U.S. Fish & Wildlife Service

Recovery Plan for *Silene spaldingii* (Spalding's Catchfly)

Silene spaldingii
Janice Hill

Silene spaldingii/Steve Wirt

Silene spaldingii/Steve Wirt

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Region 1
U.S. Fish and Wildlife Service
Portland, Oregon

Approved: ______________________
Regional Director, U.S. Fish and Wildlife Service

Date: SEP 6 2007

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Executive Summary

Current Species Status: *Silene spaldingii* (Spalding's catchfly) is an herbaceous perennial plant in the pink family (Caryophyllaceae). It is a regional endemic found predominantly in bunchgrass grasslands and sagebrush-steppe, and occasionally in open pine communities, in eastern Washington, northeastern Oregon, west-central Idaho, western Montana, and barely extending into British Columbia, Canada. There are currently 99 known populations of *S. spaldingii*, with two thirds of these (66 populations) composed of fewer than 100 individuals each. There are an additional 23 populations with at least 100 or more individuals apiece, and the 10 largest populations are each made up of more than 500 plants. Occupied habitat includes five physiographic (physical geographic) regions: the Palouse Grasslands in west-central Idaho and southeastern Washington; the Channeled Scablands in eastern Washington; the Blue Mountain Basins in northeastern Oregon; the Canyon Grasslands of the Snake River and its tributaries in Idaho, Oregon, and Washington; and the Intermontane Valleys of northwestern Montana. *Silene spaldingii* was listed as a threatened species under the Endangered Species Act on October 10, 2001 (U.S. Fish and Wildlife Service 2001). *Silene spaldingii* has been assigned a recovery priority number of 8C on a scale from 1C (highest) to 18 (lowest), indicating its taxonomic status as a full species, a moderate degree of threats or impacts, high potential for recovery, and potential conflict with economic activities.

Habitat Requirements and Limiting Factors: In general *Silene spaldingii* is found in open, mesic (moist) grassland communities or sagebrush-steppe communities. However, the species is occasionally found within open pine forests. The bunchgrass grasslands where *S. spaldingii* primarily occurs are characterized by either *Festuca idahoensis* (Idaho fescue) or *F. idahoensis* (Idaho fescue) with *Agropyron spicatum* = *Pseudoroegneria spicata* (bluebunch wheatgrass) except in Montana where the dominant bunchgrass is *F. scabrella* (rough fescue). The plant is found at elevations ranging from 365 to 1,615 meters (1,200 to 5,300 feet), usually in deep, productive loess soils (fine, windblown soils). Plants are generally found in swales or on northwest to northeast facing slopes where soil moisture is relatively higher. *Silene spaldingii* continues to be impacted by habitat loss due to human development, habitat degradation associated with adverse grazing and trampling by domestic livestock and wildlife, and invasions of aggressive nonnative plants. In addition, a loss of genetic fitness (the loss of genetic variability and effects of inbreeding) is a problem for many small, fragmented populations where genetic exchange is limited. Other impacts include changes in fire frequency and seasonality, off-road vehicle use, and herbicide spraying and drift.

Recovery Strategy: The objective of the recovery program is to recover *Silene spaldingii* by protecting and maintaining reproducing, self-sustaining populations in each of the five distinct physiographic regions where it resides. Within each of these regions we have identified **key conservation areas** to focus conservation efforts at larger populations. A key conservation area possesses the following qualities:

- Composed of intact habitat (not fragmented), preferably 40 acres (16 hectares) in size or greater[1]
- Native plants comprise at least 80 percent of the canopy cover of the vegetation community
- Adjacent habitat sufficient to support pollinating insects
- Habitat is of the quality and quantity necessary to support at least 500 reproducing individuals of *S. spaldingii*

The protection and management of these key conservation areas, or areas that have the potential to serve as key conservation areas, forms the foundation of the recovery strategy for *S. spaldingii*. When possible, these key conservation areas should be surrounded by 300 acres of habitat that is intact or can be restored to eventually support *S. spaldingii*.

Recovery Goal, Objectives, and Delisting Criteria: The goal of the recovery program is to recover *Silene spaldingii* to the point where it can be delisted, *i.e.*, to remove the species from threatened status. The primary objectives to meet this goal are to reduce or eliminate the threats to the species, and protect and maintain multiple reproducing, self-sustaining populations distributed across each of the five distinct physiographic regions where it resides sufficient to ensure the long-term persistence of the species. Delisting of the species will be considered when the following criteria have been met:

1. Twenty-seven populations, with at least 500 reproducing *Silene spaldingii* individuals in each and with intact habitat, occur rangewide at key

[1] In some regions, such as the already severely fragmented Palouse Grasslands, reaching a minimum size of 40 acres (16 hectares) of contiguous habitat may not be feasible

conservation areas and are distributed throughout the 5 identified physiographic provinces as follows: 5 within the Blue Mountain Basins, 7 within the Canyon Grasslands, 8 within the Channeled Scablands, 4 within the Intermontane Valleys, and 3 within the Palouse Grasslands. Given the uncertainty associated with creating new key conservation areas (*i.e*. transplanting) and the limited available habitat within the Palouse physiographic region, the delisting criteria of three key conservation areas within the Palouse Grasslands will be evaluated within 10 years (by the year 2017) based on new information. Populations with more than 500 plants will be maintained at or above current population numbers.

The number of populations/key conservation areas for each physiographic province was set at a minimum of three to preserve genetic diversity. For some regions, a greater number of key conservation areas are proposed to reflect the number of populations needed to maintain connectivity and, to the extent possible, preserve historical distribution across the remaining potential habitat estimated to be available.

2. All 27 key conservation areas of *Silene spaldingii* are composed of at least 80 percent native vegetation (by canopy cover), have adjacent habitat sufficient to support pollinating insects, and are not fragmented (*i.e*., intact; see criterion #1).

3. Populations of *Silene spaldingii* at key conservation areas demonstrate stable or increasing population trends (less than a 10 percent chance that the population is declining) for at least 20 years. To address this criterion, consistent range-wide long-term monitoring methodologies that identify what parameters will be monitored, how, and at what frequency need to be developed. Acceptable statistical power and false-change error rates will be established at a later date when a standardized rangewide monitoring protocol is developed.

4. Habitat management plans have been developed and implemented for all key conservation areas. These management plans will provide for the protection of *Silene spaldingii* habitat, and will also protect the ecosystem by addressing conservation of other rare species, reducing the identified threats (*e.g.*, off-road vehicle use, adverse grazing and trampling by

wildlife and domestic stock, herbicide application, etc.), protecting pollinators, enacting monitoring strategies, incorporating integrated pest management strategies, and incorporating appropriate fire management activities.

5. Invasive nonnative plants with the potential to displace *Silene spaldingii* have been continually controlled or eradicated within a 100-meter (328-foot) radius of all *S. spaldingii* populations within key conservation areas. Certain invasive plants that are established and difficult to eradicate, as detailed for each physiographic province under Recovery Actions 1.1.4, 1.2.4, 1.3.4, 1.4.4, and 1.5.5, may be controlled within 25 meters (82 feet) of *S. spaldingii* populations.

6. Prescribed burning is conducted, whenever possible, to mimic historical fire regimes within a particular physiographic region in *Silene spaldingii* habitat. Prior to burning, presence/absence surveys for the plant will be completed. Prescribed burning of more than 30 percent of the individuals at a *S. spaldingii* population should not occur at any one time and should not take place when it may exacerbate invasive nonnative plant populations unless invasive nonnative plant control measures, monitoring, and a management strategy are in place prior to the prescribed burn. Where *S. spaldingii* is present, monitoring is enacted prior to and following the prescribed burn. Historical fire regimes are carefully analyzed utilizing the best available technology.

7. Seed banking occurs *ex situ* first at all smaller *Silene spaldingii* populations (not key conservation areas or potential key conservation areas) and second at all larger *S. spaldingii* populations (key conservation areas or potential key conservation areas) to preserve the breadth of genetic material across the species' range.

8. A post-delisting monitoring program for the species will be developed and ready for implementation. This program will be developed through coordination with the Bureau of Land Management, U.S. Forest Service, U.S. Fish and Wildlife Service, Tribes, States, The Nature Conservancy, and other interested parties.

Recovery Actions Needed: *Silene spaldingii* cannot be recovered if its habitat is not conserved and restored. The goal of this recovery plan is to manage self-sustaining *S. spaldingii* populations through good habitat (ecosystem) management at key conservation areas. This will be done through the following primary actions: **1)** Conserve, identify, develop, and expand *Silene spaldingii* populations and habitat in each of the five physiographic regions where *S. spaldingii* resides; **2)** Conduct general recovery actions across the range of *Silene spaldingii*; **3)** Develop a post-delisting monitoring plan.

These actions will be accomplished by developing and implementing habitat management plans at these key conservation areas that provide a strategy for managing *Silene spaldingii* and its habitat; these plans must address the threats to the species. Larger populations where small population sizes and fragmentation are less of a problem should be protected (kept from harm) before small, more fragmented populations that are more vulnerable to a loss of genetic diversity. To preserve genetic diversity, populations should be conserved in each of the five physiographic regions where the plant resides; if necessary, populations may need to be expanded or developed. Invasive nonnative plants need to be controlled within *S. spaldingii* habitat with minimal impact to the species itself by utilizing integrated pest management techniques. Fire management and prescribed burning must be conducted carefully and with sound monitoring strategies and scientific information. Development of lands where *S. spaldingii* resides, especially sites with large populations, should be prevented. Livestock grazing, where it occurs, will need to be conducted so that *S. spaldingii* and its habitat are not deleteriously affected. To ensure these threats are adequately being addressed, monitoring and research are required to evaluate management actions. Additional needs include surveys to identify other *S. spaldingii* populations in need of protection or management, outreach to inform the public about the species so they may assist in conservation, and seed banks to protect the species from catastrophic losses. Funding is necessary to implement these actions. A regular review of this recovery plan is recommended so that new information may be incorporated and management adjusted accordingly.

Total Estimated Cost of Recovery: The total estimated cost for recovery of *Silene spaldingii* is $8,666,000 with an average yearly cost across the first 5 years of $349,200 (Table 1). Of the estimated total, roughly a quarter of the dollars are for surveys and monitoring.

Table 1. Expanded cost estimates through plan year 2040 (in $1,000 units). Actions refer to the primary recovery actions developed in this plan (see "actions needed" above).

Year	Recovery Action			Year Totals
	1*	2	3	
2007	17	322		339
2008	17	330		347
2009	17	330		347
2010	17	331		348
2011	17	348		365
2012	13	293		306
2013	13	293		306
2014	13	293		306
2015	13	290		303
2016	13	315		328
2017	13	277		290
2018	13	277		290
2019	13	237		250
2020	13	236		249
2021	13	261		274
2022	13	217		230
2023	13	217		230
2024	13	207		220
2025	13	206		219
2026	13	231		244
2027	13	187		200
2028	13	187		200
2029	13	187		200
2030	13	186		199
2031	13	211		224
2032	13	187		200
2033	13	187		200
2034	13	187		200
2035	13	186		199
2036	13	211		224
2037	13	187		200
2038	13	187	5	205
2039	13	187	5	205
2040	13	211		224
TOTALS	462	8,194	10	8,666

***Because Action 1 is a general action item, many of the costs associated with Action 1 are instead included under the more specific sub-actions of Action 2.**

Date of Recovery: If recovery actions are prompt and effective, delisting might be possible in 2040. Because *Silene spaldingii* annual counts vary significantly in response to climatic events (*i.e*., precipitation, temperature) and individuals may exhibit prolonged dormancy (with no above ground parts) for up to 3 years, given what we currently know, a minimum of 20 years of monitoring will be needed to determine long term population trends. The estimated recovery date accounts for this long-term monitoring as well as the time it may take to supplement or establish new populations.

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A. Introduction

Silene spaldingii (Spalding's catchfly) is an herbaceous perennial plant. It is a regional endemic found predominantly in bunchgrass grasslands and sagebrush-steppe, and occasionally in open pine communities, in eastern Washington, northeastern Oregon, west-central Idaho, western Montana, and barely extending into British Columbia, Canada. *S. spaldingii* is affected by a variety of factors including competition with invasive nonnative plants; habitat destruction and fragmentation resulting from agricultural and urban development; habitat degradation; adverse grazing and trampling by domestic livestock and native herbivores; herbicide treatments; annual climatic conditions (*i.e.*, drought cycles); climate change; alterations in fire frequency, intensity, and seasonality; off-highway vehicles; and a loss of genetic variation associated with small, fragmented populations.

Silene spaldingii was listed as a threatened species under the Endangered Species Act on October 10, 2001 (U.S. Fish and Wildlife Service [USFWS] 2001). The intent of this draft recovery plan is to guide implementation of the recovery of *S. spaldingii*. The ultimate goal of our recovery program is to eliminate or eradicate threats to persistence and restore populations of threatened or endangered species to the point at which the protections of the Endangered Species Act are no longer necessary, and the species may be delisted. The broad recovery recommendations in this plan are twofold: (1) resolve the impacts to the species; and (2) ensure self-sustaining populations in the wild. Definitions for some of the terms that will be commonly used within this document are provided in Box 1.

Silene spaldingii has been assigned a recovery priority number of 8C on a scale of 1C (highest) to 18 (lowest), indicating a moderate degree of threats or impacts, high potential for recovery, potential conflict with economic activities, and its taxonomic status as a full species (Appendix A).

