pygmy Whitefish (*Prosopium coulterii*) in Alberta. Alberta Sustainable Resource Development and Alberta Conservation Association. 46 pp. (2011)

No. 28 Status of the Short-eared Owl (*Asio flammeus*) in Alberta, by Kort M. Clayton. 15 pp. (2000)

No. 29 Status of the Willow Flycatcher (*Empidonax traillii*) in Alberta, by Bryan Kulba and W. Bruce McGillivray. 15 pp. (2001)

No. 30 Status of the Woodland Caribou (*Rangifer tarandus caribou*) in Alberta, by Elston Dzus. 47 pp. (2001)

No. 30 Update 2010. Status of the Woodland Caribou (*Rangifer tarandus caribou*) in Alberta. Alberta Sustainable Resource Development and Alberta Conservation Association. 88 pp. (2010)

No. 31 Status of the Western Spiderwort (*Tradescantia occidentalis*) in Alberta, by Bonnie Smith. 12 pp. (2001)

No. 32 Status of the Bay-breasted Warbler (*Dendroica castanea*) in Alberta, by Michael Norton. 21 pp. (2001)

No. 33 Status of the Cape May Warbler (*Dendroica tigrina*) in Alberta, by Michael Norton. 20 pp. (2001)

No. 34 Status of the Whooping Crane (*Grus americana*) in Alberta, by Jennifer L. White. 21 pp. (2001)

No. 35 Status of Soapweed (*Yucca glauca*) in Alberta, by Donna Hurlburt. 18 pp. (2001)

No. 36 Status of the Harlequin Duck (*Histrionicus histrionicus*) in Alberta, by Beth MacCallum. 38 pp. (2001)

No. 37 Status of the Grizzly Bear (*Ursus arctos*) in Alberta, by John L. Kansas. 43 pp. (2002)

No. 37 Update 2010. Status of the Grizzly Bear (*Ursus arctos*) in Alberta. Alberta Sustainable Resource Development and Alberta Conservation Association. 44 pp. (2010)

No. 38 Status of the Wood Bison (*Bison bison athabascae*) in Alberta, by Jonathan A. Mitchell and C. Cormack Gates. 32 pp. (2002)

No. 39 Status of the Bull Trout (*Salvelinus confluentus*) in Alberta, by John R. Post and Fiona D. Johnston. 40 pp. (2002)

No. 39 Update 2009. Status of the Bull Trout (*Salvelinus confluentus*) in Alberta. Alberta Sustainable Resource Development and Alberta Conservation Association. 48 pp. (2009)

No. 40 Status of the Banff Springs Snail (*Physella johnsoni*) in Alberta, by Dwayne A.W. Lepitzki. 29 pp. (2002)

No. 41 Status of the Shortjaw Cisco (*Coregonus zenithicus*) in Alberta, by Mark Steinhilber. 23 pp. (2002)

No. 42 Status of the Prairie Falcon (*Falco mexicanus*) in Alberta, by Dale Paton. 28 pp. (2002)

No. 43 Status of the American Badger (*Taxidea taxus*) in Alberta, by Dave Scobie. 17 pp. (2002)

No. 44 Status of the Yucca Moth (*Tegeticula yuccasella*) in Alberta. Alberta Sustainable Resource Development. 21 pp. (2002)

No. 45 Status of the White-winged Scoter (*Melanitta fusca deglandi*) in Alberta. Alberta Sustainable Resource Development. 15 pp. (2002)

No. 46 Status of the Lake Sturgeon (*Acipenser fulvescens*) in Alberta. Alberta Sustainable Resource Development. 30 pp. (2002)

No. 47 Status of the Western Silvery Minnow (*Hybognathus argyritis*) in Alberta. Alberta Sustainable Resource Development. 24 pp. (2003)

No. 48 Status of the Small-flowered Sand Verbena (*Tripterocalyx micranthus*) in Alberta. Alberta Sustainable Resource Development. 24 pp. (2003)

No. 49 Status of the Brown Creeper (*Certhia americana*) in Alberta. Alberta Sustainable Resource Development. 30 pp. (2003)

