Recovery Strategy for Spalding's Campion (*Silene spaldingii*) in British Columbia

Prepared by the Southern Interior Rare Plants Recovery Implementation Group

BRITISH COLUMBIA
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Ministry of Environment

March 2008

About the British Columbia Recovery Strategy Series

This series presents the recovery strategies that are prepared as advice to the Province of British Columbia on the general strategic approach required to recover species at risk. The Province prepares recovery strategies to meet its commitments to recover species at risk under the *Accord for the Protection of Species at Risk in Canada*, and the *Canada – British Columbia Agreement on Species at Risk*.

What is recovery?

Species at risk recovery is the process by which the decline of an endangered, threatened or extirpated species is arrested or reversed, and threats are removed or reduced to improve the likelihood of a species' persistence in the wild.

What is a recovery strategy?

A recovery strategy represents the best available scientific knowledge on what is required to achieve recovery of a species or ecosystem. A recovery strategy outlines what is and what is not known about a species or ecosystem; it also identifies threats to the species or ecosystem, and what should be done to mitigate those threats. Recovery strategies set recovery goals and objectives, and recommend approaches to recover the species or ecosystem.

Recovery strategies are usually prepared by a recovery team with members from agencies responsible for the management of the species or ecosystem, experts from other agencies, universities, conservation groups, aboriginal groups, and stakeholder groups as appropriate.

What's next?

In most cases, one or more action plan(s) will be developed to define and guide implementation of the recovery strategy. Action plans include more detailed information about what needs to be done to meet the objectives of the recovery strategy. However, the recovery strategy provides valuable information on threats to the species and their recovery needs that may be used by individuals, communities, land users, and conservationists interested in species at risk recovery.

For more information

To learn more about species at risk recovery in British Columbia, please visit the Ministry of Environment Recovery Planning webpage at:

<http://www.env.gov.bc.ca/wld/recoveryplans/rcvry1.htm>

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Disclaimer

This recovery strategy has been prepared by the Southern Interior Rare Plants Recovery Implementation Group, as advice to the responsible jurisdictions and organizations that may be involved in recovering the species. The British Columbia Ministry of Environment has received this advice as part of fulfilling its commitments under the *Accord for the Protection of Species at Risk in Canada*, and the *Canada – British Columbia Agreement on Species at Risk*.

This document identifies the recovery strategies that are deemed necessary, based on the best available scientific and traditional information, to recover Spalding's campion populations in British Columbia. Recovery actions to achieve the goals and objectives identified herein are subject to the priorities and budgetary constraints of participatory agencies and organizations. These goals, objectives, and recovery approaches may be modified in the future to accommodate new objectives and findings.

The responsible jurisdictions and all members of the recovery team have had an opportunity to review this document. However, this document does not necessarily represent the official positions of the agencies or the personal views of all individuals on the recovery team.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that may be implementing the directions set out in this strategy. The Ministry of Environment encourages all British Columbians to participate in the recovery of Spalding's campion.

RECOVERY IMPLEMENTATION GROUP MEMBERS

Southern Interior Rare Plants Recovery Implementation Group

- Harold Baumbrough, Biologist, Naramata, BC
- Brenda Costanzo, Plants at Risk Biologist, Ministry of Environment, Victoria, BC
- Orville Dyer (co-chair), Wildlife Biologist, Ministry of Environment, Penticton, BC
- Matt Fairbarns, Botanist, Victoria, BC
- Ron Hall, Osoyoos Indian Band, Oliver, BC
- Pam Krannitz, Canadian Wildlife Service, Vancouver, BC
- Ted Lea (co-chair), Vegetation Ecologist, Ministry of Environment, Victoria, BC

AUTHOR

Michael T. Miller

RESPONSIBLE JURISDICTIONS

The British Columbia Ministry of Environment is responsible for producing a recovery strategy for Spalding's campion under the *Accord for the Protection of Species at Risk in Canada*. Environment Canada's Canadian Wildlife Service participated in the preparation of this recovery strategy.

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EXECUTIVE SUMMARY

This recovery strategy addresses the recovery of the globally imperiled, herbaceous plant Spalding's campion (*Silene spaldingii*). In Canada, the species is known only from Tobacco Plains, an area of semi-open grasslands near Roosville on the British Columbia–Montana border. Currently, three populations are known, totaling an estimated 150–250 plants. Due to its extreme rarity and ongoing threats to survival and habitat, the species was assessed as Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 2005, and listed on Schedule 1 of the federal *Species at Risk Act* in August 2006. Identified threats include, in approximate order of importance: invasive alien species encroachment; urban/residential development; habitat fragmentation and small population size; alteration of fire regimes; herbicide drift; livestock grazing; herbivory and predation; and prolonged drought and global warming.

The overall recovery goal of this strategy is to maintain Spalding's campion at Tobacco Plains at a level of abundance and distribution sufficient to ensure a viable Canadian population with a moderate probability of persistence. Recovery to this level is deemed to be ecologically and technically feasible, and will entail mitigating threats to survival and habitat through such approaches as stewardship and protection, site management and restoration, population enhancement, inventory and monitoring, and research. Over the long term, the recovery goal will be achieved by:

1. maintaining or enhancing the three extant populations at Tobacco Plains, such that after 10 years, each population is stable or increasing in size; and
2. achieving an average census size over 10 years of at least 100 established plants (not counting dormant individuals) in at least six separate subpopulations, with a size class structure that demonstrates no missing vital life stages.

Critical habitat will be fully identified at a later stage through the recovery action plan, following consultation and development of stewardship options with affected landowners and First Nations, and completion of outstanding studies required to quantify specific habitat and area requirements for Spalding's campion.

The long-term population and distribution objectives set out for Spalding's campion will provide the primary basis for evaluating the progress of the recovery program. However, several short-term performance measures are also identified, including: the number of priority sites successfully protected by conservation covenants or stewardship agreements; the number of sites substantially improved through invasive alien species control and other management activities; and the number of knowledge gaps addressed. The strategy will be reviewed in 5 years to assess progress and to identify additional approaches or changes that may be required to achieve recovery.

It is recommended that a draft recovery action plan be completed by October 2011.

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BACKGROUND

Spalding's campion (*Silene spaldingii* Wats.) is a perennial herb endemic to Washington, Oregon, Idaho, Montana, and southeastern British Columbia (B.C.). In B.C., Spalding's campion is restricted to three small populations in the Tobacco Plains region near Roosville, adjacent to the international border. This document provides guidance to ensure the future survival of Spalding's campion in Canada. It summarizes information on the biology and status of the species, identifies ongoing threats to it and its habitat, proposes goals and objectives for recovery, and identifies the habitat needed to achieve recovery. The species was listed on Schedule 1 of the federal *Species at Risk Act* (SARA) in August 2006. The strategy was produced to conform to the SARA and is designed to guide the development of a recovery action plan.

Summary Information from COSEWIC

Date of assessment: May 2005
Common name: Spalding's campion
Scientific name: *Silene spaldingii*
COSEWIC status: Endangered
Canadian occurrence: B.C.
Reason for designation: This long-lived perennial herb is a globally imperiled species restricted to two small areas west of the Rockies with only a single population in southern British Columbia. The Canadian population is one of the largest populations known but may contain fewer than 250 mature plants. These plants are at risk from ongoing habitat loss and degradation especially by introduced weeds.
COSEWIC status history: Designated Endangered in May 2005. Assessment based on a new status report.

Species Description

Spalding's campion (also known as Spalding's Catchfly) is an herb with an erect stem 20–60 cm tall, and an inflorescence of several greenish-white flowers in a leafy cluster (Figure 1). The outer, green portion of the flower forms a tube (calyx) about 1 cm long with 10 distinct veins running its length. The flower consists of five petals, each with a long narrow "claw" that is largely concealed by the calyx, and a very short "blade," or flared segment at the end of the claw. The stem has four to seven pairs of stalk-less, lance-shaped leaves. The light green foliage and stem are typically densely covered with sticky hairs (hence the term "catchfly"). The fruit is a 10–15 mm long capsule with a single chamber that holds numerous small seeds (Hitchcock *et al.* 1964; Douglas and MacKinnon 1998). Flowering begins in July and continues into September. Most other herbs in its habitat have already finished flowering when Spalding's campion is reaching its peak, making this species relatively easy to spot in the field.