Box 1. Definition of terms as used in this recovery plan.

conservation – The controlled use and systematic protection of *Silene spaldingii* and its habitat.
element occurrence record – Location information stored by each State or Province's Natural Heritage Program or Conservation Data Center.
extirpated – Eliminated from a certain area.
fire regime – The frequency, intensity, and seasonality of fire within a given area.
intact habitat – A place or environment for *Silene spaldingii* that is not fragmented by agricultural fields, urban developments, etc., and where the native ecosystem is functioning with few invasive nonnative plants and suitable habitat for pollinators.
key conservation area – Significant populations and habitat of *Silene spaldingii* that have been identified by members of the technical team as the primary areas for recovery actions, protection, and conservation in this recovery plan. The defining criteria for key conservation areas are provided on page 42 of this plan.
physiographic region – Geographic regions delineated by their physical characteristics. These regions are segregated in this recovery plan because of their significant differences in plant communities, climate, soil properties, fire regimes, and invasive nonnative plants.
prolonged dormancy – When *Silene spaldingii* plants remain below the ground for up to 3 years. Summer dormancy is an example.
protection (protected areas) – Securing *Silene spaldingii* in areas that are either: (1) owned or managed by a government agency and with appropriate management standards in place for *S. spaldingii*; (2) managed by a conservation organization that identifies maintenance of the species as a primary objective for an area; or (3) on private lands with a voluntary, long-term conservation easement or covenant that commits present and future landowners to the perpetuation of the species.
population – An aggregation of element occurrence records of *Silene spaldingii* that are within 1.6 kilometers (1 mile) of one another.
rangewide distribution – *Silene spaldingii*'s distribution across all four states (Idaho, Montana, Oregon, and Washington) as well as British Columbia, Canada.
site – Equivalent to a *Silene spaldingii* element occurrence record.

B. Species Description and Taxonomy

Silene spaldingii is a member of the pink or carnation family, the Caryophyllaceae. It was first collected by Henry Spalding around 1846 near the Clearwater River in Idaho (Oliphant 1934, pp. 98-99) and later described by Sereno Watson in 1875, based on the Spalding material (Watson 1875, p. 344). The species has no other scientific synonyms nor has its taxonomy been questioned. Common names include Spalding's catchfly, Spalding's silene, and Spalding's campion. *Silene spaldingii* overlaps in range and is somewhat similar in appearance with several other species in the genus (see Figure 1): *S. scouleri* (Scouler's catchfly), *S. douglasii* (Douglas' catchfly) *S. csereii* (Balkan catchfly, not included in Figure 1), *S. oregana* (Oregon catchfly) and *S. scaposa scaposa*

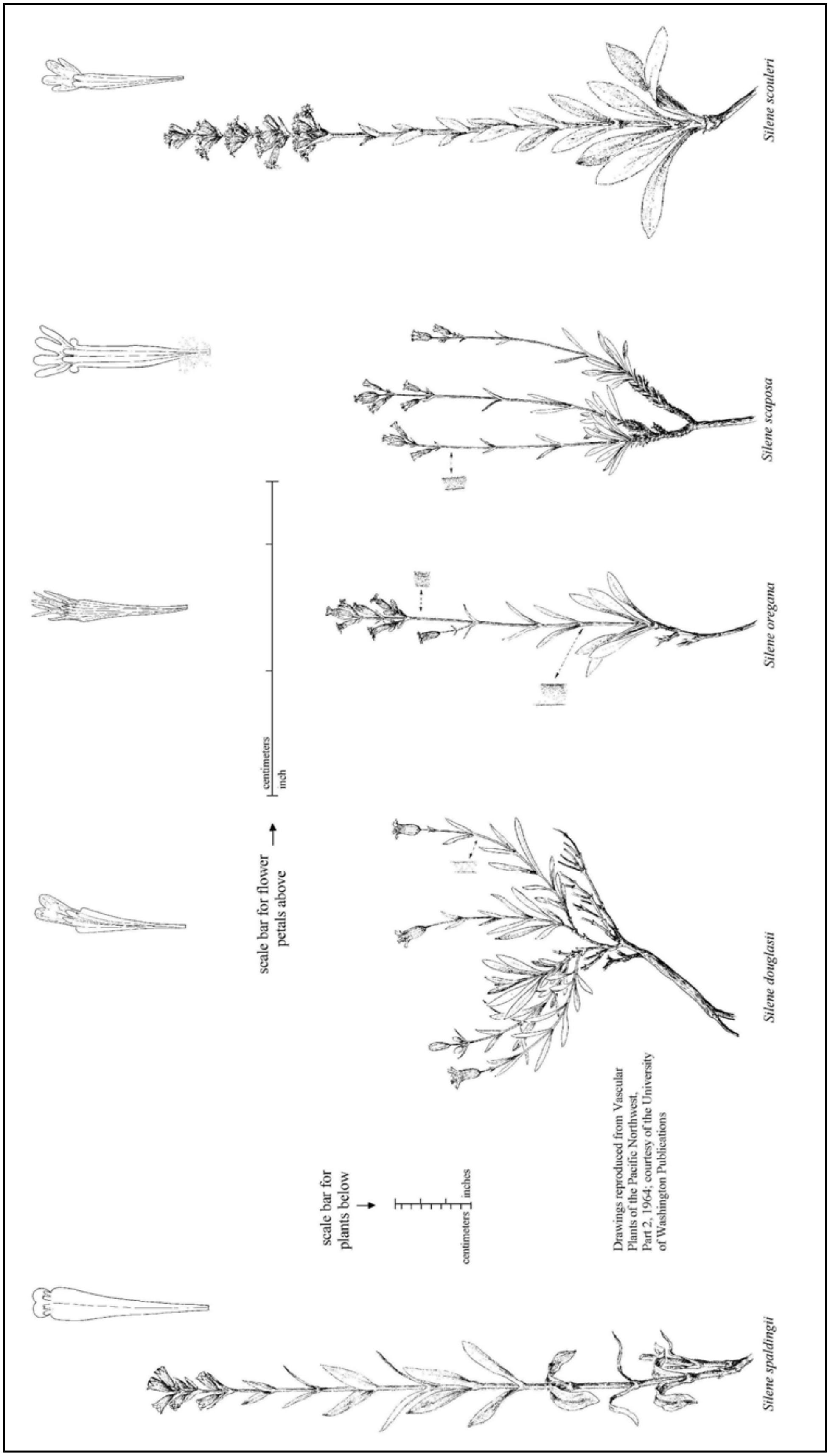


Figure 1. *Silene spaldingii* and a few of its closest look-alikes.

var. *scaposa* (scapose silene) (Schassberger 1988, pp. 6,10; Youtie 1990, p. 2; Lichthardt 1997, pp. 2-3). A simple key for distinguishing Pacific Northwest bunchgrass *Silene* is provided in Figure 2. One member of the genus, *S. latifolia* ssp. *alba* (bladder campion), is an invasive nonnative plant that may be separated from *S. spaldingii* by its much larger, inflated flowers. Several other *Silene* included in Figure 2 below are nonnative but are not considered invasive at this time.

Silene spaldingii is an herbaceous perennial, emerging in spring and dying back to below ground level in the fall. Plants range from 20 to 61 centimeters (8 to 24 inches) in height, occasionally up to 76 centimeters (30 inches). There is generally one distinctively yellow-green stem per plant, but sometimes there may be multiple stems. Each stem bears 4 to 7 (up to 12 or more) pairs of leaves that are 5 to 8 centimeters (2 to 3 inches) in length, and has swollen nodes where the leaves are attached to the stem. All green portions of the plant (leaves, stems, calyx [defined below]) are covered in dense sticky hairs that frequently trap dust and insects, hence the common name “catchfly.” The plant has a persistent caudex (underground stem tissue) atop a long taproot (1 meter [3 feet] or longer in length). The long taproot makes transplanting the species difficult at best, and perhaps impossible. Typically *S. spaldingii* blooms from mid-July through August, but it can bloom into September.

Three to 20 (sometimes over 100) flowers are horizontally positioned near the top of the plant in a branched arrangement (inflorescence). Flowers are approximately 1.5 centimeter (0.6 inch) long; however, the majority of the flower petal is enclosed within a leaf-like tube, the calyx, which resembles green material elsewhere on the plant and has 10 veins running from the flower mouth to the base of the flower. The visible portion of the five flower petals is small (2 millimeters [0.08 inch]), cream-colored, and extends only slightly beyond the calyx. Attached to the visible flower petals (blades) are four to six very small (0.5 millimeter [0.02 inch]) appendages, the same color as the blades (Figure 2). The flowers are perfect (have both male and female parts). Each fertilized flower matures vertically and becomes a many-seeded (up to 150 seeds) cup-like fruit capsule. Fruits mature from August until September and one stem may have both flowers and mature fruit capsules at the same time. Seeds are small (2 millimeters [0.08 inch]), wrinkled, flattened, winged, and light brown when mature. The above plant description is adapted from Schassberger (1988, pp. 5-6); Gamon

1a Styles generally 5 (the style is the narrowed portion of the pistil, connecting the stigma to the ovary)

2a Flowers of two separate types (male and female), petal blade >5 millimeters ……………………..……… **bladder campion** (*Silene latifolia* Poir. ssp. *alba* (P. Mill) Greuter and Burdet)^

2b Flowers of one type (contain both male and female parts), petal blade < 5mm ………………………………….…………………………… **Drummond campion** (*Silene drummondii* Hook.)

1b Styles generally 3

3a Sepals (united) smooth/hairless, often bell-shaped, depressed and indented at the point where the flower attaches to its stem, lightly 15-20-nerved, becoming membrane-like in texture; petals white, blades (upper portion of petals) 4-6 mm, bilobed, appendages lacking or reduced to tiny bumps (appendages are projections located on the inner surface of a petal at the junction of the petal blade and petal claw)

4a Sepals strongly inflated, up to 2 cm long when in post-flowering stage; fruit that forms is entirely surrounded by the sepal structure …**maidenstears** (*Silene vulgaris*(Moench) Garcke – was *S. cucubalus*)^

4b Sepals slightly inflated, rarely as much as 1.5 cm long when in post-flowering stage; fruit that forms generally protrudes beyond the sepal structure…………………**Balkan catchfly** (*Silene csereii* Baumg.)^

3b Sepals (united) hairy, or plant not possessing the combination of characteristics listed under 3a

5a Annual plant (germinates, flowers, produces seed, and dies during one growing season)

6a Sepals (united) 25- to 30-nerved, shaped like an egg or inverted cone; depressed and indented at the point where the flower attaches to its stem; mostly over 20 mm long. Blade of petals with a small terminal notch in an otherwise rounded or blunt tip, 8-12 mm long. Appendages 2-5 mm long.…………………………………………………………………………**conoid cat** (*Silene conoidea* L.)^

6b Sepals (united) 10-nerved, usually tubular, and mostly not depressed and indented at the point where the flower attaches to its stem, 4-15 mm long. Blade of petals shallowly to deeply 2-lobed, 2-9 mm long; appendages 0.2-0.4 mm long

7a Sepals very prominently nerved with stiff, coarse hairs. Blade of petals 5-9 mm long, 2-lobed at least half of the length; appendages about 0.2 mm long ……………..**forked cat** (*Silene dichotoma* Ehrh.)^

7b Sepals usually not prominently nerved with stiff, coarse hairs. Blade of petals 2-4 mm long, very shallowly-lobed at tip; appendages up to 0.4 mm long …………**sleepy cat** (*Silene antirrhina* L.)

5b Perennial plant (generally lives for multiple years; regenerating each growing season from a persistent underground stem (caudex) just beneath the soil surface which sits atop a long, narrow taproot)

8a Petals, including the ovary stalk and blades, usually less than 10 (rarely 12) mm long; overall flower arrangement appears open and leafy ……………………….…. **Menzies' catchfly** (*Silene menziesii* Hook.)

8b Petals, including the ovary stalk and blades, usually over 12 mm long; overall flower arrangement appears more compact than as described above and mostly with considerably reduced bracts (leaf-like structures) attached below.

9a Blade of the petals 1-2 mm long, with no notch to a shallow terminal notch; ovary stalk smooth, without hairs or glands; appendages 4 (possibly 5-6); seeds inflated, about 2 mm long, the seed surface covered with alternating ridges and furrows....**Spalding's catchfly** (*Silene spaldingii* S. Wats.)

9b Blade of the petals usually over 2 mm long and deeply lobed; ovary stalk mostly hairy; appendages sometimes only 2; seeds usually not over 1.5 mm long, the seed surface not covered with alternating ridges and furrows.

10a Appendages 4 or 6, linear; petals equally 4-lobed or the middle lobes again deeply divided; auricles usually lacking (auricles are ear-shapd lobes on the outer margins of the upper part of the petal's claw) …………………………………….…...…**Oregon catchfly** (*Silene oregana* S. Wats.)

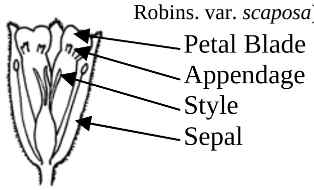
10b Appendages usually 2, or if 4 often not linear, or petals 2-lobed or unequally 4-lobed or with auricles

11a Ovary stalk 3-7mm long; petal blade 3-8 mm long, divided into 2 lobes for up to 1/3 of its length, rarely with a small lateral tooth on each margin of the petal blade

12a Plant with abundant glands on the overall flower arrangement itself and on the sepals; appendages mostly oblong and with more or less irregularly toothed margins, 1-3 mm long……………………………………….…**Scouler's catchfly** (*Silene scouleri* Hook.)

12b Plant without glands or if present, only slightly glandular on the overall flower arrangement itself and on the sepals; appendages linear or narrowly oblong but not with irregularly toothed margins 1(rarely 3) mm long...............**Douglas' catchfly** (*Silene douglasii* Hook.)

11b Ovary stalk 1.5-2.5 mm long; petal blade 2.5-5.5 mm long, may be almost completely unlobed or may be heart-shaped…………………….….**Scapose silene** (*Silene scaposa* B. L. Robins. var. *scaposa*)



Schematic *Silene*

*Key compiled by LeAnn Abell, U.S. Bureau of Land Management (L. Eno (Abell) *in litt.* 2004) from Hitchcock *et al.* 1964; Hitchcock and Cronquist 1973; Harris and Harris 1994)

Figure 2. Dichotomous key for Pacific Northwest Bunchgrass *Silene**

(1991, p. 22); Lesica and Heidel (1996, pp. 2-3); Lichthardt (1997, p. 2); and Hill and Gray (2004a, pp. 5-6).