No. 50 Status of the Mountain Plover (*Charadrius montanus*) in Alberta. Alberta Sustainable Resource Development. 25 pp. (2003)

No. 51 Status of the St. Mary Shorthead Sculpin (provisionally *Cottus bairdi punctulatus*) in Alberta. Alberta Sustainable Resource Development. 24 pp. (2003)

No. 52 Status of the Stonecat (*Noturus flavus*) in Alberta. Alberta Sustainable Resource Development. 22 pp. (2003)

No. 53 Status of the Sage Thrasher (*Oreoscoptes montanus*) in Alberta. Alberta Sustainable Resource Development. 23 pp. (2004)

No. 54 Status of the Tiny Cryptanthe (*Cryptantha minima*) in Alberta. Alberta Sustainable Resource Development. 39 pp. (2004)

No. 55 Status of the Slender Mouse-ear-cress (*Halimolobos virgata*) in Alberta. Alberta Sustainable Resource Development. 27 pp. (2005)

No. 55 Update 2009. Status of the Slender Mouse-ear-cress (*Halimolobos virgata* or *Transberingia bursifolia* subsp. *virgata*) in Alberta. Alberta Sustainable Resource Development and Alberta Conservation Association. 28 pp. (2009)

No. 56 Status of the Barred Owl (*Strix varia*) in Alberta. Alberta Sustainable Resource Development. 15 pp. (2005)

No. 57 Status of the Arctic Grayling (*Thymallus arcticus*) in Alberta. Alberta Sustainable Resource Development. 41 pp. (2005)

No. 58 Status of the Weidemeyer's Admiral (*Limenitis weidemeyerii*) in Alberta. Alberta Sustainable Resource Development and Alberta Conservation Association. 13 pp. (2005)

No. 59 Status of the Porsild's Bryum (*Bryum porsildii*) in Alberta. Alberta Sustainable Resource Development and Alberta Conservation Association. 30 pp. (2006)

No. 60 Status of the Western Grebe (*Aechmophorus occidentalis*) in Alberta. Alberta Sustainable Resource Development and Alberta Conservation Association. 29 pp. (2006)

No. 60 Update 2012. Status of the Western Grebe (*Aechmophorus occidentalis*) in Alberta. Alberta Sustainable Resource Development and Alberta Conservation Association. 45 pp. (2012)

No. 61 Status of the Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisii*) in Alberta. Alberta Sustainable Resource Development and Alberta Conservation Association. 34 pp. (2006)

No. 62 Status of the Limber Pine (*Pinus flexilis*) in Alberta. Alberta Sustainable Resource Development and Alberta Conservation Association. 17 pp. (2007)

No. 63 Status of the Whitebark Pine (*Pinus albicaulis*) in Alberta. Alberta Sustainable Resource Development and Alberta Conservation Association. 22 pp. (2007)

No. 64 Status of the Western Small-footed Bat (*Myotis ciliolabrum*) in Alberta. Alberta Sustainable Resource Development and Alberta Conservation Association. 24 pp. (2008)

No. 65 Status of the Verna's Flower Moth (*Schinia verna*) in Alberta. Alberta Sustainable Resource Development and Alberta Conservation Association. 17 pp. (2008)

No. 66 Status of the Athabasca Rainbow Trout (*Oncorhynchus mykiss*) in Alberta. Alberta Sustainable Resource Development and Alberta Conservation Association. 32 pp. (2009)

No. 67 Status of the Chestnut-collared Longspur (*Calcarius ornatus*) in Alberta. Alberta Sustainable Resource Development and Alberta Conservation Association. 40 pp. (2011)

No. 68 Status of the Brassy Minnow (*Hybognathus hankinsoni*) in Alberta. Alberta Environment and Sustainable Resource Development and Alberta Conservation Association. 22 pp. (2012)

No. 69 Status of the Hare-footed Locoweed (*Oxytropis lagopus* var. *conjugans*) in Alberta. Alberta Environment and Sustainable Resource Development and Alberta Conservation Association. 31 pp. (2012)