Populations and Distribution[1]

Spalding's campion is a regional endemic known only from eastern Washington, northeastern Oregon, and north-central Idaho, with several disjunct occurrences in northwestern Montana and adjacent southeastern B.C. (Figure 2). Five physiographic regions are covered by this distribution: (1) Palouse Grasslands of southeastern Washington and adjacent Idaho;

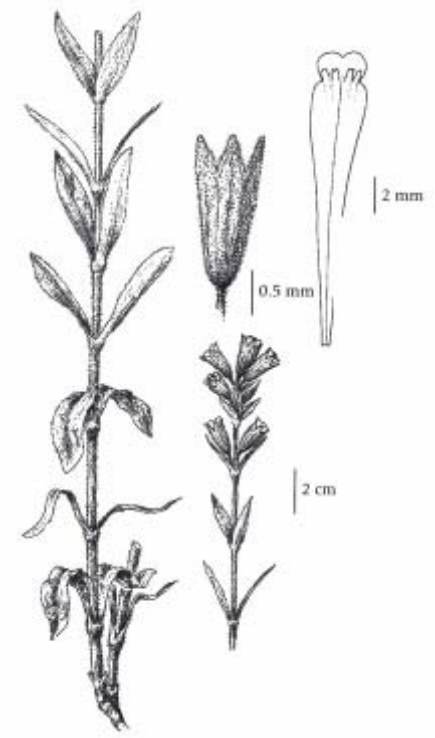

Figure 1. Spalding's campion (*Silene spaldingii*). Line drawing from Douglas and MacKinnon (1998) (with permission); photo courtesy of M. Miller.

(2) Canyon Grasslands along major river systems in the tri-state area of Washington, Idaho, and Oregon; (3) Channeled Scablands of east-central Washington; (4) Wallowa Plateau in northeastern Oregon; and (5) Intermontane valleys of northwestern Montana and British Columbia (Hill and Gray 2004).

Currently, Spalding's campion is known globally from about 130 geographic locations, representing about 69 populations[2]: 12 in Idaho, 8 in Oregon, 38 in Washington, 8 in Montana, and 3 in B.C., for a total of over 20 000 plants (Hill and Gray 2004; B.C. CDC 2006). The B.C. populations are located just 1–2 km north of the closest Montana population. Of the U.S. records, eight are historical or unconfirmed, and five are assumed extirpated (Hill and Gray 2004). It is thought that Spalding's campion was once widespread in the Palouse region, and persists now only on isolated sites on the periphery of its former range (Lesica 1997).

[1] This section contains some new information not present in the COSEWIC status report.
[2] Population is defined as being >1 km separation vs. a subpopulation which is <1 km separation based on the B.C. CDC and NatureServe definition.

In B.C., Spalding's campion was known until recently from just a single collection at Tobacco Plains (Miller and Allen 1997; Douglas and Smith 2005). However, separate surveys in 2004 and 2005 yielded several additional records for the area (B.C. CDC 2006). The species is currently known from three populations (six subpopulations) distributed over approximately 3 km^2 (Figure 2). Some of these are small patches occurring relatively close to one another. Thus they likely do not constitute distinct populations, and are therefore called subpopulations. Other patches are separated by more extensive areas of unoccupied habitat and could represent distinct populations. In cases where dispersal patterns or habitat suitability are generally unknown or undocumented, the usual convention is to treat plant occurrences as separate populations if they are ≥ 1 km apart (NatureServe 2006). Applying this standardized separation criterion, there are currently three distinct populations within six subpopulations of Spalding's campion in B.C, totaling between 150 and 250 flowering plants (Table 1).

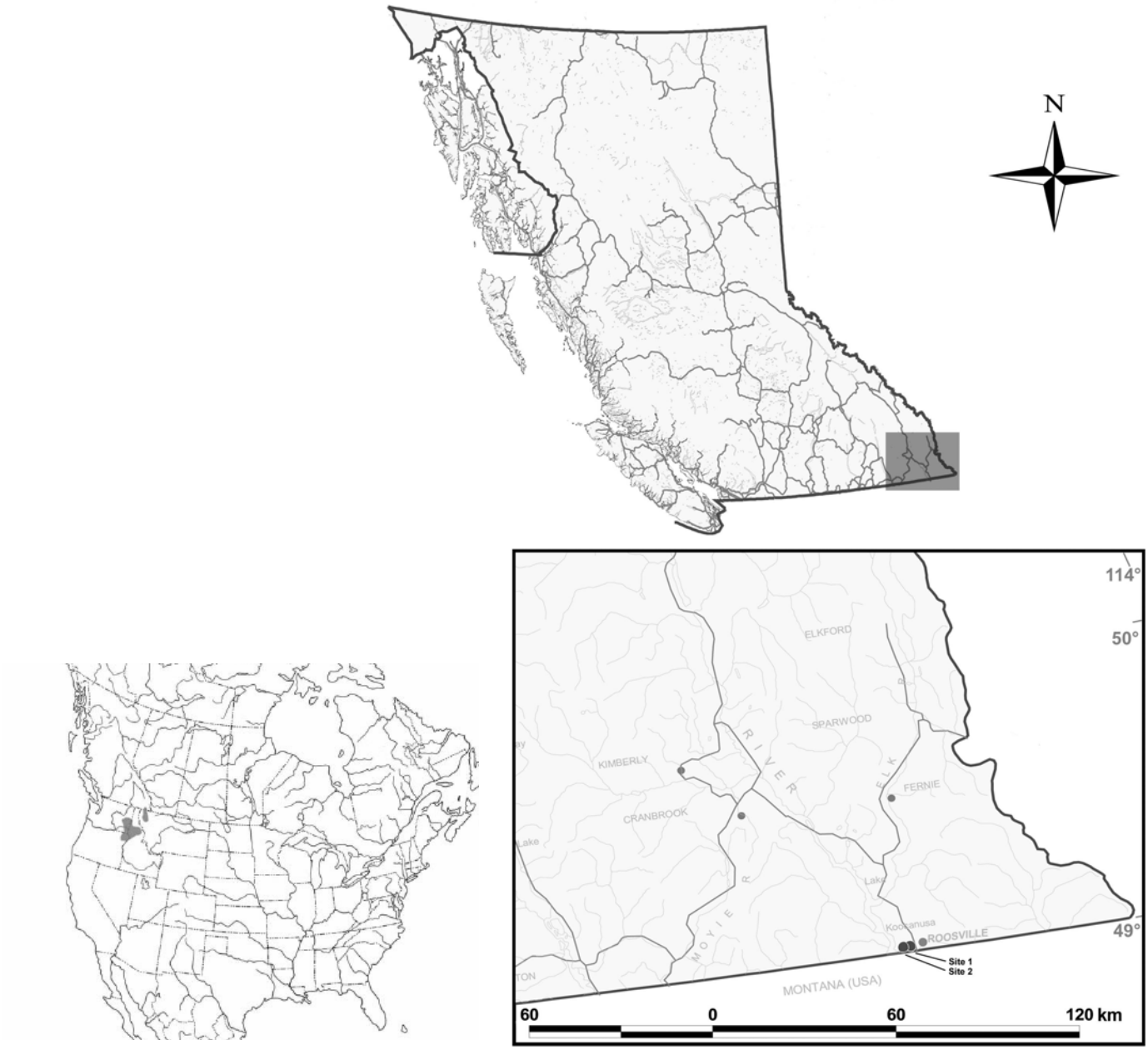

Figure 2. Global and Canadian distribution of Spalding's campion (from Douglas and Smith 2005, with permission). For clarity, only two of the three populations have been indicated on the inset map.

Table 1. Population information for Spalding's campion, including first and last observation date, estimated abundance and land tenure/jurisdiction. Source: B.C. CDC (2006).

Population	Locality/ subpopula-tion	First observation date & surveyor[1]	Estimated abundance (reproducing plants)	Most recent observed date & surveyor[1]	Estimated abundance (reproducing plants)	Land tenure/ jurisdiction
Tobacco Plains 1	1	08/08/1995 MM	100	07/14/2005 MF	1? (cursory census)	Private
	2	06/23/2004 GD-SM-NG	5	06/23/2004 MF	33	Private
Tobacco Plains 2	1	07/14/2005 MF	8	07/14/2005 MF	8	Private
	2	07/14/2005 MF	8	07/14/2005 MF	8? (cursory census)	Private
Tobacco Plains 3	1	06/23/2004 GD-SM	80–100	07/14/2005 MF	49–100	Indian Reserve
	2	06/23/2004 GD-SM	3	06/23/2004 GD-SM	3	Indian Reserve

[1] MM: Mike Miller; MF: Matt Fairbarns; GD: George Douglas; SM: Shyanne Smith; NG: Nick Gravelle.