C. POPULATION TRENDS AND DISTRIBUTION

Within the United States, *Silene spaldingii* is known from four counties in Idaho (Idaho, Latah, Lewis, and Nez Perce), four counties in Montana (Flathead, Lake, Lincoln, and Sanders), one county in Oregon (Wallowa), and five counties in Washington (Adams, Asotin, Lincoln, Spokane, and Whitman) (Mincemoyer 2005; Oregon Natural Heritage Program [ONHP] 2006; Idaho Conservation Data Center [ICDC] 2007; Montana Natural Heritage Program [MNHP] 2007; Washington Natural Heritage Program [WNHP] 2007; summarized in USFWS 2007). Two element occurrence records of *S. spaldingii* are known in British Columbia, Canada, both are within 1.6 kilometers (1 mile) of plants in Montana (British Columbia Conservation Data Center [BCCDC] 2007), therefore we consider these plants to be within one single population. Figure 3 depicts the current rangewide distribution of *S. spaldingii*.

The distribution and habitat of *Silene spaldingii* are primarily restricted to mesic slopes, flats or depressions in grassland, sagebrush-steppe, or open pine forest vegetation dominated by native perennial grasses such as *Festuca idahoensis* (Idaho fescue) or *F. scabrella* (rough fescue). Within its range, *S. spaldingii* occurs within five physiographic (physical geographic) regions: the Palouse Grasslands in west-central Idaho and southeastern Washington; the Channeled Scablands in eastern Washington; the Blue Mountain Basins in northeastern Oregon; the Canyon Grasslands of the Snake River and its tributaries in Idaho, Oregon, and Washington; and the Intermontane Valleys of northwestern Montana (see Figure 4). The Palouse Grasslands, a subset of the Pacific Northwest Bunchgrass Grasslands (Tisdale 1986a, p. 2), are somewhere in the middle of *S. spaldingii*'s range.

Plants are tracked by State or province Natural Heritage Programs or Conservation Data Centers by sites or element occurrence records. When *Silene spaldingii* was initially listed in 2001, it was known from 98 separate element

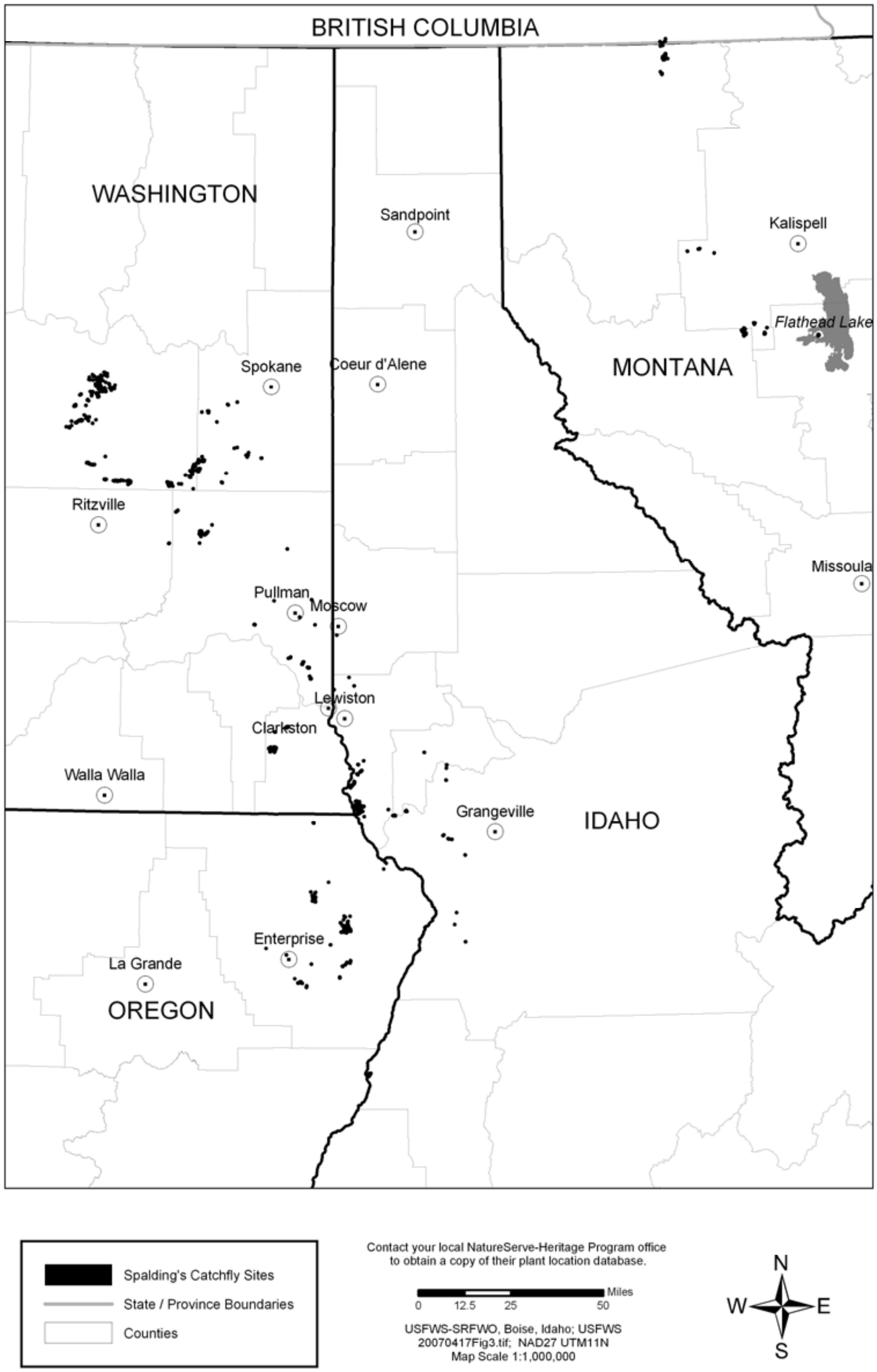


Figure 3. Rangewide distribution of *Silene spaldingii*.

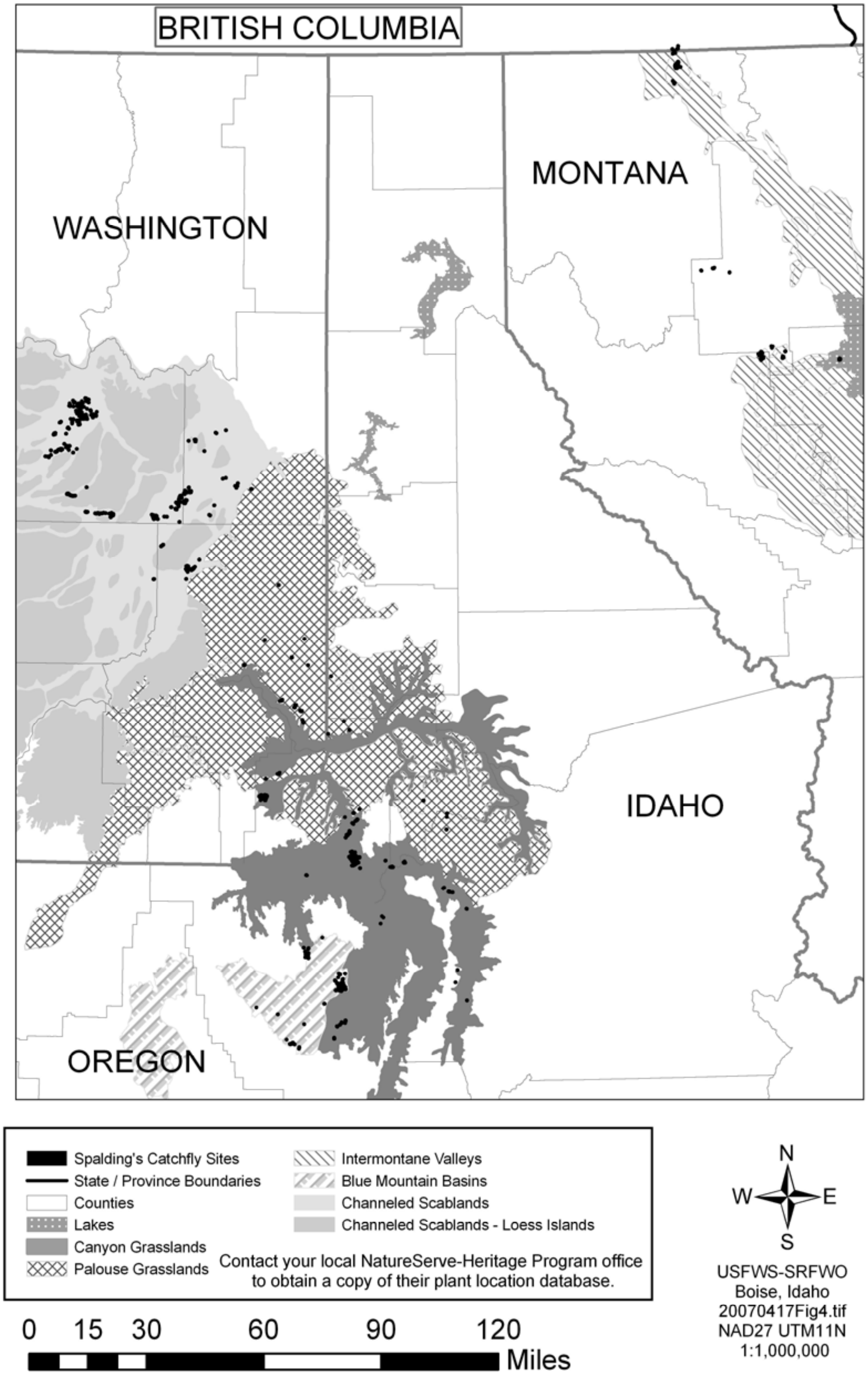


Figure 4. Physiographic regions where *Silene spaldingii* has been found

occurrence records, or 58 populations if the element occurrence records within 1.6 kilometers (1 mile) of one another are grouped together[2]. Nine of these 58 populations were located within the Blue Mountain Basins (excluding 1 extirpated population), 5 from the Canyon Grasslands, 21 from the Channeled Scablands (excluding 2 extirpated populations and 2 with poor location records), and 16 within the Palouse Grasslands (excluding 1 extirpated population and 3 with poor location records), and 7 in the Intermontane Valleys (excluding 1 historical population and 1 with poor location records) (USFWS 2004, p. 3). When examined by state or province there were 7 populations in Idaho, 6.5[3] in Montana, 9 in Oregon, 35 in Washington, and 0.5 in British Columbia, Canada (USFWS 2004, p. 1). Some 16,500 individual plants were estimated at the time of listing, although given the problems associated with counting plants due to prolonged dormancy this number should not be viewed as definitive (please see page 12 for a more detailed description of fluctuations in yearly population counts).

Since *Silene spaldingii* was listed in 2001, increased survey efforts in suitable habitat have resulted in the identification of 39 new populations. Today we have 110 extant element occurrences in the United States and an additional 6 sites that are not yet designated as element occurrences of *S. spaldingii* in 99 populations (Figure 3): 14 in the Blue Mountain Basins, 22 in the Canyon Grasslands, 35 in the Channeled Scablands, 11 in the Intermontane Valleys, and 17 in the Palouse Grasslands. When examined by state or province, there are 22 populations in Idaho, 10.33 in Montana, 17 in Oregon, 49 in Washington, and 0.66 in British Columbia, Canada (Mincemoyer 2005; ONHP 2006; BCCDC 2007; ICDC 2007; MNHP 2007; WNHP 2007; summarized in USFWS 2007). The number of individual plants in each population ranges from one to several thousand. Several new sites within the Canyon Grasslands have expanded our knowledge of the range of the species by 50 miles from those locations known in 2001. New occurrences are likely a result of increased survey effort, not an increase in actual plant distribution or vigor. The current estimated number of plants is approximately 28,750 individuals in the United States, although this

[2] We defined populations of *Silene spaldingii* based on studies suggesting that genetic exchange via pollen transfer would typically not occur over a distance greater than 1.6 kilometers (1 mile). Recent improvements in mapping technology and criteria for designating extirpated populations have allowed us to refine the delineation of *S. spaldingii* populations, suggesting the 52 populations originally identified in the Final Rule listing the species (U.S. Fish and Wildlife Service 2001) would have been more accurately reported as 58 populations.
[3] One population, now with three sites, spans the border of the United States and Canada, reported here as 0.5 (in 2001) or now as 0.33 portion of a population.

number includes only above ground plants in any given year and therefore is an underestimation of the actual numbers of *S. spaldingii* (please see page 12 for a more detailed description of fluctuations in yearly population counts).

It is expected that more populations of *Silene spaldingii* will be found in the future as survey efforts increase. To date, survey effort has been lower on privately owned lands than on publicly managed lands. Yet even with this lower survey effort, over half the known sites and estimated plant numbers occur on privately owned lands. Thirty-two of the known populations of *S. spaldingii* (32 percent) occur on lands that are entirely in private ownership, with an additional 18 populations (18 percent) in partial private ownership (Mincemoyer 2005; ONHP 2006; ICDC 2007; MNHP 2007; WNHP 2007; summarized in USFWS 2007). The participation of private landowners, including organizations such as The Nature Conservancy, will therefore be vital in the recovery of this species.