The extant B.C. occurrences are likely a northern extension of the adjacent U.S. Tobacco Plains population (Hill and Gray 2004). These occurrences may represent the historical remnants of a formerly more widespread distribution within the Intermontane valley region of southeastern B.C.; at least one nearby subpopulation in northwest Montana is believed to have been extirpated in recent decades due to human factors (Mincemoyer 2005). However, due to the lack of historical information (Douglas and Smith 2005), this cannot be confirmed.

Conservation Status

Spalding's campion has an International Union for Conservation of Nature (IUCN) global conservation ranking of G2 ("imperiled globally because of rarity or because other factors demonstrably make it very vulnerable to extinction"). In Canada, Spalding's campion is listed as Endangered under the *Species At Risk Act* (SARA). In B.C., it is classified as S1 (critically imperiled) and is Red-listed by the B.C. Conservation Data Centre (B.C. CDC). In the U.S., it is listed as Threatened under the *Endangered Species Act* (ESA). It is classified as S1 in Montana, Oregon, and Idaho, and S2 (imperiled) in Washington. It also has a state ranking of Endangered in Oregon and Threatened in Washington (USFWS 2001; COSEWIC 2005; NatureServe 2006).

Biological Needs, Ecological Role, and Limiting Factors[3]

Life history and demography

Spalding's campion is a long-lived perennial that resprouts each year from a root crown surmounting a long, slender taproot. Plants emerge in mid-May and die back at the end of the growing season. New recruits and young plants appear as rosettes (i.e., no stem). Plants may become reproductive in their second season, but most individuals flower for the first time when

[3] Material in this section has been adapted from Lesica (1997, 1999), Hill and Gray (2004), Douglas and Smith (2005), and Mincemoyer (2005).

2 years or older. Reproduction is primarily by seed. The fruit capsules contain up to 150 seeds and mature primarily in August. Seed dispersal occurs from mid-August through October. Seeds are dispersed through an opening at the top of the mature capsule. Most seeds are probably gravity-dispersed, although animals that digest the seeds and/or seed heads (deer, elk, and possibly birds and rodents) could also aid in dispersal (Hill and Gray 2004). Not all established plants reproduce each year: some may remain vegetative, producing a stem but no flowers, while others may not emerge at all, instead remaining dormant underground. The long lifespan of Spalding's campion (possibly extending into decades; P. Lesica, pers. comm., 2006) likely enables populations to persist many years without recruitment.

Due to the occurrence of summer dormancy, plants can go undetected for one to several years before re-emerging. In a long-term study at the Dancing Prairie Preserve, located just south of the Canadian border in the Tobacco Plains of northwest Montana, Lesica (1997) reported that plants spent nearly half their summers in a dormant condition. The ability of bulbs to remain dormant for prolonged periods is an important life history feature that should not be ignored when conducting censuses or population counts, since the presence of summer-dormant plants makes exact estimation of population size and other demographic parameters difficult. Long-term monitoring is essential for determination of population sizes and trends in Spalding's campion.

Pollination ecology

The pollination ecology of Spalding's campion in Montana has been studied by Lesica (1993) and Lesica and Heidel (1996). The flowers are protandrous (the anthers release their pollen and wither before the stigma on the same flower becomes receptive), a strategy that encourages genetic out-crossing, and are pollinated mainly by the Golden Northern Bumblebee (*Bombus fervidus*). Pollinators are likely critical to the persistence of Spalding's campion: reduced fitness (i.e., lower proportion of fruits matured, seeds per fruit, germination, seedling growth and survival) was observed in plants from which pollinators were excluded (Lesica 1993). Competition for pollinators has been noted at a number of Spalding's campion sites that have large populations of other flowering plant species.

The bumblebee was found to be an important pollinator of Spalding's campion at sites in Idaho, Montana, Oregon, and Washington, where over 80% of floral visits were by this species. The Bumblebee was also the only important pollinator at Dancing Prairie (Tobacco Plains, MT). Common throughout most of temperate North America, the bumblebee inhabits grasslands and meadows where it builds nests on or near the surface of the ground. Agricultural conversion, application of pesticides, domestic livestock grazing, and fire could be detrimental to populations of this species (and by extension to Spalding's campion).

Habitat needs

Spalding's campion is associated primarily with the bunchgrass grasslands that extend from Washington and Oregon into parts of Montana and into adjacent B.C. and Alberta. The Tobacco Plains, which host the southern B.C.–northern Montana population, are part of the Intermontane valley region between the Purcell and Salish mountains on the west and the Whitefish Range on

the east; these valleys are transitional between the Palouse Prairies typical of the Columbia Basin and grasslands of the northern Great Plains (Antos *et al.* 1983; Hill and Gray 2004). The Tobacco Plains lie within the dry hot subzone of the Ponderosa Pine biogeoclimatic zone (PPdh; Meidinger and Pojar, eds. 1991). The climate is characterized by cool winters and moderately warm summers, and winter-low and summer-high precipitation patterns. The terrain is characterized by rolling glacial kettle–moraine topography, with Spalding's campion typically found in the bottoms of shallow swales and on cool northerly slope exposures in deep but relatively infertile glacial soils (Figure 3). Elevations of known occurrences in B.C. and northwest Montana range from 800 to 1100 m (Hill and Gray 2004).

Figure 3. Typical Spalding's campion habitat at Tobacco Plains. Photo courtesy of M. Miller.

The native plant community at Tobacco Plains consists predominantly of fescue (*Festuca*) grasslands (Mincemoyer 2005). These grassland communities are characterized by: (1) domination by perennial bunchgrasses of which a fescue (*Festuca*) species is always a major component at climax; (2) a varied and conspicuous forb component; (3) often a shrub component, occurring as scattered, dwarfed individuals or taller patches; (4) a well-developed cryptogam (lichen/moss) layer; and (5) occasionally scattered trees (Hill and Gray 2004). Here, Spalding's campion is usually associated with the needle-and-thread (*Hesperostipa comata*) phase of the rough fescue–bluebunch wheatgrass (*Festuca campestris–Pseudoroegnaria spicata*) habitat type. This habitat type is dominated by rough fescue (*Festuca campestris*), Idaho fescue (*Festuca idahoensis)*, and bluebunch wheatgrass (*Pseudoroegnaria spicata)*. Needle-and-thread grass, prairie Junegrass (*Koeleria macrantha*), and various forbs are also present, as are scattered ponderosa pines and rose shrubs (*Rosa woodsii*) (Hill and Gray 2004). Associated forbs include arrowleaf balsamroot (*Balsamorhiza sagittata*), timber milk-vetch (*Astragalus miser*), bergamot (*Monarda fistulosa*), Columbia gromwell (*Lithospermum ruderale*), old man's whiskers (*Geum triflorum*), and silky lupine (*Lupinus sericeus*).

In B.C., sites with conditions suitable for growth of Spalding's campion occur sporadically throughout the rolling grasslands on the valley bottom west of Roosville. Many unoccupied sites with a suitable slope and aspect have large populations of competitive invasive alien species (IAS)

such as sulphur cinquefoil (*Potentilla recta*), spotted knapweed (*Centaurea maculosa*), and St. John's-wort (*Hypericum perforatum*)[4] and/or suffer from past overgrazing which has led to an increase in the cover of early succession species (primarily needle-and-thread grass). Many apparently suitable sites have been seeded to pasture grasses and may no longer be capable of supporting Spalding's campion (B.C. CDC 2005).

For a comprehensive description of Spalding's campion habitat across its range, see Hill and Gray (2004).

Fire

Disturbances such as fire or grazing that reduce litter and thatch buildup and decrease competition from perennial bunchgrasses may have a positive effect on the population dynamics of Spalding's campion. Fire was shown to increase fecundity in *Silene regia*, a related prairie species of the eastern United States, by removing accumulated litter and vegetation cover and increasing ground-level light (Menges and Dolan 1998). Studies over a 5-year period at a Spalding's campion site at the Garden Creek Ranch in Idaho indicate a late-September wildfire that occurred during this period had little effect on established plants (Menke and Muir 2004). However, prescribed fall and spring fires within Spalding's campion sites at Dancing Prairie Preserve resulted in enhanced seedling recruitment and a temporary decline in the incidence of prolonged dormancy (Lesica 1999, 2005). Considering that the Tobacco Plains area may have burned historically on average every 6–9 years, a generally positive response of Spalding's campion to burning is not surprising (Mincemoyer 2005). Nevertheless, it remains unclear whether fire is needed to maintain viable populations of Spalding's campion at Tobacco Plains (P. Lesica, pers. comm., 2006). The pervasive presence of invasive alien species (IAS) at many Spalding's campion sites makes the long-term effects of fire problematic, since fire can also promote the establishment and spread of IAS.