There are only 10 populations of *Silene spaldingii* that may be considered relatively large, each with over 500 individuals (Mincemoyer 2005; ONHP 2006; ICDC 2007; MNHP 2007; WNHP 2007; summarized in USFWS 2007). The largest population with over 10,000 plants is at The Nature Conservancy's Dancing Prairie Preserve in Montana, followed by Garden Creek, Idaho, (managed by The Nature Conservancy and the Bureau of Land Management) with approximately 4,000 plants. The other 8 large populations range from 500 plants at Coal Creek, Washington, to some 2,385 individuals at Crow Creek on the Wallowa-Whitman National Forest in Oregon. Approximately 78 percent of the total known individuals of *S. spaldingii* are found within these few large populations. Of the 99 known *S. spaldingii* populations, two-thirds (66 populations, or 67 percent) are small populations, each made up of fewer than 100 individuals (Mincemoyer 2005; ONHP 2006; ICDC 2007; MNHP 2007; WNHP 2007; summarized in USFWS 2007). Much of the remaining habitat occupied by *S. spaldingii* is fragmented by roads, agricultural fields, and other developments. When small populations with few individuals are isolated and genetic exchange is not possible, they become vulnerable to the loss of genetic variation and, ultimately, the loss of the population itself (Barrett and Kohn 1991, p. 4; Ellstrand and Elam 1993, pp. 219-225; see Section G-2 of this plan for further discussion).

It is not known how many *Silene spaldingii* individuals and how much habitat may have been lost to human related activities during the last 150 years since European settlement of this region. Historical documentation indicates the species was seldom collected (Hitchcock and Maguire 1947, p. 1), but because most land conversions within the plant's historical range took place before botanical surveys had been done, we may never know how extensive or numerous *S. spaldingii* once was. Instead, we assume that the loss and alteration of large portions of suitable habitat have translated to a decline in population numbers. For example, the Palouse Prairie region (referred to in this plan as the Palouse Grasslands), centered around Pullman, Washington, and Moscow, Idaho, underwent a rapid and extensive conversion to agricultural lands around 1880 prior to significant botanical surveys of the area. It is estimated that more than 99 percent of the original Palouse Prairie and 47 percent of the Channeled Scablands habitat has been lost (Noss *et al.* 1995, p. 58), with obvious ramifications for *S. spaldingii*. Other areas such as the Canyon Grasslands have undergone a less dramatic land-use conversion, but have been and continue to be affected by adverse livestock grazing and trampling, and nonnative plant invasions.

Four population extirpations or probable extirpations have been documented since tracking of *Silene spaldingii* began in the early 1980's, with an additional three populations that are assigned element occurrence rankings of F in Natural Heritage Program datasets, indicating subsequent surveys by qualified botanists have failed to find *S. spaldingii* individuals (Schassberger 1988, p. 26; Gamon 1991, pp. 11-13; ONHP 2006; ICDC 2007; MNHP 2007; WNHP 2007; J. Holt, WNHP, *in litt.* 2007; summarized in USFWS 2007). At least three other sites that formerly supported the species have been documented as having no plants present at the last visit (J. Holt, *in litt*. 2007). Populations are not necessarily considered extirpated, however, if sites are revisited and *S. spaldingii* is not found, because plants at these sites may be exhibiting prolonged dormancy (see discussion in Section D, Life History and Ecology, below). Subsequent visits are needed to confirm extirpations at these sites.

Because of its prolonged dormancy, monitoring *Silene spaldingii* to track trends requires long term data sets. The only area where monitoring has occurred for a long enough time period to begin detecting trends is at the Dancing Prairie in Montana where the plant has been monitored in 1991, 1992, 1993, 1994, 1995, 1996, 2003, 2004, 2005, and 2006 (Lesica 2005, p. 2; Lesica and Crone 2007, Table 1). The mean density of *S. spaldingii* over this time period shows a statistically significant downward trend. The authors suggest this may be a true downward trend, the trend may be linked to a drought in the latter half of the 10 year period, or the trend may actually be an increase in prolonged dormancy since 1991-1996 (Lesica 2005, pp. 2-3).

D. LIFE HISTORY AND ECOLOGY

At the end of the first 5 years of a demography study, 72 percent of *Silene spaldingii* plants remained alive (Lesica 1997, p. 355), suggesting that individuals may regularly reach an age of at least 15 to 20 years. However, it is hypothesized some individuals may live up to 30 years of age or longer. Seedlings generally sprout in spring, form rosettes the first year, and occasionally flower the second year (Lesica 1995, p. 6), but generally flowering does not occur until during or after the third season (Lesica 1997, p. 348). Adult plants emerge in spring, usually May, as either a stemmed plant, a rosette, or occasionally as a plant with both rosette(s) and stem(s) (Hill and Weddell 2003, p. 1). Stemmed plants may remain vegetative or may become reproductive in July or August. Plants senesce or wither in fall (September or October), reappearing the next spring (Hill and Gray 2004a, p. 44).

A demographic study in Montana found *Silene spaldingii* exhibits prolonged or summer dormancy (Lesica and Steele 1994, p. 210; Lesica 1997, p. 349); that is, plants can remain below the ground, without leaves, for up to 6 years when conditions are unfavorable (Lesica and Crone in review, p. 10). In one study plants were found to exhibit prolonged dormancy for 1 year 76 percent of the time and for 2 years 16 percent of the time (Lesica and Crone in review, p. 10). Another demographic study in Idaho across 5 years (2002 to 2006) found only 21 of 150 plants had dormant periods, 20 plants were dormant for 1 year, and 1 plant was dormant for 2 years (J. Hill, ICDC, *in litt.* 2007a, p. 2).

The Montana study concluded that prolonged dormancy increases *Silene spaldingii*'s fitness and may be a way to obtain below-ground resources that limit the production of flowers or fruits (Lesica and Crone in review, p. 11). This increased fitness in dormant plants was assumed since dormant plants had similar survival and growth, and were more likely to flower the following year compared to vegetative plants, resulting in a greater reproductive value associated with the dormant state (Lesica and Crone in review, pp. 1, 10, 11). Discriminant function analysis showed that prolonged dormancy was dependent on both external (precipitation) and internal (life history stage) factors; that is, prolonged dormancy was associated with the plant having flowered the previous year and following high summer (July through September) precipitation and lower fall (October) precipitation the previous year (Lesica and Crone in review, pp. 1, 2, 10, and 11). In contrast, two demographic studies in the Canyon Grasslands of Idaho found equal numbers of vegetative and reproductive plants become dormant the following year; and after dormancy two to three times more individuals emerge as vegetative plants than as reproductive plants (results from Lichthardt and Gray 2003; Gray and Lichthardt 2004; Hill and Gray 2005a; and summarized in Gray and Hill 2006, Appendix 1).

A demographic study in the Canyon Grasslands of Idaho conducted for 5 years on *Silene spaldingii* (2002 to 2006) (Hill and Weddell 2003; Hill and Gray 2004b; Hill and Gray 2005b; Hill 2006; J. Hill, *in litt.* 2007a) included two monitoring periods during each growing season, once early in the season soon after emergence (early June) and once late in the season at flowering time (early August). Most monitoring that has occurred for *S. spaldingii* has taken place only once, later in the season when individuals are flowering. Annual censuses at early sampling showed large proportions of the plants above ground were rosette plants (averaging 34 percent), the remainder were stemmed individuals. Annual censuses at the later sampling revealed large proportions of both stemmed and rosette plants had disappeared (39 percent). The majority of the plants that had disappeared (77 percent) were rosette plants. The authors performed demographic analyses on both early and late data sets to determine how demographic parameters would have differed. Monitoring only at flowering time would have resulted in an under-representation of the rosette plant stage class, under-representation of the total plants present, over-representation of dormancy and the duration of dormancy, and erroneous recruitment determinations (J. Hill, *in litt.* 2007a, p. 2). Another demographic study in the Canyon Grasslands of Idaho is showing similar results (Lichthardt and Gray 2003; Gray and Lichthardt 2004; Hill and Gray 2005a; Gray and Hill 2006). The demographic study in Montana found only a 10 percent difference between early and late monitoring (Lesica 2005, p. 1).

Prolonged dormancy of *Silene spaldingii* can make population estimates and monitoring difficult. In one demography study in Montana, dormancy varied from a yearly low of 11 percent of individuals dormant to a high of 74 percent

(Lesica 1997, p. 351). Long-term monitoring is necessary to accurately assess population trends of *S. spaldingii*. Due to this ability to go dormant, population estimates of *S. spaldingii*, if based on visible plants, will always be lower than the actual population size (P. Lesica, private consultant, *in litt.* 2003, pp.1-2).

Seed dispersal studies have not yet been conducted on *Silene spaldingii*. However, the capsules of *S. spaldingii* serve as an open cup from which seeds are likely carried by the wind, jostled out by passing wildlife, or tossed when plants are knocked over. Seeds are small, flat, and somewhat winged. Plant height and seed characteristics suggest that short-distance wind dispersal may be common. In addition, the sticky nature of the plant makes it possible for portions of the plant to break off and stick to the fur of passing animals. This method of seed dispersal is probably infrequent but may provide an opportunity for more long distance dispersal. No studies have investigated how long *S. spaldingii* seeds may remain dormant in the soil before they lose their viability or if they survive passage through the digestive tract of herbivores. A recent study on the closely related *S. douglasii* found high initial seed germination but that seed viability declines to about 20 percent after 7 to 8 years (Lofflin and Kephart 2005, p. 1695).

Two laboratory studies have looked at seed germination for *Silene spaldingii* (Lesica 1988a, 1993; A. Raven, Berry Botanic Garden, pers. comm. 2004). Both studies found an increase in germination after cold stratification (a period of chilling), suggesting germination occurs predominantly in the spring. However, results from a 4-week cold stratification period (Lesica 1988a, pp. 1-2, 1993, p. 198; 1997, p. 348) indicate some germination could occur in fall when shorter chilling periods would occur. Lesica's (1988a, p. 1) study found 5 percent germination after 35 days without cold stratification and 60 to 70 percent germination after a 30-day cold stratification. An 8-week versus a 4-week cold stratification period greatly enhanced germination (Lesica 1993, pp. 197-198). Preliminary results from the Berry Botanic Garden in Portland, Oregon, found the highest germination (86 percent) with an 8-week cold stratification treatment followed by growth in a germination chamber with alternating periods of time at temperatures of 10 and 20 degrees Celsius (50 and 68 Fahrenheit; thought to mimic night and day time temperature fluctuations) (A. Raven, pers. comm. 2004, p. 1).

In a demography study in Montana, Lesica (1997, p. 355) found that significant recruitment (germination and seedling survival) of *Silene spaldingii* occurred in only 2 of 7 years, indicating recruitment is a rare and sporadic event. A continuation of this study found significant recruitment in 3 of 13 years (Lesica and Crone in review, Figure 1). After germination, Lesica (1988a, p. 1) in Montana found seedlings began to grow immediately in small pots, continued growing for 2 months, remained green for another month, turned brown and went dormant for a month and a half, and then developed new leaves. It is hypothesized the initial growth would reflect early spring growth within native habitats, the dormant period would occur during the hot, dry summer, and re-growth would reflect fall growth (Lesica 1988a, p. 1). Another greenhouse study did not find the same dormant period: after germination seedlings grew for over a year and began bolting 13 months later (Hill *et al.* 2001, p. 8; Hill and Gray 2004a, p. 48).

Measuring new recruits (seedlings) of *Silene spaldingii* within native habitats can be problematic. Adult plants can produce rosettes that are similar to those of seedlings. Various characteristics have been used to distinguish adult rosettes from seedling rosettes, including: seedling rosettes with a conspicuous lack of stem material between leaves (Lesica 1997, p. 349; Hill and Weddell 2003, pp. 7-8; Hill and Gray 2004b, p. 48; Lesica 2005, p. 1) although this characteristic does not appear reliable (Hill and Weddell 2003, pp. 7-8), seedling rosettes with hairless leaves (Hill and Gray 2000, p. 6; Hill and Weddell 2003, p. 8), seedling leaves with hairs only along the edges (Hill and Gray 2004b, p. 48), nearly hairless seedling rosettes (P. Lesica, *in litt.* 2006, p. 2), seedling rosette leaves not being opposite or equal sized as they are in adult rosettes (P. Lesica, *in litt* 2006, p. 2), and leaf size (Hill and Weddell 2003, p. 8). None of these techniques are definitive and persons performing monitoring for the species should be aware of this constraint. A demographic study in Idaho has concluded no diagnostic anatomical features could be identified to distinguish seedling rosette plants from older rosette plants and therefore made the distinction based on long-term monitoring. A rosette plant that appeared at a location where no plant had occurred in the previous 3 years was considered a seedling (J. Hill, *in litt.* 2007a, p. 1).

Silene spaldingii reproduces only by seed, with no means of vegetative reproduction (spread by vegetative growth) (Lesica 1993, p. 194). The species is partially self-compatible, meaning the pollen is capable of fertilizing the female reproductive structures on the same plant. Flowers of *S. spaldingii* contain both male (stamen) and female (pistil) parts. However, the male parts mature, shed pollen, and wither prior to the female parts of the same flower becoming receptive (Lesica 1988b, p. 2). This reduces the chances of self-pollination within an individual flower, but still allows for pollination between different flowers on the same plant.

Using mesh bags to exclude pollinators, Lesica (1993, pp. 195-200) found significant decreases in fruit development, the number of seeds produced per fruit, germination after both a 4- and 8-week cold stratification period, seedling survival, and juvenile growth. Low pollinator visitation rates and a pollinator shifting more readily from *Silene spaldingii* to another plant species (lower pollinator constancy) were both correlated with reduced fruit set in *S. spaldingii* (Lesica and Heidel 1996, p. 9). Lesica and Heidel (1996, p. 9) found pollinator constancy and visitation rates were lower at sites where large displays of flowers competed for the primary pollinator, the bumblebee *Bombus fervidus*. Observational data at Garden Creek found *B. fervidus* switching from *S. spaldingii* to *Hypericum perforatum* (St. Johnswort), suggesting that *H . perforatum* will compete with *S. spaldingii* for pollinator services (Lesica and Heidel 1996, p. 8 and 11). Collectively these studies suggest that *S. spaldingii* reproduces best when outcrossing occurs, pollinators are essential in maintaining the fitness of *S. spaldingii*, adjacent invasive nonnative plants may negatively affect reproduction, and pollinators must consistently visit *S. spaldingii*.

Pollinators were observed for over 30 hours, both during the day as well as the night, at each of five *Silene spaldingii* populations across the range of the species, one in Idaho, one in Montana, one in Oregon, and two in Washington (Lesica and Heidel 1996, p. 5). The populations selected occurred in relatively intact habitat with at least 100 plants in a population. Across populations, the bumblebee *Bombus fervidus* accounted for over 83 percent of all visitations (Lesica and Heidel 1996, p. 7). Other pollinators included solitary bees from the Halictidae family (*Lasioglossum ovaliceps*, *Halictus tripartitus*, *Dienoplus rugulosis*, *Lasioglossum* spp.), one wasp visit, and a minor contribution from a night-pollinating moth species in Oregon (Lesica and Heidel 1996, p. 7).

Bombus fervidus is known from southern Canada and most of the United States, except the extreme south (Thorp *et al.* 1983, p. 27). The species is common within grasslands but rare in wooded foothills, and tends to build its nests either on or just below the surface of the ground, generally within the first 0.3 meters (1 foot) of soil (Hobbs 1966, p. 34). The queen emerges from hibernation in spring and establishes a seasonal colony that can contain over 200 individuals by fall (Hobbs 1966, p. 37). In California, the queen flies from early April to late October, workers from early May to late October, and males from early July to early October (Thorp *et al.* 1983, p. 27). *Bombus* species are generally less faithful to a particular plant species than honey bees (*Apis* spp.) within a foraging trip and do not specialize on pollination of any one species or group of plant species; in other words, they utilize a wide range of plant species for nourishment (Stephen *et al.* 1969, p. 118).

The distance that pollinators can travel is significant to plants because pollen transfer and seed dispersal are the only mechanisms for genetic exchange. In general pollinators will focus on small areas where floral resources are abundant; however, occasional longer distance pollination will occur, albeit infrequently. No research has been conducted on flight distances of *Bombus fervidus*, but one study documented that bees fly 1 kilometer (0.6 mile) or less (Steffan-Dewenter and Tscharntke 1999, pp. 434-435). In another study, the bumblebee *Bombus terrestris* did not fly more than a distance of 621 meters (2,037 feet; Osborne *et al.* 1999, pp. 524-526). Another bumblebee-pollinated plant species, *Scabiosa columbaria* (dove pincushions), experienced decreased pollen flow at a patch isolation distance of 25 meters (82 feet), and little to no pollen transfer when patches were isolated by 200 meters (656 feet) (Velterop 2000, p. 65).

In contrast, another study found that displaced *Bombus terrestris* species were able to return to their nests from distances over 9 kilometers (5.6 miles) (Goulson and Stout 2001, p. 108). One study found that *B. terrestris* workers were recaptured while foraging on super-abundant resources at distances of 1.75 kilometers (1.1 miles) from the nest (Walther-Hellwig and Frankl 2000, p. 303). One study that looked at genetics of fragmented populations of the rare plant *Scutellaria montana* (large-flowered skullcap) hypothesized a maximum distance over which pollen dispersal rates were high enough to counteract genetic drift at 8 kilometers (5 miles), and higher levels of selfing due to an absence of pollinators at only 2 kilometers (1.2 miles) (Cruzan 2001, p. 1578). These studies suggest variability in the distances over which pollen transfer may occur. *Silene spaldingii* populations are generally small and therefore do not represent "super-abundant" resources. We expect that most pollen exchange will be rare for distances over 1.6 kilometers (1 mile). This is one of the rationales we used when grouping *Silene spaldingii* sites within 1.6 kilometers (1 mile) of one another as populations. Recently the Washington Natural Heritage Program increased its separation distances of element occurrence records from 1 to 2 kilometers (0.6 to 1.2 miles) based on further research into pollinator flying distances (J. Holt, *in litt.* 2006).

Baldwin and Brunsfeld (1995) did a preliminary genetic analysis of *Silene spaldingii*. Leaf samples were taken from five sites, one in Idaho, one in Montana, one in Oregon, and two in Washington. Samples were collected during a year with low precipitation when many plants remained dormant and consequently sample sizes were small. All sites where material was collected were known to have at least 200 individuals in good years. This study (Baldwin and Brunsfeld 1995, p. 4) found that genetic diversity of *S. spaldingii* was comparable to that of other rare *Silene* (*S. regia* [Dolan 1994, pp. 968-970] and *S. hawaiiensis* [Westerbergh and Saura 1994, pp. 1489-1492]). The only exception was that the Dancing Prairie site in Montana had lowered genetic diversity. This finding is consistent with the results of Lesica and Heidel (1996, p. 7), who reported lower pollinator visitation rates and a higher incidence of fruit abortion at the Dancing Prairie site. Baldwin and Brunsfeld (1995, pp. 2-3) also suggested that genetic diversity varies across the species' range, indicating that sites throughout the range of *S. spaldingii* need to be protected in order to preserve the full array of genetic variability within the species.

E. Habitat Characteristics/Ecosystems

Silene spaldingii occurs at elevations between 365 to 1,615 meters (1,200 to 5,300 feet) (ONHP 2006; ICDC 2007; MNHP 2007; WNHP 2007; summarized in USFWS 2007). In general summers are hot and dry, while winters are cool to cold and moist across the range of *S. spaldingii* (Western Regional Climate Center 2003a, pp. 2, 6, 10, 17); anywhere from 45 to 65 percent of the precipitation occurs during the winter months (Daubenmire 1942, p. 59). A drought period occurs in mid and late summer when precipitation is minimal and temperatures are high (Tisdale 1983, p. 230). Consequently, most of the vegetation does not grow in summer, but can remain active during the winter months when moisture is more readily available. The majority of growth, however, occurs in spring (Daubenmire 1970, p. 6). *Silene spaldingii* is different; it grows during the summer drought when the majority of the surrounding vegetation is dormant.

Annual precipitation ranges from 254 millimeters (10 inches) near Odessa, Washington, to 610 millimeters (24 inches) near Moscow, Idaho (Western Regional Climate Center 2003b, pp. 1-2, 13-14). Mean annual temperature ranges from a low of 6 degrees Celsius (43 degrees Fahrenheit) at Enterprise, Oregon, to 13 degrees Celsius (55 degrees Fahrenheit) at Wawawai, Washington (Hill and Gray 2004a, p. 34). Average temperatures can vary significantly from winter to summer and from day to night. These are general climatic parameters; variations across the range of *S. spaldingii* can be dramatic and are heavily influenced by elevation, geography, and topography (Hill and Gray 2004a, p. 34-35).

Silene spaldingii is generally found in deep loamy soils (fertile soils composed of organic material, clay, sand, and silt) and in more mesic, moist sites such as northern slopes, swales, or other small landscape features (Hill and Gray 2004a, pp. 23-24). These mesic sites are highly productive, with total plant cover and forage dry weight sometimes three times greater than drier, more shallowly soiled bluebunch wheatgrass (*Pseudoroegneria spicata*) communities (Johnson and Simon 1987, p. 9). Soils in the tri-state (Idaho, Oregon, and Washington) area are loess (wind-dispersed) and ash (from volcanic eruptions) influenced (Tisdale 1986b, pp. 1-2; Johnson and Simon 1987, pp. 8-9), while soils in Montana are more glacially influenced (Schassberger 1988, p. 48). *S. spaldingii* is found on a wide range of slopes, from flat areas to slopes as great as 70 percent. Most occurrences are found on grades ranging from 20 to 40 percent slope (Hill and Gray 2004a, p. 24), although this may be an artifact of where intact habitat has not been converted to other uses.

Silene spaldingii is found primarily within the more mesic grasslands of the Pacific Northwest Bunchgrass association/type, extending from Washington and Oregon into parts of Montana and into adjacent British Columbia, and Alberta, Canada (Tisdale 1983, p. 223). This area has mistakenly, at times, been broadly described as the "Palouse Prairie" or the Palouse region (Tisdale 1983, p. 223; Lichthardt and Moseley 1997, p. 1; U.S. Fish and Wildlife Service 2001, p. 51598). The term "Palouse Grasslands" will be used in this recovery plan to delineate a much narrower area than that covered by the Pacific Northwest Bunchgrass Grasslands (Figure 4). Pacific Northwest bunchgrasses where *S. spaldingii* is found are characterized by either *Festuca idahoensis* (Idaho fescue) or by both *F. idahoensis* and *Pseudoroegneria spicata* (bluebunch wheatgrass) and *Festuca idahoensis* (Idaho fescue) in Idaho, Oregon, and Washington; and with *Festuca idahoensis* sometimes co- or subdominant with *Festuca scabrella* (rough fescue) in Montana (Tisdale 1983, p. 225). The summer drought across *S. spaldingii*'s range prevents tree species from establishing in most *S. spaldingii* habitats and results in a climax grassland community (Daubenmire 1968, pp. 432, 437-438). Exceptions include the Dancing Prairie in Montana and Turnbull National Wildlife Refuge in Washington. At the Dancing Prairie site it is thought that tree establishment is probably prevented by a combination of summer drought, competition with grasses, and wildfire (P. Lesica, *in litt.* 2007a, p. 1).

Primary grassland habitat types within the Pacific Northwest bunchgrass grasslands include: 1) *Festuca idahoensis – Symphoricarpos albus* (snowberry); 2) *Festuca idahoensis – Rosa* spp. (rose); 3) *Festuca idahoensis – Koeleria cristata* (prairie junegrass); 4) *Pseudoroegneria spicata – Festuca idahoensis* or *Festuca idahoensis – Pseudoroegneria spicata*; and 5) *Festuca scabrella* (Daubenmire 1970, pp. iii-iv; Mueggler and Stewart 1980, p. 5; Tisdale 1986b, pp. 16-18; Johnson and Simon 1987, pp. 29-31). Primary shrub habitats include: 1) *Artemisia tridentata* (big sagebrush) – *Festuca idahoensis*; and 2) *Artemisia tripartita* (three-tip sagebrush) – *Festuca idahoensis*. Primary forest habitat types include: 1) *Pinus ponderosa* (ponderosa pine) – *Festuca idahoensis*; and 2) *Pinus ponderosa – Symphoricarpos albus*. In 2004, 73 percent of known *Silene spaldingii* occurrences are within grassland habitat types, 20 percent within shrub-steppe habitat types, and 7 percent within forest habitat types (summarized by Hill and Gray 2004a, p. 37). Although the recent discovery of several new sites in the shrub-steppe of the Canyon Grasslands significantly increases the number of plants and sites in this habitat type. Some of the most difficult nonnative invasive plants to control in *Silene spaldingii* habitat include *Cardaria draba* (whitetop), *Centaurea maculosa* (spotted knapweed), *Centaurea solstitialis* (yellow starthistle), *Chondrilla juncea* (rush skeletonweed), *Euphorbia esula* (leafy spurge), *Hypericum perforatum* (St. Johnswort), *Linaria dalmatica* (Dalmatian toadflax), *Poa pratensis* (Kentucky bluegrass), and *Potentilla recta* (sulfur cinquefoil).

We have split the occupied habitat of *Silene spaldingii* into five physiographic regions that are characterized by distinctive physical features. These regions are distinctive from one another in climate, plant composition, historical fire frequencies, and soil characteristics. These differences are significant in that they may translate into differences in life histories, habitat trends, consequences of fire suppression, and types of weed control as they apply to conservation of *S. spaldingii*. The five physiographic regions utilized in this recovery plan are:

1. the **Blue Mountain Basins** in northeastern Oregon;
2. the **Canyon Grasslands** along the Snake, Salmon, Clearwater, Grande Ronde, and Imnaha Rivers in Idaho, Oregon, and Washington;
3. the **Channeled Scablands** of east-central Washington;
4. the **Intermontane Valleys** of northwestern Montana; and
5. the **Palouse Grasslands** in southeastern Washington and adjacent west-central Idaho.

These regions are shown in Figure 4 above, and were delineated by taking the physiographic regions from Hill and Gray (2004a, Figure 3a) and relating the regions to the more widely used Level IV Ecoregions for each state (U.S. Environmental Protection Agency 2004, p. 1). The only *S. spaldingii* populations that did not fit well into the regions characterized in Figure 4 were those on Clear Lake Ridge in Oregon and those at Lost Trail National Wildlife Refuge in Montana. The Clear Lake Ridge populations will be included with the Blue Mountain Basins here instead of the Canyon Grasslands, as pictured in Figure 4, and the Lost Trail populations are included within Montana’s Intermontane Valleys.

Of the five physiographic regions where *Silene spaldingii* is found, the habitat of the Canyon Grasslands is the most intact, largely because the canyon walls are steep and do not lend themselves to agricultural or urban developments. The Canyon Grasslands range widely in elevation, as evidenced by the presence of Hells Canyon, the deepest canyon in the United States at a depth of 2,400 meters (7,900 feet; Alt and Hyndman 1989, p. 193). The dramatic range in elevation within the Canyon Grasslands results in marked variations in the climate and vegetation. Soils within the Canyon Grasslands range from solid bedrock cliffs to deep loess and ash deposits (Alt and Hyndman 1989, p. 175).

Within the Canyon Grasslands, *Silene spaldingii* is found at the lowest and highest elevations rangewide from 365 to 1,615 meters (1,200 to 5,300 feet) (ICDC 2007; summarized in USFWS 2007), generally on northerly slopes that support more mesic *Festuca idahoensis* communities. At higher elevations (over approximately 1,525 meters [5,000 feet]) in the Canyon Grasslands the northern slopes are inhabited by tree species and *S. spaldingii* is found on southern slopes where bunchgrass communities reside. Because of their steep topography, the Canyon Grasslands are the most undersurveyed area for *S. spaldingii,* and also represent the area where large populations of *S. spaldingii* may be most easily conserved because they are more removed from human influence.