Interactions with other organisms

The flowers and fruits of Spalding's campion appear to be a food source for both deer and various insects (e.g., noctuid larvae, seed weevils). Rodent activity (in the form of runways, burrows, and holes) has also been recorded at Spalding's campion sites (Hill and Gray 2004).

Threats[5]

Much of the original grassland habitat of the Columbia Basin has been lost or modified by urbanization, agricultural conversion, grazing, invasion of non-native species, and altered fire regimes (Hill and Gray 2004). The conversion of significant portions of native grasslands to other uses may have led to a decline in Spalding's campion abundance from historical levels, as it has for other rare native plant species in the region. However, it is difficult to know to what degree (if any) Spalding's campion populations have declined in Canada due to any one factor, as abundance and distribution data before 1995 are lacking (Douglas and Smith 2005). Current

[4] The three previously mentioned species are introduced.

[5] This section contains new information not present in the COSEWIC status report. Some material in this section has been adapted from USFWS (2001), Hill and Gray (2004), and Douglas and Smith (2005).

threats to the persistence of Spalding's campion are described below. Threats have been listed in perceived order of significance.

Invasive alien species (IAS)

The most serious current threat to extant Canadian populations of Spalding's campion is competition from invasive alien species (IAS) (M. Fairbarns, pers. comm., 2006). A number of IAS have been recorded at Spalding's campion sites in B.C., such as Kentucky bluegrass (*Poa pratensis*), Canada bluegrass (*Poa compressa*), cheatgrass (*Bromus tectorum*), smooth brome (*Bromus inermis*), timothy (*Phleum pratense*), sulphur cinquefoil (*Potentilla recta*), St. John's-wort (*Hypericum perforatum*), spotted knapweed (*Centaurea maculosa*), woolly mullein (*Verbascum thapsus*), white sweet clover (*Melilotus alba*), yellow salsify (*Tragopogon dubius*), and meadow hawkweed (*Hieracium pratense*).[6] Some species (e.g., timothy) are pasture grasses that may have been intentionally introduced for range fodder. IAS threaten Spalding's campion in four major ways: (1) by altering the composition, structure and function of the native bunchgrass communities that support it; (2) by increasing thatch buildup; (3) by altering microclimate and soil structure/chemistry; and (4) by directly competing for critical resources such as water, nutrients, pollinators, and germination safe sites. For example, competition for pollinators has been noted at a number of Spalding's campion sites that have large populations of other flowering plant species (Hill and Gray 2004). Reduced pollinator activity has the potential to cause inbreeding depression, resulting in reduced fertility and fitness of the species and, ultimately, population declines (Lesica 1993).

IAS are cited as one of the primary threats to Spalding's campion in the United States (Schassberger 1988; Lorain 1991; USFWS 2001). At Dancing Prairie Preserve (Montana), control measures have been in place since about 1995 and include spot-spraying for IAS from backpack sprayers. Plants targeted include sulfur cinquefoil, spotted knapweed and St. John's-wort (Mincemoyer 2005). Extensive infestations of these three species also occur in the B.C. Tobacco Plains, where sulfur cinquefoil appears to pose the most serious current threat to Spalding's campion (M. Fairbarns, pers. comm., 2006). A provincially listed "noxious weed," sulfur cinquefoil, colonizes dry to moist habitats, roadsides, pastures, overgrazed rangelands, and disturbed areas (Douglas *et al.,* eds. 1999). Unpalatable to grazing animals, it is highly competitive with native plants and reduces forage for livestock. Once established in areas with limited competitive vegetation, the spreading root system and seed producing capability of sulfur cinquefoil enable it to become the dominant plant species. It is commonly associated with knapweed infestations (Rice 1999). At Dancing Prairie, sulfur cinquefoil was found to increase in abundance following prescribed fires (Lesica and Martin 2003).

Urban/residential development

All known B.C. occurrences of Spalding's campion are either on First Nations lands or active private range land, where urbanization does not appear to pose any immediate threat to occupied habitat. However, habitat conversion in nearby U.S. jurisdictions may be reducing overall population viability: where the population extends south across the border into Montana, forming three U.S. subpopulations, development and housing subdivisions now dot the area. Two of these

[6] The previously mentioned are introduced species.

subpopulations have houses built adjacent to them, while one of the subpopulations has not been observed since 1986 and may be extirpated (Mincemoyer 2005). In a best-case scenario, Spalding's campion plants in these adjacent U.S. subpopulations will be relegated to highly fragmented habitat and potentially will be lost entirely to development in the years to come (Mincemoyer 2005). Slightly farther south, at Dancing Prairie Preserve, urban and residential development near the largest known occurrence of Spalding's campion has destroyed potential habitat, increased the likelihood of weed invasion, and reduced management options such as controlled burning on the preserve (Hill and Gray 2004).

Habitat fragmentation and small population size

Extant Spalding's campion occurrences are exceedingly small (Table 1), making them potentially highly vulnerable to chance environmental and demographic events (e.g., drought, herbivory, disease, low recruitment, high mortality). They are also somewhat also isolated from one another by physical or ecological discontinuities in the landscape (e.g., flat areas, slopes with warmer aspects, areas of denser vegetation, IAS infestations, encroaching forest, roads, land development on the U.S. side of the border) that could impede dispersal and/or pollination. Consequently, some occurrences may be experiencing deleterious genetic effects such as inbreeding depression (i.e., loss of vigour or fitness due to inbreeding), another hazard often associated with small isolated populations (Huenneke 1991). Although genetic constraints are likely to be secondary to the demographic difficulties of small population size in a varying environment, inbreeding depression could theoretically contribute to decreased population growth rate and increased extinction probability (Schemske *et al.* 1994).

Alteration of fire regimes

In many habitats that were historically fire-maintained, such as the bunchgrass–fescue grasslands in southeastern B.C., fire suppression has resulted in succession toward a more shrub- or tree-dominated habitat type. Woody encroachment can pose a threat to Spalding's campion, which is unable to persist in the dense shade created by this vegetation. Heavy thatch buildup can also negatively affect survival, growth, and reproduction of this species. Prescribed fire may have a positive effect on Spalding's campion by removing litter and creating suitable sites for recruitment (Lesica 1999). For these reasons, fire is a preferred management tool at Dancing Prairie Preserve, Montana, where invasion of ponderosa pine as well as interference from dominant grasses both present concerns (Lesica 1997, 1999). However, more study is needed to determine what effect alteration of fire regimes has had on Spalding's campion in B.C., and also to what extent these populations would benefit from reintroduction of fire at the present time. The effects of prescribed fire on aggressive, non-native species, where they occur near Spalding's campion, must be carefully considered. In some cases, prescribed fires may adversely affect Spalding's campion if the fire indirectly leads to increased coverage of IAS (see IAS section above).

Herbicide application and drift

In B.C., herbicides may be used to control sulphur cinquefoil (*Potentilla recta*) and other IAS that occur near Spalding's campion. Herbicides used to control invasive weeds pose a potential

threat to rare plant populations. Unpredictable wind currents and high temperatures can volatilize herbicides (i.e., cause them to become suspended in the air, allowing them to drift into non-target areas) (Bussan and Dyer 1999). Herbicide overspray has been cited as a threat to Spalding's campion in Idaho, Oregon, and Washington (USFWS 2001; Hill and Gray 2004). Broadleaf herbicides used to control forbs such as knapweed could have an especially serious impact on Spalding's campion and the native plant community supporting it. However, limited and carefully controlled application of herbicides (such as spot-spraying) can probably be safely used near known populations of Spalding's campion (Hill and Gray 2004; P. Lesica, pers. comm., 2006).

Livestock grazing

All known Canadian populations of Spalding's campion occur on land presently used for domestic livestock grazing. In the absence of fire, limited grazing may actually benefit Spalding's campion habitat by reducing cover of competing vegetation as well as ground litter (Lesica 1999). The effects of grazing on Spalding's campion probably depend on the moisture conditions of the site and the timing and the degree of grazing pressure. For example, Spalding's campion plants on more mesic sites, which are often more vigorous, may be damaged less by livestock grazing than plants in drier sites (Hill and Gray 2004). However, heavy grazing pressure can reduce populations both directly, through the consumption of plants and trampling (Gamon 1991), and indirectly by soil compaction, by altering the composition and structure of the native plant communities that support them (USFWS 2001). Livestock can also serve as vectors for introducing IAS into native vegetation, while the soil disturbance they create provides sites for IAS establishment (Lichthardt 1997; Hill and Gray 2004; Douglas and Smith 2005). If grazing occurs early in the season (i.e., after Spalding's campion plants have emerged but before seeds have dispersed) reproductive output can be impacted. At Zumwalt Prairie in Idaho, for example, cattle grazed 75% of Spalding's campion flower and seed heads during a 10-day period in July (Hill and Gray 2004). Therefore, until more is known about the long-term effects of livestock grazing on Spalding's campion, it is suggested this activity be managed to minimize direct impacts on established plants during the flowering season, and to include the development of a healthy fescue grassland within the grazing management regime.

Herbivory and predation

Grazing or browsing of Spalding's campion stems and inflorescences by native herbivores has been observed within U.S. populations and is considered a significant threat to the species (USFWS 2001). While herbivory likely occurred historically, the effects of grazing or browsing become amplified as plant population sizes decrease. At one study site in Idaho, ungulates (deer and elk) consumed 62% of the total 453 stems monitored (Hill and Gray 2000). None of the grazed stems produced significant regrowth by the end of the season. Insect herbivores damaged a further 30% of reproductive structures. Seeds were often missing in capsules that exhibited insect herbivory. Another 7% of the monitored plants were completely missing by the end of the season. The cause of the disappearances is unknown, but appears to have been related to gopher activity (Hill and Gray 2000). Similarly, in Oregon, seed weevils destroyed a high percentage of Spalding's campion seed heads (Kagan 1989). Insect damage to the foliage of Spalding's

campion has also been noted (Lichthardt 1997). This threat is considered potential within the B.C. populations until further studies determine whether this threat is real

Prolonged drought and global warming

Prolonged drought can adversely affect Spalding's campion and may contribute to the extirpation of small populations. For example, at Wild Horse Island (Montana), a Spalding's campion population declined from approximately 250 to 10 plants, due primarily to drought conditions in the late 1980s (USFWS 2001). At monitoring sites in Washington, plants withered early in the flowering period and had lower fruit set during drought years (Hill and Gray 2004). The proportion of plants exhibiting prolonged dormancy has been observed to be higher during extremely dry years (Heidel 1995). Although prolonged dormancy may be an important life history strategy for coping with semi-arid environments, the length of time plants can remain dormant appears limited; in a long-term study, Lesica (1997) considered plants to be dead if they had not reappeared aboveground within 3 years. At the community level, drought can hasten the spread of invasive weeds, and affect where cattle choose—or are permitted—to forage (G. Proudfoot, pers. comm., 2006).

Global climate change could have significant impact on Spalding's campion habitat in the future. For example, a decrease in precipitation could lead to droughty conditions unsuited to moisture-dependent grassland communities in general, and to growth and survival of Spalding's campion in particular. Alternatively, increases in precipitation could lead to woody vegetation establishing on formerly open sites, resulting in loss of habitat (Hill and Gray 2001).

Actions Already Completed or Underway

No specific recovery actions for Canadian populations of Spalding's campion have been completed to date. However, the Tobacco Plains Indian Band received funding under Aboriginal Habitat Protection Program 2006/07 and again in 2007/08 to protect the habitat of Spalding's campion located on Reserve lands. The project was to implement stewardship activities such as fencing, control of IAS, and removal of competing saplings to mitigate threats to the survival of the species.

In March 2006, Mike Miller (consultant) and Ralph Gravelle (Natural Resource Officer - Tobacco Plains Band) co-delivered a presentation on Spalding's campion recovery planning to participants of the Ktunaxa First Nations Species at Risk Workshop.

Also in March 2006, the U.S. Fish and Wildlife Service released a draft recovery plan for Spalding's campion (see <http://idahoes.fws.gov>). The plan calls for the development of habitat management plans for key conservation areas that will address conservation measures for self-sustaining Spalding's campion populations, including invasive non-native plant control, plant surveys and monitoring, fire management, livestock grazing management, and pollinator protection. Activities such as herbicide spraying, seed banking, population viability analysis, and agricultural/urban development are also addressed in the draft recovery plan.

Knowledge Gaps

A number of knowledge gaps concerning Spalding's campion and its relationship to the biotic and abiotic elements of its environment challenge our ability to effectively protect and conserve this species. In particular, more information is needed on the following topics:

Invasive alien species control

Research is needed to determine the effectiveness of different weed control techniques (i.e., spraying, hand pulling, mowing, burning) within and adjacent to Spalding's campion populations. Since chemical control may be a preferred method of control because of its residual effects, speed of application, and reduced cost, it is necessary to determine the sensitivity of Spalding's campion to various types and strengths of herbicides.

Impacts of grazing

Another gap in knowledge relates to the response of Spalding's campion at Tobacco Plains to livestock grazing (and, alternatively, to the removal of grazing). It is currently unclear whether grazing at current levels of intensity is having a detrimental impact on Spalding's campion populations and habitat, or whether limited grazing may even be beneficial (by reducing competition and retarding thatch buildup). Moreover, grasslands can experience widely fluctuating weather patterns from year to year; management prescriptions may thus need to be flexible to accommodate changing environmental conditions. For example, grazing may pose different concerns for Spalding's campion in droughty versus wet years. More research in these topics is needed to help inform land managers about the appropriate use of livestock grazing, and the possible need for fencing, around occupied areas.

Impacts of fire

Many of the same questions relating to grazing also apply to fire and the potential benefits/impacts of prescribed burns.

Demography and population dynamics

Demographic studies are needed to determine local trends in Spalding's campion populations, including trends in survival, reproduction, and recruitment. Information on population dynamics (including metapopulation dynamics) is crucial for assessing response to threats and management activities.

Pollinators

Pollinators, in particular bumblebees, are closely tied to the reproductive and genetic vigor of Spalding's campion. However, no known assessment of bee populations within fescue grasslands at Tobacco Plains has been conducted. Bumblebee populations at the extant populations of Spalding's campion should be surveyed.

Genetic factors

Little is known regarding the effects of habitat fragmentation and small population size on gene flow (pollination and dispersal), inbreeding depression, and other genetic factors. Research in these areas will help to elucidate metapopulation dynamics, provide a genetic basis for habitat

prioritization, and improve estimates regarding the viability of small Spalding's campion populations on isolated habitat fragments.

Herbicide application and drift

Studies are needed to determine whether herbicide application on nearby lands poses a current or future threat to B.C. populations of Spalding's campion.

Herbivory and predation

There are no documented observations on this potential threat within the B.C. populations of Spalding's campion, and further studies are needed to determine whether this is a real threat to the species.

RECOVERY

Recovery Feasibility

Recovery of this species is deemed to be technically and biologically feasible, based on the following four criteria from Environment Canada *et al.* (2005):

1. *Are individuals capable of reproduction currently available to improve the population growth rate or population abundance?*

Yes. Field surveys indicate that the three extant populations include at least some reproductively capable individuals (Table 1), although the ratio of flowering to non-flowering plants is known to fluctuate markedly from year to year.

2. *Is sufficient suitable habitat available to support the species or could it be made available through habitat management or restoration?*

Yes. Sufficient habitat is available to support the extant populations on their existing sites. It is unknown whether additional habitat is available to allow for an expanded distribution of the species, in part because of the lack of information relating to historical distribution. However, the current range of Spalding's campion extends across an extensive area of semi-intact grasslands, and there is no evidence to indicate that it is strongly habitat-limited at present. Furthermore, it seems likely that additional suitable habitat could be made available through active habitat stewardship or restoration, if needed.

3. *Can significant threats to the species or its habitat be avoided or mitigated through recovery actions?*

Yes. With the participation of all responsible jurisdictions and those stewarding the land, the primary threat of competition from invasive alien species can be mitigated, and additional threats can also be addressed.

4. *Do the necessary recovery techniques exist and are they demonstrated to be effective?*

Yes. Recovery success will be tied primarily to threat reduction through habitat stewardship, in combination with long-term population monitoring and inventory. However, the feasibility of introducing/re-introducing populations at the northern edge of the range is still unknown (field trials designed to address this question are now underway in Montana; P. Lesica, pers. comm., 2006).

Recovery Goal, Objectives, and Corresponding Approaches

Recovery goal

The overall goal of this recovery strategy is *to maintain Spalding's campion at Tobacco Plains at a level of abundance and distribution sufficient to ensure a viable Canadian population with a moderate probability of persistence.*

Moderate probability of persistence is defined as a 95% probability that the total population remains above a critical threshold size of 100 mature individuals[7] over the next 50 years.

Population and distribution objectives

Over the long term, the recovery goal will be achieved by:

1. maintaining or enhancing the three extant populations at Tobacco Plains, such that after 10 years, each population is stable or increasing in size; and
2. achieving an average census size over 10 years of at least 100 established plants (not counting dormant individuals) in at least six separate subpopulations, at a size class structure that demonstrates no missing vital life stages.