The Channeled Scablands are similar to the Palouse Grasslands with an underlying basalt layer covered by deep deposits of loess and ash, forming long undulating dune-like plains of rich soils; except that massive flooding, associated with bursting ice dams in the last ice age 12,000 to 16,000 years ago, has scoured portions of the area (Mueller and Mueller 1997, p. 29). This scouring has created a network of various habitats (loess islands surrounded by flood channels) that is far less consistent than the deep soil deposits of the Palouse Grasslands. Soils vary from basalt bedrock outcroppings to fertile loess and ash deposits to flood deposits (Daubenmire 1970, p. 6). An interesting landscape feature of the Channeled Scablands is referred to as “biscuit and swale” topography, commonly used to describe small biscuit-like loess mounds that are 1 meter deep by 5 meters in diameter (3 feet deep by 15 feet in diameter) and are regularly dispersed over scablands or bare tracts of basalt outcrops (Daubenmire 1970, pp. 6-7). Like the Palouse Grasslands, the large loess islands that remain in the Channeled Scablands are fertile and consequently have been largely converted to agriculture. The forested portion of the Channeled Scablands is a mosaic of forest / non-forest, and *S. spaldingii* plants occur in the non-forested microsites.

Silene spaldingii is reported to be primarily associated with relict flood channels within the Channeled Scablands (see Figure 4). More specifically, *S. spaldingii* is generally found on northern facing slopes below talus or rock outcroppings, gentle northern slopes just above valley floors, or on the northern sides of biscuits (B. Benner, U.S. Bureau of Land Management [USBLM], *in litt.* 1993, pp. 1-5). The species is found at elevations from 472 to 747 meters (1,550 to 2,450 feet) within the Channeled Scablands. Since we lack earlier botanical surveys, we do not know how much *S. spaldingii* may have formerly occurred within the loess islands between channels. However, its affinity for deep soils elsewhere indicates that habitat conversion has most likely reduced the number of plants found on these loess islands.

The Intermontane Valleys of northwestern Montana were glaciated more heavily than any other part of Montana. The valleys have been shaped by glacial activity associated with the continental ice sheet and the formation of Glacial Lake Missoula during the last ice age (Alt and Hyndman 1986, pp. 50-54). Topography in this region is characterized as "kettle and moraine." Kettles are steep-sided hollows without surface drainage and moraines are earth and stone deposits; both are formed by glacial flows.

Silene spaldingii populations within Montana are disjunct (separated by well over 160 kilometers [100 miles]) from *S. spaldingii* sites elsewhere. Plants have only been found near Eureka on the Tobacco Plains, in the Niarada and Flathead Lake area, and, most recently, on the Lost Trail National Wildlife Refuge. The species is found at elevations from 820 to 1,150 meters (2,700 to 3,800 feet) within the Intermontane Valleys. *S. spaldingii* is found in small isolated grasslands outside the larger valleys delineated in Figure 4, demonstrated by the recent discoveries at the Lost Trail National Wildlife Refuge. Within Montana, *Festuca idahoensis* is codominant or subdominant with *Festuca scabrella*, sometimes near the forest's edge.

The Palouse Grasslands, as delineated here (Figure 4), are extremely fertile and may comprise the world's best wheat land (Alt and Hyndman 1989, p. 190). An underlying basalt layer is covered with deep deposits of loess and ash, forming long undulating dune-like plains of rich soils. These soil deposits can reach depths of 105 to 140 meters (350 to 450 feet), although generally less (Mueller and Mueller 1997, p. 25), and have high moisture-holding capacity and water infiltration rates (Johnson and Simon 1987, p. 8). Occasionally tall granitic hills ("steptoes") protrude above the undulating dunes. Beginning in 1880, the Palouse Grasslands have undergone a dramatic conversion to farm lands; it is estimated that today only 0.1 percent of the grasslands remain in a natural state

(Noss *et al.* 1995, p. 2). The remains of the Palouse Grasslands include small remnants in rocky areas or at field corners (Daubenmire 1970, p. 1; Tisdale 1986a, p. 206). The Camas Prairie in Idaho between the Clearwater and Salmon Rivers is included with the Palouse Grasslands here because soil properties and land conversions are similar; however, the Camas Prairie is generally higher in elevation and cooler and moister than other portions of the Palouse Grasslands (Ertter and Moseley 1992, p. 62; Lichthardt and Moseley 1997, p. 5).

Silene spaldingii within the Palouse Grasslands is restricted to small fragmented populations ("eyebrows[4]," field corners, cemeteries, rocky areas, and steptoes) on private lands, and in larger remnant habitats such as research lands owned by Washington State University. Elevations occupied by *S. spaldingii* within the Palouse Grasslands range from 700 to 1,340 meters (2,300 to 4,400 feet). Of all the places where *S. spaldingii* resides, those in the Palouse Grasslands are the most threatened, and care is needed to maintain occupied sites and representative genetic material from these sites.

The Blue Mountain Basins were once contiguous Pacific Northwest Bunchgrass Grasslands. Today much of the Wallowa Valley has been converted into residential or urban areas surrounded by agricultural and grazing lands. Soils are composed of deep loess similar to the Palouse Grasslands or glacial till soils such as those at the head of Wallowa Lake.

Silene spaldingii ranges from 1,130 meters (3,700 feet) to 1,555 meters (5,100 feet) within the Blue Mountain Basins, specifically the Wallowa Valley (ONHP 2006, pp. 10, 14). The basin abuts habitat characterized as Canyon Grasslands, with no clear demarcation between the two regions. In the Blue Mountain Basins, *S. spaldingii* is often found along slopes of low broad ridges and ridgebrows, some with biscuit and swale topography (Hill and Gray 2004a, p. 25). Within the Wallowa Valley, habitat is highly dissected by urban and agricultural lands. A large *S. spaldingii* population (over 500 individuals) occurs at the end of Wallowa Lake. This population is the largest occurring on private land, other than land owned by The Nature Conservancy, and is threatened by urban development.

[4] "Eyebrows" are patches of prairie that occur along rocky ridges that were too steep to farm. They appear as "eyebrows" on the landscape because they have more vegetation than the surrounding farmlands.

Rangewide suitable habitat for *Silene spaldingii* would include all flat, east facing, northern facing, and even southern facing (at higher elevations) slopes between 365 to 1,615 meters (1,200 to 5,300 feet) in elevation within *Festuca idahoensis* and *Festuca scabrella* communities that are associated with Pacific Northwest bunchgrasses, sagebrush-steppe, and open pine forests. However, even within what is presently understood to be suitable habitat, *S. spaldingii* is quite infrequent (rare). If another habitat parameter was identified that would help to narrow the definition of suitable habitat for this species, field searches could become more focused. At present it appears that there are tracts of suitable habitat for *S. spaldingii* on private and public lands within the Canyon Grasslands, Channeled Scablands, and the Blue Mountain Basins. Identifying a mechanism to help facilitate searches on these lands may identify other large populations where conservation efforts could occur. There is little remaining habitat within the Palouse Grasslands, limiting the possibilities of finding significant new *S. spaldingii* populations. Within the Intermontane Valleys there are large areas of apparently suitable habitat, but much of it has been searched, and it is thought that new discoveries of populations with over 1,000 individuals are unlikely (P. Lesica, *in litt.* 2006, p. 2).

F. Associated Species of Conservation Concern

Rare animal species that occur within the range of *Silene spaldingi* include the Columbian sharp-tailed grouse (*Tympanuchus phasianellus columbianus*). Rare endemic plant species include *Aster jessicae* (Jessica’s aster), *Astragalus riparius* (Piper’s milk-vetch), *Calochortus macrocarpus* var. *maculosus* (green-band mariposa lily), *Calochortus nitidus* (broad-fruit mariposa), *Cirsium brevifolium* (Palouse thistle), *Polemonium pectinatum* (Washington polemonium), *Pyrrocoma liatriformis* (Palouse goldenweed), *Rubus nigerrimus* (Northwest raspberry), and *Trifolium plumosum* var. *amplifolium* (plumed clover) (Hill and Gray 2004a, Tables 9-12A). Many of these species face the same impacts as does *S. spaldingii* and some are more restricted in distribution. Conservation activities implemented through this recovery plan should, whenever possible, include measures for conservation of the rare species listed above.

G. REASON FOR LISTING/THREATS ASSESSMENT

Section 4(a)(1) of the Endangered Species Act identifies five factors or categories of threats that are considered when making listing, delisting, or reclassification decisions. In the narrative threat assessment that follows, we have classified the threats to *Silene spaldingii* according to these five factors, which are as follows:

Factor A — The present or threatened destruction, modification, or curtailment of habitat or range;
Factor B — Overutilization for commercial, recreational, scientific, or educational purposes;
Factor C — Disease or predation;
Factor D — The inadequacy of existing regulatory mechanisms; and
Factor E — Other natural or man-made factors affecting the continued existence of a species.

1. Invasive Nonnative Plants (Factor A)

Invasive nonnative plants (weeds) are called the “silent invaders” because they subtly invade and alter diverse native communities into nonnative plant monocultures that support little wildlife. For example, in Idaho over the last 30 years, *Centaurea solstitialis* (yellow starthistle) has increased from a few small patches to 120,000 hectares (300,000 acres) (Westbrooks 1998, p. 3). Since the 1960s, *Chondrilla juncea* (rush skeletonweed) has expanded in Idaho from 16 hectares (40 acres) to more than 1,600,000 hectares (4,000,000 acres) (Westbrooks 1998, p. 3). *Centaurea maculosa* (spotted knapweed) is considered to be “the number one weed problem on rangeland in western Montana” (Whitson *et al.* 1996, p. 89) and has infested more than 1,900,000 hectares (4,700,000 acres) in the State (Westbrooks 1998, p. 4). In southeastern Washington, *Centaurea solstitialis* has increased from 400 hectares (1,000 acres) in 1954 to more than 56,650 hectares (140,000 acres) (Westbrooks 1998, p. 8).

Many experts believe that following habitat destruction, invasive nonnative plants are the next greatest threat to biodiversity (Randall 1996, p. 370). Nonnative plant invasions have been identified by numerous individuals working with *S. spaldingii* as one, if not the largest, of the threats facing the species and its habitat (Hill and Gray 2004a, p. 100). Invasive nonnative plants alter different attributes of ecosystems including geomorphology, fire regime, hydrology, microclimate, nutrient cycling, and productivity (for a good summary see Dukes and Mooney 2004).

Invasive nonnative plants detrimentally affect native plants through competitive exclusion, altering pollinator behaviors, niche displacement, hybridization, and changes in insect predation; examples are widespread among taxa and locations or ecosystems (D'Antonio and Vitousek 1992, pp. 65-66, 68-71; Olson 1999 p. 2, 7-11; Mooney and Cleland 2001, pp. 6-9). Rare plants with already small and fragmented populations can be particularly vulnerable to adverse effects from invasive nonnative plants. For example, invasive nonnative annual grasses (including *Bromus* spp.) significantly increased mortality and decreased survivorship, plant size, and reproductive output in an endangered annual herb (*Amsinckia grandiflora* [large-flowered fiddleneck]) (Pavlik *et al.* 1993, p. 520). In another study, Huenneke and Thomson (1995, p. 423) found that competition from *Dipsacus sylvestris* = *Dipsacus fullonum* ssp. *sylvestris* (teasel), an invasive nonnative plant, negatively affected growth and seedling recruitment in the threatened *Cirsium vinaceum* (Sacramento Mountains thistle). In Montana, Lesica and Shelly (1996, p. 118) found that *Centaurea maculosa* reduced recruitment and population growth of the rare *Arabis fecunda* (Mt. Sapphire rockcress). Rangelands throughout the range of *S. spaldingii* have been broadly affected by nonnative plant invasions, with consequent effects upon community composition, resource availability, pollinator dynamics, and fire frequency. The effects of invasive nonnative plants on *S. spaldingii* have been addressed qualitatively by a few studies as discussed below, but further research is needed to determine details of how invasive plants may affect the demography of *S. spaldingii* populations at different life stages and which invasive species pose the most significant threat.

Annual invasive nonnative grasses co-occur with *Silene spaldingii* at most populations and pose a threat to the species in most locations except northwest Montana where annual grass invasions are not as prolific. The annual invasive grasses are most commonly represented by *Bromus japonicus* (Japanese brome), *Bromus secalinus* (cheat), *Bromus tectorum* (cheatgrass), and *Ventenata dubia* (ventenata) (Hill and Gray 2004a, pp. 67-69). *Bromus tectorum*, for example, has contributed to the widespread degradation of native rangelands throughout the western United States. Due to its ability to germinate readily under a wide variety of environmental conditions, *Bromus tectorum* is extremely difficult to eradicate once established in native plant communities (Franklin and Dyrness 1988, p. 211). In rangelands that are dominated by *Bromus tectorum*, seedling establishment of native perennial species may be limited by *Bromus tectorum*'s ability to compete for moisture (Young 1994). And most significantly, invasive nonnative grasses alter natural fire regimes (D'Antonio and Vitousek 1992, p. 72-77; see Section G-3).

Rhizomatous[5] invasive nonnative plants, because of their deep and extensive root systems, are the most difficult invasive nonnative plants to remove from *Silene spaldingii* habitat, often requiring persistent herbicides for control. Persistent herbicides, such as picloram products, remain in the soil longer where they may be transported and affect non-target plant species (Cox 1998, pp. 17-18), such as *S. spaldingii*. Co-occurring rhizomatous species include *Acroptilon repens* (Russian knapweed), *Chondrilla juncea* (rush skeletonweed), *Cirsium arvense* (Canada thistle), *Euphorbia esula* (leafy spurge), *Hypericum perforatum* (St. Johnswort), *Linaria dalmatica* (Dalmatian toadflax), and *Poa pratensis* (Kentucky bluegrass) (Hill and Gray 2004a, pp. 67-70).

Like the invasive nonnative annual grasses, a common strategy employed by invasive nonnative plants is to produce copious quantities of seeds. These species are difficult to control because seeds are capable of quickly spreading to new *S. spaldingii* habitats. Prolific seeding invasive nonnative plants found within or near *S. spaldingii* include *Acroptilon repens*, *Centaurea solstitialis*, *Centaurea diffusa* (diffuse knapweed), *Centaurea maculosa*, *Chondrilla juncea*, *Dipsacus sylvestris* (teasel), *Hypericum perforatum*, and *Potentilla recta* (Hill and Gray 2004a, p. 67). Some of these species are also rhizomatous, making them doubly difficult to control.

Some of these invasive nonnative plants can invade and displace native plant communities in a relatively short period of time. For example, at Garden Creek Ranch, the largest *Silene spaldingii* population in Idaho (ICDC 2007, Element Occurrence 005; summarized in USFWS 2007), *Centaurea solstitialis* spread from approximately 60 hectares (150 acres) in 1987 to 810 hectares (2,000

[5] "Rhizomatous" plants have rhizomes, horizontal underground stems with leaves and buds that serve as a means of vegetative propagation. Such plants are particularly difficult to eradicate, as the rhizomes (and thus the plant) often survive most traditional methods of plant removal.

acres) in 1998 (J. Hill, *in litt.* 1999, p. 3; Hill and Gray 1999, p. 100). Another roadside *S. spaldingii* site in Idaho (Lawyer's Creek) was apparently extirpated as a result of the disturbance caused by highway construction in 1990 and the subsequent invasion of *Centaurea solstitialis* (Lichthardt 1997, p. 7).

Centaurea solstitialis is found in the vicinity of all *Silene spaldingii* populations in Idaho (Lichthardt 1997, p. 12). This aggressive and invasive nonnative plant can form almost complete monocultures, invading and outcompeting native species. Even small areas that experience soil disturbance are almost immediately colonized by *Centaurea solstitialis* or other invasive nonnative winter annuals (Lichthardt 1997, p. 12). The seeds of *Centaurea solstitialis* can remain dormant in the soil for 10 years (Callihan and Miller 1997, p. 59), making effective control of this invasive nonnative plant difficult. Originally it was thought that *Centaurea solstitialis* only invaded southerly and flat aspects, and that it could not invade northerly slopes because of limited light during winter months (Roché 1965). However, in recent years *Centaurea solstitialis* has invaded several northern slopes that support *S. spaldingii* in the Canyon Grasslands (Hill and Gray 2000, p. 14) and may be expanding its ecological amplitude.

A 2-year study investigating the effects of invasive nonnative plants, such as *Centaurea solstitialis*, on *Silene spaldingii* at Garden Creek Ranch did not find any appreciable differences in plant vigor between invaded and uninvaded sites (Menke 2003, p. 35). However, most *S. spaldingii* individuals in this study were at least 2 meters (6.5 feet) away from *Centaurea solstitialis* and *Bromus tectorum* infestations and may not have experienced significant competition. The researcher proposed that mature *S. spaldingii* individuals and the invasive nonnative plants may also partition resources differently in space or time; effects of invasive nonnative plants upon recruitment of *S. spaldingii* seedlings are potentially important to population viability but were not measured in this study. Another study found that high levels of invasive nonnative plant cover (predominantly *Bromus secalinus*, *Hypericum perforatum*, and *Ventanata dubia*) were associated with less vigorous occurrences of *S. spaldingii* at the Fairchild Air Force Base in Washington (Caplow 2002a, p. 8). Further research is needed on the specific effects of nonnative plant invasions upon *S. spaldingii*.

Competition with other plant species for a limited number of pollinators, particularly competition with invasive nonnative plants, has the potential to adversely affect both fecundity and individual fitness in *S. spaldingii* (Lesica and Heidel 1996, p. 10). These deleterious effects occur: (1) when insects switch from one plant species to another resulting in a transfer and loss of pollen to a second species, and (2) because insects will demonstrate preferences for plant species (including invasive nonnative plants) where resources are more easily obtained. That is, either a plant species is more abundant or the resources (pollen and nectar) a plant provides are more nutritive (Richards 1997, p. 148-152). For example, investigations have found visitation rates of the bumblebee *Bombus fervidus* are lower for *S. spaldingii* when it co-occurs with the invasive nonnative *Hypericum perforatum* (Lesica and Heidel 1996, p. 10).

Nonnative grasses such as *Agropyron cristatum* and *A. desortum* (crested wheatgrass), *Bromus inermis* (smooth brome), and *Poa pratensis* are used in rangeland revegetation within *Silene spaldingii* habitat. These grasses are used because they are broadly-adapted, widely available as seed, establish easily, are grazing tolerant, and provide competitive invasive nonnative plant control. Rangeland revegetation focuses on providing forage for livestock, erosion control, and watershed rehabilitation. However, there is an increasing body of research that demonstrates these nonnative grasses, in some instances, can decrease biodiversity and compete with native plants (summarized by Harrison *et al.* 1996, see especially *Poa pratensis*). For example, *Agropyron cristatum* stands in 1966 in southern Idaho had already persisted for 30 to 50 years and were spreading into adjacent habitats (Hull and Klomp 1966, p. 10; 1967, p. 226). Other studies have also found nonnative planted grasses invading adjacent native communities (D'Antonio and Vitousek 1992, pp. 69-70). In one study, a Snake River Plain endemic, *Lepidium papilliferum* (slickspot peppergrass) had decreased abundance in areas that had been planted with *Agropyron cristatum* (Scholten and Bunting 2001, p. 5-6). The planting of nonnative range grasses is thought to have eliminated habitat for *S. spaldingii* in several locations across its range (Hill and Gray 2004a, pp. 64-65), particularly in the Channeled Scablands (B. Benner, *in litt.* 1993, p. 5; B. Weddell, Draba Consulting, *in litt.* 2003, p. 6; WNHP 2007). Nonnative grasses are being planted at Corral Creek, near *S. spaldingii* sites in Idaho, and spreading along road corridors (K. Gray, ICDC, *in litt.* 2004, p. 3).

There is considerable discussion on how best to restore degraded sites within the arid West (Lesica and Allendorf 1999, Jones 2003, Roundy 2005). We recognize that native species may be more difficult to obtain and costly, and that successful invasive nonnative plant control and restoration with native species can be more difficult on arid sites or sites adjacent to invasive nonnative sites (Roundy 2005, p. 48). The use of nonnative restoration species and competition with rare species is not well understood. But, the examples in the preceding paragraph illustrate that caution is needed. For these reasons, nonnative restoration species should not be used for restoration near *S. spaldingii* sites unless previous greenhouse studies have shown that the nonnative restoration species will not compete with *S. spaldingii*.

2. Problems Associated with Small, Geographically Isolated Populations (Factors A, E)

Most populations of *Silene spaldingii* are restricted to small, remnant patches of native habitat (Gamon 1991, p. 16; Lichthardt 1997, p. 8; Hill and Gray 2004a, pp. 61-64; ONHP 2006; ICDC 2007; MNHP 2007; WNHP 2007). If populations are defined by grouping together sites within 1.6 kilometers (1 mile) of one another (a long distance for pollen transfer), there are 99 known populations of *S. spaldingii*. Of these 99 populations, 56 (57 percent) have fewer than 50 plants, and another 10 populations have 100 or fewer individuals, meaning that 67 percent of the populations have 100 or fewer individual plants overall (Figure 5) (summarized in USFWS 2007). Many of these small remnant populations exist within habitat that is generally further degraded by one or more of the threats listed here. Many *S. spaldingii* populations are isolated from other populations by large distances, and the majority occur at scattered localities separated by habitat that is not suitable for the species, such as agricultural fields. For example, extirpation appears to be certain for at least two isolated *S. spaldingii* populations in Idaho due to their small size and habitat degradation (Lichthardt 1997, p. 15). One of these populations consists of four individuals, and the other population has only one *S. spaldingii* plant. Even if the habitat was completely undisturbed, these populations would not be viable into the future. Small *S. spaldingii* populations have likely persisted due to prolonged dormancy and the relatively long life span of the plants, but the likelihood of future recruitment in these populations to replace senescent individuals is vanishingly small.

Figure 5. Known populations of *Silene spaldingii*.

Small populations are vulnerable to relatively minor environmental disturbances such as fire, herbicide drift, and nonnative plant invasions (Barret and Kohn 1991, p. 7; Gamon 1991, p. 28) and are subject to the loss of genetic diversity from genetic drift and inbreeding (Ellstrand and Elam 1993, p. 218). Genetic drift, more prevalent in small populations, is the loss of genetic diversity through chance mating events. Inbreeding occurs when plants "self" (fertilization occurs within the same individual) or when closely related individuals mate, thereby reducing genetic diversity. Populations with lowered genetic diversity are more prone to local extinction (Barrett and Kohn 1991, p. 4). Smaller populations generally have lower genetic diversity, and lower genetic diversity may in turn lead to smaller populations by decreasing the species' ability to adapt. Relatively low levels of genetic exchange (one migrant per generation) are generally considered sufficient to counteract the effects of genetic drift (Newman and Tallmon 2001, p. 1059).

Habitat fragmentation, similar to that which has occurred in the Palouse Grasslands and other habitats where *S. spaldingii* resides, has been documented as a problem for many rare species and even common species can be affected by habitat fragmentation (Honnay and Jacquemyn *in press*, p. 6). Often the fragments are not of sufficient size to support the natural diversity prevalent in an area (as summarized in Soulé 1987) and so exhibit a decline in native biodiversity (Noss and Cooperrider 1994, p. 52). Habitat fragments are often functionally smaller than they appear because edge effects impact the available habitat within the fragment (Lienert and Fischer 2003, p. 597), and intense agricultural practices will affect adjacent fragments (Boutin and Jobin 1998, p. 551). Habitat fragmentation has been shown to disrupt plant-pollinator interactions and predator-prey interactions (Steffan-Dewenter and Tscharntke1999, p. 437), and alter seed germination percentages (Menges 1991a, p. 160). Extensive habitat fragmentation, such as that seen in the Palouse Grasslands, can result in dramatic fluxes in available solar radiation, water, and nutrients (Saunders *et al.* 1991, pp. 20-22).

There are numerous examples of habitat fragmentation affecting native plant species. Reduced seed set, reduced plant-to-plant variability, and lower pollination intensity in smaller populations was found for a small forest herbaceous plant, *Primula elatior* (oxlip) (Jacquemyn *et al.* 2002, p. 622).

Lowered seed germination percentages were found in smaller prairie fragments of *Silene regia* (royal catchfly) (Menges 1991a, pp. 161-162). Within a heavily utilized agriculturally fragmented area, *Dianthus deltoides* (maiden pink) exhibited lowered diversity and abundance of both flowering plants and flower-visiting insects, as well as lowered seed set attributed to lower numbers of available pollinators (Jennersten 1988, p. 364). Plants that were less capable of self-fertilization showed strongly reduced population viability with pronounced extinction thresholds at high levels of fragmentation (Lennartsson 2002, pp. 3065-3067). This reduced population viability was attributed to inbreeding and reduced seed production as a result of low numbers of pollinators.

For plant populations that do not reproduce vegetatively, pollen exchange and seed dispersal are the only mechanisms for gene flow. Pollen exchange, because of the opportunity for more reliable and specific long distance dispersal, is thought to be the more important of these two mechanisms (Fenster 1991, pp. 420-421; Richards 1997, p. 147). Pollen dispersal in species requiring an insect for pollination, such as *Silene spaldingii*, is limited by the distance the pollinator can travel, in this case probably less than 1.6 kilometers (1 mile); see previous discussion in section D. Life History/Ecology). Reduced pollinator activity has been correlated with lowered reproductive success and possibly reduced genetic diversity for *S. spaldingii* (Lesica 1993, p. 198; Lesica and Heidel 1996, p. 9; Baldwin and Brunsfeld 1995, p. 3). Populations of *S. spaldingii* occupying small areas surrounded by lands that do not support bumblebee colonies (*e.g.*, crop lands) are not likely to persist over the long term (Lesica 1993, p. 199-200; Lesica and Heidel 1996, p. 11). In addition to agricultural conversion and pesticides, pollinators are vulnerable to plant herbicide applications, adverse domestic livestock grazing and trampling, and fire, and these potential impacts to pollinators must therefore be considered in conservation strategies for *S. spaldingii* (Gamon 1991, pp. 60-82; Lesica 1993, pp. 193, 199-200).

3. Changes in the Fire Regime and Fire Effects (Factor A)

Organisms adapt to disturbances such as historical fire regimes (fire frequency, intensity, and seasonality) with which they have evolved (summarized by Landres *et al.* 1999). Fire regimes within *Silene spaldingii* habitat in the western United States have been highly disrupted (Whisenant 1990, p. 4; D’Antonio and Vitousek 1992, pp. 74-75; Mutch *et al.* 1993, p. 2-4; Narolski

1996, pp. 5-6; Weddell 2001, p. 7; Hilty *et al.* 2004, p. 90). In some instances, fire suppression has allowed grasslands to be invaded by trees (Menges 1995, p. 7; Lesica and Martin 2003, p. 517). At the same time, in many grassland and shrub habitats fire frequencies have increased because of annual nonnative grass and forb invasions (Whisenant 1990, p. 4; D'Antonio and Vitousek 1992, p. 73; Hilty *et al.* 2004, p. 90). These annual nonnative invasive grasses and forbs fill gaps that would naturally occur between vegetation, dramatically increasing the ability of fire to spread. Annual nonnative invasive grasses are common within *S. spaldingii* populations everywhere except northwestern Montana (Hill and Gray 2004a, pp. 67-71, P. Lesica, *in litt.* 2006, p. 2). Seasonally, prescribed burns occur within *S. spaldingii* habitat during cool fall months as opposed to the hot summer months when fires would have historically burned (Hill and Gray 2004a, p. 58).