Short-term recovery objectives

Recovery will be considered significantly advanced if the following short-term (5-year) objectives have been met:

1. Ensure protection[8] of the habitat of Spalding's campion at all existing sites within its range in Canada.
2. Maintain or enhance essential native grassland habitat at/to a level sufficient to support viable subpopulations of Spalding's campion.
3. Achieve a measurable and sustained reduction in sulfur cinquefoil infestations at occupied Spalding's campion sites and increase control of other nuisance invasive alien species (e.g., spotted knapweed).
4. Ensure that 80% of occupied Spalding's campion habitat is not degraded by forest/shrub encroachment.
5. Determine the threats posed by livestock grazing and, if appropriate, protect all extant sites from the effects of grazing.

[7] Mature individuals are defined as any of the following: flowering, vegetative, or dormant life form of the species.
[8] Protection can be achieved through various mechanisms including: voluntary stewardship agreements, conservation covenants, sale by willing vendors on private lands, land use designations, and protected areas.

6. Gain sufficient knowledge about the demography, population dynamics, and genetic factors to assess the viability of the species and its response to threats and management activities.

Rationale for recovery goal and population/distribution objectives

In the context of the federal *Species at Risk Act* (SARA), a species is considered "recovered" when its long-term persistence in the wild has been secured (Environment Canada *et al.* 2005). The appropriate target level for persistence will vary among species depending on both historical and current status, taking into account factors such as former range and current threats, and might denote a state anywhere on the spectrum between survival (i.e., maintaining the current population size and distribution) and full recovery (i.e., down-listing to Special Concern or Not at Risk) (Environment Canada *et al.* 2005).

What does "recovery" mean for Spalding's campion, a highly rare species for which historical distribution data are lacking? As a peripheral species (i.e., one that reaches the northern limit of its geographical range close to the Canadian border) inhabiting a relatively uncommon (for Canada) habitat type, it seems unlikely that Spalding's campion was ever abundant or widespread in this country. However, the habitat it currently occupies occurs within a landscape that has been substantially altered by human activities; the possibility that it has experienced a significant decline from historical levels (as in the U.S.) must therefore also be considered. In general, such peripheral occurrences tend to have a reduced level of viability relative to more central populations, particularly when subjected to external pressures such as fluctuating climate conditions or habitat degradation (Lesica and Allendorf 1995). In the case of Spalding's campion, intrinsic life history traits such as slow growth, prolonged dormancy, delayed reproduction, and low fertility have likely further limited its capacity for rapid demographic rebound (Miller 2004). These factors together suggest that Spalding's campion may have never possessed more than a marginal level of viability within Canada. In light of these considerations, "full recovery" may be an unrealistic recovery target to set for this species (Environment Canada *et al.* 2005). Recovery efforts should focus instead on ensuring its survival in Canada at an appropriate level of viability (i.e. a generally stable population with a moderate probability of persistence), even if this means dependence on continued conservation activities.

In the absence of demographic information with which to confirm population trends or to define the minimum viable population, and without a firm understanding of key limiting factors, setting specific population and distribution objectives and performance measures is an uncertain process reflecting the best interpretation of available data (Schemske *et al.* 1994). This does not, however, preclude the setting of tentative recovery targets, while acknowledging that these may be subject to future revision once more data become available through monitoring and research. Following is a brief rationale for each of the proposed population/distribution objectives.

Given the extreme rarity of Spalding's campion in Canada, and uncertainties regarding the potential for reintroducing the species into formerly occupied areas, protecting the existing populations should clearly be a first priority of recovery. This is especially true in the case of extirpations resulting from preventable circumstances (such as anthropogenic disturbances or, perhaps, benign neglect).

While an argument could be made for increasing the number of extant populations to ensure long-term viability, there is at present no obvious historical or demographic justification for doing so. Nevertheless, if additional undocumented subpopulations or populations are discovered to exist, there would be strong justification for revising this target upward.

The target of maintaining an average census size of at least 100 established plants in at least six separate subpopulations, while necessarily arbitrary, is nevertheless defensible on several grounds. One, it addresses the three guiding principles of "representation" (seek to maximize ecological representation throughout the range of the species), "redundancy" (maintain multiple occurrences of the species as a hedge against unpredictable catastrophic loss), and "resiliency" (aim to ensure that each population is large enough to be self-sustaining) (Environment Canada 2005). Two, it is consistent with what most plant ecologists would suggest is the minimum population size needed to counter random variation in demographic rates (e.g., Menges 1998).[9] Three, the actual population size attained would likely be substantially larger given that a proportion of plants are banked underground as dormant stems in most years (Lesica 1997; Mincemoyer 2005), making this a less conservative population target than it might at first appear. Four, although ambitious, a target of 100 established plants per site appears to be an achievable objective based on historical and recent censuses of Spalding's campion populations within comparable habitats in northwest Montana (Mincemoyer 2005). Last, rapid growth (and ultimately persistence) of subpopulations is only likely to occur if all the major stages in the life cycle are adequately represented in the population structure (Caswell 2001). In the case of Spalding's campion, important life stages include seeds, seedlings, immature rosettes, vegetative stems, dormant phases, and flowering plants (Lesica 1997).

Ensuring proper environmental conditions for plant growth and establishment is the most straightforward and cost-effective way of ensuring species persistence in an area and should be also be a top priority of recovery.

Broad Strategies Recommended to Address Threats

Successful recovery of Spalding's campion will depend first and foremost on successful stewardship (Table 2). Stewardship involves the voluntary cooperation of landowner/First Nations to protect species at risk and the ecosystems they rely on. The *Canada – British Columbia Agreement on Species at Risk* recognizes that "cooperative, voluntary measures are the first approach to securing the protection and recovery of species at risk." Stewardship can include many different kinds of activities, such as: following guidelines or best management practices to support species at risk; voluntarily protecting important areas of habitat on private property; establishing conservation covenants on property titles; eco-gifting portions of property to protect certain ecosystems or species at risk; or selling property for conservation. Agencies such as the Nature Conservancy of Canada could assist in this approach.

[9] For genetic health, however, this suggested population target may still be too modest to ensure long-term viability for Spalding's campion—a species thought to be prone to inbreeding depression. Lynch *et al*. (1995) have suggested that, in general, populations with effective breeding sizes <100 individuals (and actual sizes <1000 individuals) may be seriously threatened by deleterious genetic mutations on timescales of approximately 100 generations.

Another important approach to recovery will be to restore, to the extent possible, the structure and function of the fescue–wheatgrass–needlegrass plant community that supports Spalding's campion (Table 2). Invasive alien species (IAS) encroachment poses the primary threat to this habitat, and control of IAS should form a major component of habitat restoration and site management activities. Population enhancement will also be critical, possibly entailing direct demographic intervention to increase plant distribution and abundance to desired levels. To this end, it is recommended that an experimental colony be established at a suitable local site to test and refine management techniques. To enable adaptive management in the future, extant sites should be monitored on an ongoing basis to assess population trends, habitat condition, and the status of new or ongoing threats. Effective management may also require further research on impacts of competition from invasive species (both native and non-native), effects of grazing, and optimal fire management (Table 2).

Table 2. Recovery planning table for Spalding's campion

Priority	Threat addressed	Broad strategy to address threats	Recommended approaches to meet recovery objectives
Objective 1: Ensure protection of the habitat of Spalding's campion at all existing sites within its range in Canada.			
Urgent	All	Stewardship and protection	• Encourage landowner/First Nations participation in Spalding's campion recovery and promote landowner/First Nations capacity in this regard (e.g., by providing information on potential conservation partners and/or funding initiatives). • Work with landowners/First Nations to identify effective alternatives for protecting Spalding's campion habitat. "Effective protection" for habitat could range from stewardship agreements and conservation easements, to land securement (e.g., donation or sale of land to an environmental non-governmental agency). • Assist landowners/First Nations in developing best management practices. • Communicate conclusions regarding best management practices (e.g., with respect to grazing) to neighbouring responsible jurisdictions such the B.C. Ministry of Forests and Range, to ensure that management objectives and activities are effectively synchronized at the landscape/ecosystem level. • Work with landowners/First Nations to identify and map potential critical habitat areas for Spalding's campion and to ensure that critical habitat identification respects private interests and property rights vested in the land.
Objective 2: Maintain or enhance essential native grassland habitat at/to a level sufficient to support viable subpopulations of Spalding's campion. Objective 3: Achieve a measurable and sustained reduction in sulfur cinquefoil infestations at occupied Spalding's campion sites and increase control of other nuisance invasive alien species (e.g., spotted knapweed). Objective 4: Ensure that 80% of occupied Spalding's campion habitat is not degraded by forest/shrub encroachment. Objective 5: Determine the threats posed by livestock grazing and, if appropriate, protect all extant sites from the effects of grazing.			

Priority	Threat addressed	Broad strategy to address threats	Recommended approaches to meet recovery objectives
High	IAS; habitat fragmentation; alteration of fire regimes; herbicide drift; livestock grazing	Site management & restoration	Work with landowner/First Nations to: • design and implement an invasive alien species (IAS) management plan. This might entail mapping IAS infestations in relation to Spalding's campion occurrences, establishing priorities for IAS management, eliminating non-directed herbicide spray in or near occupied sites during critical phenological periods, experimenting with different weed control methods, and initiating a monitoring program. • design and implement a plan for increasing landscape connectivity between occupied sites. • design and implement a prescribed burn program for occupied sites (possibly based on methods currently being employed to restore Spalding's campion habitat at Dancing Prairie Preserve, MT) to enhance Spalding's campion habitat while minimizing interference with ranching operations. • design and implement a phenologically appropriate livestock grazing schedule for Tobacco Plains that minimizes threats to Spalding's campion at the same time as minimizing interference with ranching operations.
Objective 2: Maintain or enhance essential native grassland habitat at/to a level sufficient to support viable subpopulations of Spalding's campion.			
Beneficial	Habitat fragmentation/ small population size; predation; prolonged drought/global warming	Population enhancement	• Use information gained through research to enhance critical life history stages (e.g., adult survival, seedling establishment) where needed to meet population and distribution objectives. • Use artificial seed establishment and/or translocations to increase local population size/distribution where needed to meet population and distribution objectives. • Identify and rank for recovery potential, unoccupied or restorable Spalding's campion habitat at Tobacco Plains. • Establish one experimental colony of Spalding's campion at a suitable local site to test and refine management techniques.
Objective 6: Gain sufficient knowledge about the demography, population dynamics, and genetic factors to assess the viability of the species and its response to threats and management activities.			
Beneficial	N/A	Research	• Conduct research to determine demographics, population dynamics and genetic factors related to population viability. • Conduct research to determine whether threats are real or potential. • Conduct research to determine if management activities are positively or negatively affecting populations of Spalding's campion.

Priority	Threat addressed	Broad strategy to address threats	Recommended approaches to meet recovery objectives
All objectives.			
Necessary	All	Monitoring	• Develop and implement standardized protocols for monitoring species and habitat trends (based on methods currently being employed at the nearby Dancing Prairie Preserve, MT). • Monitor habitat condition to assess the impact of management actions and adapt management in response to observed results. • Monitor demographic performance as well as population and distribution trends of Spalding's campion. • Report monitoring results annually and assess trends in populations, area of occupancy and habitat condition every 5 years.

Critical Habitat

No critical habitat, as defined under the federal *Species at Risk Act* [S. 2], is proposed for identification at this time. It is expected that critical habitat for Spalding's campion will be identified following completion of outstanding work required to quantify specific habitat and area requirements, as outlined in the schedule of studies below. In addition, there is a need for consultation and development of stewardship options with affected landowners.

Knowledge gaps in the following areas prevent a complete identification of critical habitat at this time:

Species distribution and abundance

To date, surveys for Spalding's campion in B.C. have been relatively cursory and have covered only a portion of the potential habitat at Tobacco Plains, including both private ranchland and First Nations land (M. Fairbarns, pers. comm., 2006; R. Gravelle, pers. comm., 2006). Furthermore, the occurrence of prolonged dormancy suggests that some Spalding's campion occurrences may have been overlooked (or underestimated) by previous surveyors (G. Douglas, pers. comm., 2003). Thus, there is an immediate need for further surveys to locate potential new occurrences, and also for resurveys of previously reported occurrences. Discovery of additional populations, or different abundances within known populations, could lead to a modification of the recovery goal and/or recovery objectives, and thus affect the proposed definition of critical habitat.

Habitat requirements

More information on the habitat attributes of occupied sites is needed to inform critical habitat recommendations and also to assist in identifying and classifying potential recovery habitat in other areas.

Distribution of suitable habitat

The potential for additional occurrences of Spalding's campion to be sustained at Tobacco Plains is presently unknown. A detailed inventory (and mapping) of suitable unoccupied habitat is therefore needed to delineate potential habitat for this species.

Population dynamics

Some knowledge of population dynamics is essential for assessing the amount and configuration of habitat needed to ensure population viability. Research to assess local trends in Spalding's campion populations is therefore needed, including baseline demographic research to determine site-specific patterns of survival, reproduction, and recruitment. Due to the occurrence of prolonged dormancy, sporadic counts cannot be relied upon to provide accurate information in this regard.

Landscape-level processes

Many of the ecological processes thought to be relevant to Spalding's campion persistence (e.g., pollination, dispersal, fire, community succession) occur over a spatial scale larger than that of the occupied habitat itself. Thus, landscape context may be an important consideration when proposing critical habitat; for example:

- Reproductive and genetic vigour of Spalding's campion appears to be closely tied to the availability of insect pollinators, especially bumblebees. Therefore, should the proposed critical habitat also include the habitat needed (in quantity and type) to maintain a sufficient local density of bumblebee pollinators?
- Many plant species in spatially and temporally dynamic landscapes such as grasslands depend on dispersal to colonize suitable sites as they become available. Is Spalding's campion also dispersal-dependent? If so, how much open grassland habitat needs to be maintained to allow for effective seed dispersal among isolated microsites?

These knowledge gaps will be addressed in a schedule of studies, the results of which should allow for a complete identification of critical habitat in a recovery action plan.

Schedule of studies

The schedule of studies that is required to identify critical habitat is shown in Table 3. The results of these studies will be included within the recovery action plan.

Table 3. Schedule of studies to identify critical habitat for Spalding's campion. Results of these research activities will be incorporated into the action plan for this species.

Description of research activity	Start date	Completion date
1. Conduct species surveys. • For all occupied habitat, delineate the sites supporting the species. • Continue field surveys (during phenologically appropriate seasons) for undocumented occurrences of Spalding's campion in Tobacco Plains and surrounding region, and map all occupied habitat using established mapping techniques. Surveys should be extended over at least two growing seasons to decrease the chance that dormant plants are	2008	2010

overlooked. • Use survey results to ground-truth range coordinates for proposed critical habitat.		
2. Describe and record condition of occupied habitat. • Compile site-specific information on patch size, community composition, soil type, soil depth, slope aspect, ecological condition (woodland encroachment, land use activities, presence/density of invasive alien species, other intrinsic limitations) and landscape context (adjacent land use, succession, habitat connectivity). Information should be compiled following Conservation Data Centre (B.C. CDC) and Resources Information Standards Committee (RISC) standards for data collection.	2008	2010
3. Assess availability and distribution of suitable unoccupied habitat. • Identify and map suitable unoccupied habitat patches. • Rank unoccupied sites for recovery potential and establish a prioritized list of the most suitable sites. • Conduct seed establishment and/or transplant experiments to determine suitability of unoccupied potential critical habitat.	2008	2010
4. Monitor known occurrences over time to estimate population size and trends. • Due to the occurrence of plant dormancy, monitoring trends rigorously will require estimating density in sample plots and comparing between two time periods or over many time periods (i.e., repeated measures analysis; P. Lesica, pers. comm., 2006). An example of a monitoring protocol for Spalding's campion has been developed by Lichthardt and Gray (2003).	2008	ongoing
5. Conduct demographic research. • Design and implement a study to estimate critical demographic parameters (i.e., age/stage structure, reproduction, survival, dispersal, population growth rate). Ideally, such research should encompass multiple sites/years and/or experimental treatments (e.g., prescribed burn treatments, invasive species removal) to test demographic responses to differing environmental conditions.	2009	2011
6. Assess potential for gene flow among populations. • Determine pollinator (bumblebee) foraging patterns and pollinator needs with respect to vegetation structure and landscape connectivity. • Estimate amount of habitat required to support pollinators at densities sufficient to ensure adequate pollination of Spalding's campion. • Determine seed dispersal mechanisms and dispersal distances.	2009	2011
7. Conduct population/landscape modelling. • Identify community succession patterns at Tobacco Plains and use this information to construct a predictive model of future landscape dynamics, including possible habitat shifts. • Conduct a spatially explicit population viability analysis (PVA) that integrates demographic and landscape parameters to quantitatively estimate habitat requirements (i.e., type, amount) for population persistence. • After ground-truthing results, use information gained to refine estimates of the critical habitat requirements of Spalding's campion.	2009	2011

Effects on Other Species

This recovery strategy recognizes the value of preserving a healthy grassland community at Tobacco Plains. By emphasizing an ecosystem approach to the restoration and preservation of native grassland qualities and characteristics, the recovery initiatives recommended here should benefit most native species. Negative impacts on non-target species at risk are expected to be negligible. Nevertheless, certain specific management prescriptions (e.g., pertaining to invasive alien species control) could potentially conflict with the needs of other species at risk whose ranges overlap that of Spalding's campion. These include Badger (*Taxidea taxus*), Northern Leopard Frog (*Rana pipiens*), Lewis's Woodpecker (*Melanerpes lewis*), Long-billed Curlew (*Numenius americanus*), and Western Toad (*Bufo boreas*). Recovery teams are in place for both Badger and Northern Leopard Frog, and a draft recovery strategy for Badger has recently been completed (T. Antifeau, pers. comm., 2006). As in the case of Spalding's campion, Badger recovery will be tied in part to restoring open grassland habitats affected by forest in-growth and encroachment (*jeffersonii* Badger Recovery Team 2004). A program of research to identify specific impacts on non-target species and ecosystem processes will be provided in the recovery action plan.

Socioeconomic Considerations

Spalding's campion sites are rare and the overall land area required for physical protection of these sites is small. Effective mitigation of potentially detrimental activities can likely be accomplished through careful planning of site activities and by following beneficial management practices (such as sensitive routing of travel corridors). Nevertheless, some socioeconomic sectors could be affected as a result of protecting Spalding's campion. These include residential development; forestry, ranching operations and maintenance activities; and recreation. The expected magnitude of these effects is unknown and will be further assessed in the recovery action plan.

The socioeconomic impacts of failing to protect Spalding's campion are also unknown at present. However, the loss of this species from Canada could have negative impacts on such spheres as traditional ecological knowledge (TEK), agriculture (e.g., through potential associated losses of pollinators), scientific research, education, and ecotourism.

Recommended Approach for Recovery Implementation

A single-species approach to recovery will be required to address specific concerns related to Spalding's campion. However, many of the factors that threaten this species, such as habitat degradation and invasive species encroachment, are threats common to other species at risk in southeastern British Columbia. Opportunities exist to cooperate with other recovery groups (such as the Southern Interior Grasslands Recovery Implementation Group), land stewardship organizations, and conservation initiatives to restore and protect the grassland habitat that support Spalding's campion. These opportunities include:

- Tobacco Plains Indian Band received funding under Aboriginal Habitat Protection Program 2006/07 and again in 2007/08 to protect the habitat of Spalding's campion located on

Reserve lands. The project was to implement stewardship activities such as fencing, control of IAS, and removal of competing saplings to mitigate threats to the survival of the species.

- National recovery initiatives (and associated Recovery Teams) for Badger and Northern Leopard Frog.

- Identified Wildlife Management Strategy (IWMS): The Badger, Northern Leopard Frog, Lewis's Woodpecker, and Long-billed Curlew all qualify as Identified Wildlife under the IWMS. The term "Identified Wildlife" refers to those species at risk that the Minister of Environment designates as requiring special management attention under the *Forest and Range Practices Act* (FRPA). To date, one Wildlife Habitat Area (WHA) has been identified for Long-billed Curlew on provincial Crown land near Tobacco Plains (T. Antifeau, pers. comm., 2006). In addition, several rare plant communities listed under the IWMS potentially fall within the range of Spalding's campion: Douglas-fir/snowberry/balsamroot (*Pseudotsuga menziesii/Symphoricarpos albus/Balsamorhiza sagittata*); antelope-brush/bluebunch wheatgrass (*Purshia tridentata/Pseudoroegneria spicata*); and ponderosa pine/bluebunch wheatgrass–silky lupine (*Pinus ponderosa/Pseudoroegneria spicata–Lupinus sericeus*).

- East Kootenay Conservation Program (EKCP): The EKCP is a collection of 41 groups and agencies in the East Kootenay that have joined partnered to develop and implement a strategy to promote habitat and ecosystem management for private land that complements management of Crown land in the region. In the Tobacco Plains area, the Nature Conservancy of Canada is actively developing area targets for stewardship of grassland ecosystems (D. Hillary, pers. comm., 2006).

- East Kootenay Invasive Plant Pilot Project: This 3-year project is funded provincially through the East Kootenay Weed Control Program to coordinate commercial and public efforts to control the spread of invasive plants on provincial Crown lands, and in so doing streamline the process of on-the-ground invasive plant treatments. To date, 30 public events have drawn over 400 volunteers to hand-pull invasive plants across the East Kootenays.

- Ungulate Winter Ranges (UWR): UWR guidelines have been established by the province to guide forest stewardship plans, range use plans, range stewardship plans, and other operational plans in areas that contain habitat needed to meet the winter habitat requirements of ungulate species. The region where Spalding's campion occurs, or could occur, overlaps with identified ungulate winter ranges in the East Kootenays. The possibility that UWR objectives might indirectly benefit Spalding's campion recovery should be investigated.

- Grasslands Conservation Council of B.C. (GCC): The GCC is an alliance of organizations and individuals, including government, range management specialists, ranchers, agrologists, grasslands ecologists, First Nations, environmental groups, recreationists, and grassland enthusiasts that share a common commitment to education, conservation, and stewardship of B.C.'s grasslands. Combining efforts with programs such as this might reduce duplication of effort and competition for limited funding.

- Framework for Cooperation between the U.S. Department of the Interior and Environment Canada in the Protection and Recovery of Wild Species at Risk: Signed in 1997, the goal of the Framework is to prevent populations of wild species shared by the United States and Canada from becoming extinct as a consequence of human activity, through the conservation of wildlife populations and the ecosystems on which they depend (CWS 2006). The U.S. Fish and Wildlife Service and the Canadian Wildlife Service are responsible for implementing the Framework. To advance recovery of Spalding's campion across the international boundary, it is recommended that a Spalding's campion working group be established under the auspices of the Framework. Primary goals of the working group could include sharing information on the biology of the species, cooperating to improve management and stewardship, prioritizing recovery needs, and working together to obtain funding for recovery efforts.

Evaluation and Measures of Success

The success of the recovery program will be determined primarily through monitoring of populations and habitat trends through time. Where possible, measurable population and distribution objectives have been established for meeting the recovery goal and addressing threats; these will provide the primary basis for progress evaluation. The recovery strategy will be reviewed in 5 years to assess progress and to identify additional approaches or changes that may be required to achieve recovery.

Long-term performance measures (within 10-year time frame) should include:

1. Are there three populations extant at Tobacco Plains, with a total population size of at least 100 mature individuals (Population and distribution objective #1).
2. Do census results show at least a total of 100 mature individuals in six separate subpopulations, with no missing life stages? (Population and distribution objective #2).

Short-term performance measures (within a 5-year time frame) should include:

3. Is the species extant at all six subpopulation locations? Is the essential native grassland habitat secure? (Objectives #1 and #2).
4. Are all extant subpopulations viable? (Objective #2).
5. Have sulfur cinquefoil infestations been reduced by 80% between 2007 and 2017? Have increased control measures been undertaken for other invasive alien species? (Objective #3).
6. Has forest/shrub encroachment been prevented in 80% of occupied Spalding's campion habitat? (Objective #4).
7. Have the threats posed by livestock grazing been assessed, and effective management measures undertaken? (Objective #5).
8. Is it possible to assess the viability of the species and its response to threats and management activities? (Objective #6).

Timeline for Completion of Recovery Action Plan

It is recommended that a draft recovery action plan be completed by October 2011.

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APPENDIX 1.

Value of the Species as an Economic or Cultural Resource

Spalding's campion is not known to be a traditional food or medicinal source, nor is it currently of commercial horticulture interest. Nevertheless, the species holds significant cultural value for the First Nations peoples on whose land it is found. As expressed by members of the Tobacco Plains Band: "To be one of the only locations of the Spalding's catchfly is very humbling. The people of the community strongly believe in being responsible caretakers of the land and environment and feel it is an honor to have been given the responsibility from the Creator to protect this species by being one of the only areas to have the plant surviving" (R. Gravelle, pers. comm., 2006).

Many compelling arguments exist for protecting populations of species' at the limits of their range. Empirical evidence suggests, for example, that peripheral populations are often genetically and morphologically divergent from central populations. The ability of a species to adapt to changing conditions, and thus its long-term conservation, may depend on the protection of these genetically distinct populations. Northern peripheral populations may turn out to have particular importance as sources of migration in the event of global warming. Furthermore, recovery of species at risk and restoration of imperiled habitats associated with the Tobacco Plains grasslands will contribute to biodiversity, health, and functioning of the environment and enhance opportunities for appreciation of such special places and species, thereby contributing to overall social value in southeastern British Columbia.