The effect of fire on *Silene spaldingii* and its habitat has been investigated in two areas: the Intermontane Valleys at Dancing Prairie in Montana (Lesica 1999; Lesica and Martin 2003) and the Canyon Grasslands at Garden Creek Ranch in Idaho (Hill and Fuchs 2003; Hill and Weddell 2003; Hill *et al.* 2001; Menke 2003; Hill and Gray 2004b; Menke and Muir 2004; Hill and Gray 2005b; Hill 2006; J. Hill, *in litt.* 2007a). *Silene spaldingii* and its habitat's fire response at these two sites have some similarities, but also some major differences. Both the Montana and Idaho studies found *S. spaldingii* adults were not killed by fires (Lesica 1999, p. 999; Hill and Weddell 2003, p. 23; Menke 2003, p. 52, Table 3.4; Hill and Gray 2004b, p. 55). Fire apparently broke prolonged dormancy, so that apparent plant numbers were higher the year subsequent to a fire in both Idaho and Montana (Lesica 1999, p. 999; Hill and Fuchs 2003, p. 4; Menke 2003, pp. 60-61), and more flowers were produced per plant after a fire (Lesica 1999, p. 999; Hill and Weddell 2003, p. 21), although fewer of these flowers developed mature fruit (Menke 2003, p. 62).

Study results differed between the sites in that in Montana, *Silene spaldingii* seedling recruitment was significantly higher after fire (Lesica 1999, pp. 998-999), whereas in Idaho it was not (Hill and Weddell 2003, p. 23; Hill and Gray 2004b, pp. 49, 55-58; Hill and Gray 2005b, p. 17; Hill 2006, p. 19). Several reasons may be responsible for this difference. First, habitat in Montana's Intermontane Valleys differs in that more litter accumulates in the presence of *Festuca scabrella* (over 11 centimeters [4.3 inches]) as opposed to the *Festuca* *idahoensis*-dominated grasslands in Idaho (1.3 centimeters [0.5 inch]) (Hill and Weddell 2003, p. 24; Hill and Gray 2004a, p. 57). Litter depth has been measured as deep as 20 centimeters (7.9 inches) at the Dancing Prairie Preserve in Montana (P. Lesica, *in litt.* 2007b). Greater litter depth may affect *S. spaldingii* seedling recruitment because it is difficult for seedlings to germinate under and grow through a dense litter layer (Lesica 1999, p. 1000). Second, the year after the experiment in Montana with experimental burns was one of the few years with significant recruitment in both burned and unburned areas (Lesica 1999, Figure 1; P. Lesica, *in litt.* 2006, p. 3; Lesica and Crone in review, Figure 1). Third, criteria for classifying rosette plants as adults or seedlings vary between the two studies (J. Hill, *in litt*. 2007b, p. 7). While fire appears necessary for maintaining grasslands and preventing tree and shrub encroachment in Montana (Lesica 1999, p. 997 and 1001), it may not be important in maintaining the drier grasslands within the Canyon Grasslands or Palouse Grasslands where a lack of moisture (Daubenmire 1968, p. 438; Daubenmire 1970, p. 8; Tisdale 1986a, p. 2; Weddell 2001, p. 27) is thought to have precluded tree and shrub invasion. Some think that the upper elevation grasslands in the Canyon Grasslands may need fires to prevent tree encroachment.

Nonnative plant invasions are affected by fires, both natural and prescribed, within *Silene spaldingii* habitat. Lesica and Martin (2003, p. 520) found that the nonnative invasive plant *Potentilla recta* (sulfur cinquefoil) at Dancing Prairie in Montana demonstrated the highest recruitment within burned plots, although this recruitment did not translate to increased population growth. Also, fire seemed to reduce the efficacy of herbicide treatments on killing *P. recta*. One study at Garden Creek Ranch in Idaho found that monitoring plots established on either side of a fire line in very good-condition *Festuca idahoensis* habitat had significant increases in the frequency, basal cover, and density of both the nonnative plants *Centaurea solstitialis* (yellow starthistle) and *Bromus japonicus* (Japanese brome) in burned versus unburned plots 2 years after a burn (Hill *et al.* 2003, p. 2). Another found more invasive nonnative plants at higher densities or cover in burned versus unburned sites 2 years after a burn (Hill and Weddell 2003, p. 24). Conversely, another study in Idaho found decreased cover of the native *Festuca idahoensis*, an increase in the native forb *Lupinus sericeus* (silky lupine), and a constant cover in the native *Pseudoroegneria spicata* (bluebunch wheatgrass), exotic grasses, and other forb species 2 years after a fire (Menke 2003, p. 56). At one site in Washington, a prescribed burn escaped in

1997, burning *S. spaldingii* plants and habitat. Although the native bunchgrasses rebounded nicely, nonnative annual grasses are now dominant, opening the site to invasion by adjacent *Centaurea solstitialis* populations (J. Wood, U.S. Forest Service, *in litt.* 2004). Thus invasive nonnative plants, as a result of fire, may deleteriously affect *S. spaldingii* (see the discussion of “Invasive Nonnative Plants,” Section G-1, above).

The season or timing of fire has been shown to affect *Silene spaldingii* and its habitat. Lesica (1999, Figure 1, pp. 1000-1001) found that fall burning led to lower seedling recruitment for *S. spaldingii* than spring burning, and these effects continued to be apparent for 2 to 3 years after the burns. Most natural fires within *S. spaldingii*’s range would have historically occurred during the dry summer months, while today prescribed burning occurs during the cooler months when fires are more easily controlled. More studies are needed investigating the timing of both natural and prescribed burns and their effects on *S. spaldingii* and its habitat.

Management activities often seek to mimic historical fire regimes (Landres *et al.* 1999). Within forested stands, historical fire frequencies are relatively easy to establish by examining burn scars in tree rings. Establishing historical fire frequencies within grasslands is significantly more difficult because of the lack of trees to provide a physical record (P. Morgan, University of Idaho, *in litt.* 2007, p. 1). For example, within the Canyon Grasslands estimates of historical fire frequencies range widely, from every 6 to every 25 years (U.S Bureau of Land Management 2001, p. 39; J. White, Idaho Department of Fish and Game, pers. comm. 2003, p. 1), to infrequently (Weddell 2001, p. 7). Weddell (2001, p. 7) argued that there is little specific data on the historical fire frequency of these grasslands, and that fire has damaging effects on two dominant bunchgrasses, *Festuca idahoensis* and *Hesperostipa comata* = *Stipa comata* (needle-and-thread grass), as well as on the microbiotic crusts commonly associated with *Silene spaldingii* that recover slowly after fire.

Regardless of the accuracy of fire frequency data, *Silene spaldingii* does appear to be able to tolerate some fire (Lesica 1999, p. 1000; Hill and Fuchs 2003, p. 3; Hill and Weddell 2003, p. 23; Menke 2003, p. 60). The effects of fires will vary at different *S. spaldingii* sites due to factors such as fuel moisture content, species composition, and season and intensity of burning (Lesica and Martin

2003, p. 521). For example, burning while the plant is germinating or seeding will likely negatively affect reproduction. Most importantly, prescribed burning should not occur where invasive nonnative plants reside, since the establishment of these disturbance-adapted species can be promoted by fire (Christensen and Burrows 1986, pp. 100-101; Hobbs and Huenneke 1992, p. 327; Lesica and Martin 2003, p. 521), unless very careful weed control and monitoring will occur prior to and after the prescribed burn.

4. Land Conversion Associated with Urban and Agricultural Development (Factor A)

Extensive land conversion has already occurred on private lands across the range of *Silene spaldingi*i, and 32 known populations of *S. spaldingii* (32 percent) occur entirely on privately owned lands, with an additional 18 populations (18 percent) in partial private ownership (USFWS 2007). These populations are currently affected by changes in land use practices, including adverse livestock grazing and trampling, agricultural developments, and urbanization. Most surveys on private lands have been preliminary and occurred only once, often over 15 years ago, so it is difficult to know exactly how large or what impacts may be occurring at these populations. Rural population growth has increased over the last 2 decades in all counties where *S. spaldingii* resides (Hill and Gray 2004a, p. 62). Population growth is expected to continue in all areas where *S. spaldingii* resides, especially near urban areas. In addition to direct loss of *S. spaldingii* populations affected by urban and agricultural development, there are also indirect effects including the problems associated with small, geographically isolated populations (see 2 above) and an increased opportunity for impacts from invasive nonnative plants that are brought in with associated disturbances. For example, invasive nonnative plants frequently are spread along road corridors (Gelbard and Belnap 2003).

Active housing developments threaten to eliminate *Silene spaldingii* habitat near Redbird Ridge in Idaho (Lichthardt 1997, p. 12). Unsurveyed residential development immediately adjoining the Dancing Prairie Preserve owned by The Nature Conservancy in Montana, which has the largest *S. spaldingii* population rangewide, has destroyed potential habitat, increased the likelihood of nonnative plant invasions, and reduced management options such as controlled burning on the preserve (B. Martin, The Nature Conservancy of

Montana, *in litt*. 1998, p. 1). Continued development in this area is expected (B. Martin, *in litt*. 1998, p. 1). Recently, one population (Element Occurrences 003 and 004) in Montana was acquired by the Montana Large Animal Sanctuary and Rescue. Since this time, the area has been utilized for heavy grazing, noxious weeds have proliferated, and no plants were located in either 2003 or 2004. This population is considered "possibly extirpated" by the Montana Natural Heritage Program (Mincemoyer 2005, p. 8). The continuing fragmentation of suitable habitat and possible loss of the Tobacco Plains (now called the Roosville) area is anticipated (Mincemoyer 2005, p. 15). *S. spaldingii* on private land near Wallowa Lake in eastern Oregon, one of the 10 sites with over 500 individuals, may be threatened by development (ONHP 2006, Element Occurrence 10). Other *S. spaldingii* sites on private land in Idaho, Montana, and Washington are also threatened by development.

One *Silene spaldingii* site within Idaho is near an active gravel pit operation. Expansion of this gravel pit may be planned in the near future in association with a highway expansion project (G. Glenne, USFWS, *in litt.* 2004, p. 1). Although the *S. spaldingii* site will remain intact, disturbances associated with the gravel operation may increase the chance for nonnative plant invasions. In addition, dust has been shown to affect the energy and nutrient gathering processes of vegetation differentially, subsequently altering community composition (Farmer 1993, pp. 66-69).

5. Adverse Livestock Grazing and Trampling (Factors A, C)

Sufficient research has not been completed to determine exactly what effects adverse livestock grazing and trampling is having on *Silene spaldingii*. Adverse livestock grazing and trampling has occurred within *S. spaldingii*'s range for over 150 years (Mack 1981, p. 4). The relatively long life span of this herbaceous perennial and its long taproot has likely helped *S. spaldingii* withstand some adverse livestock grazing and trampling impacts. Without good historical population number estimates for comparison from the time prior to the initiation of livestock use, it is difficult to assess trends over time. Instead shorter term, more evident losses such as loss of reproductive structures, individuals, and habitat degradation are used to infer an impact to *S. spaldingii* from adverse livestock grazing and trampling. It has been suggested that under careful management livestock grazing has the potential to have no effect or positively affect *S. spaldingii* by reducing litter in areas where it accumulates to the detriment of *S. spaldingii* and fire is not an option (P. Lesica, *in litt.* 2006, p. 3). Adverse livestock grazing and trampling is the most contentious management issue within the range of *S. spaldingii* with critics and supporters (see Curtin 2002, p. 240).

Livestock grazing directly affects *Silene spaldingii* by the removal of flowers and/or seeds, thereby limiting reproduction for that season (G. Glenne, *in litt.* 2003, p. 2). Most all life history stages contribute to population growth; however, for perennial herbaceous species, adult survival from one year to the next has been shown to be more important to population growth than fruit production (Silvertown *et al.* 1993, p. 472; Crone 2001, p. 2613), and Lesica (1997, p. 356) found that survival of *S. spaldingii* while dormant was most critical to population growth of this species. Livestock trampling may also affect *S. spaldingii* by destroying seedlings or breaking the root caudex[6], potentially killing the plant (USFWS, pers. comm. 2003, p. 4). *S. spaldingii* remains green when much of the surrounding vegetation is brown during late summer and so may be preferentially selected by livestock. This impact may be reduced at some sites because during late summer livestock often remain close to water sources, which are usually not near areas where *S. spaldingii* resides (B. Benner, *in litt.* 2003, p. 5). Trampling by livestock may also threaten the nests of ground dwelling pollinators (Sugden 1985, p. 309; Kearns and Inouye 1997, pp. 298-299) of *S. spaldingii*, including the bumblebee *Bombus fervidus* (Lesica 1993, p. 199; Lesica and Heidel 1996, p. 9;). The development of springs or ponds for additional livestock water sources may inadvertently increase adverse livestock grazing and trampling impacts on some *S. spaldingii* populations by allowing cattle to forage in areas they were previously unable to utilize. Routine livestock management such as salt placement and fence construction may also change grazing and trampling pressures at some sites.

Aside from direct consumption or trampling impacts to *Silene spaldingii*, of concern is the habitat degradation and alterations to the ecosystem associated with livestock disturbances (summarized by Milchunas and Lauenroth 1993 and Jones 2000). In a worldwide review of 276 data sets to assess community sensitivity to grazing, Milchunas and Lauenroth (1993) found that corresponding

[6] The caudex is the root crown, the persistent and often woody base of an otherwise herbaceous perennial plant.

changes in species composition were primarily a function of low above ground net primary production (arid communities) and little evolutionary history of grazing at a site. Using similar techniques Jones (2000) analyzed 54 studies and 16 variables to assess grazing on North American arid ecosystems (across elevations, from forest ecosystems to grasslands, and across different grazing systems) and found 11 of the 16 variables revealed significant detrimental effects from cattle grazing. To name a few, the adverse effects from livestock can include changes in the timing and availability of pollinator food plants (Kearns and Inouye 1997, pp. 298-299), changes to insect communities (Kearns and Inouye 1997, pp. 298-299; Debano 2006), changes in water infiltration due to soil compaction (Jones 2000, Table 1), disturbance to soil microbiotic crusts (Belnap *et al.* 1999, p. 167; Jones 2000, Table 1), subsequent weed invasions (Parker *et al.* 2006), soil erosion from hoof action (Jones 2000, Table 1) and others.

Unlike the east side of the Rockies where grasslands coevolved with bison, grasslands and steppe communities west of the Rockies historically experienced little pressure from large, hoofed animals during the last 10,000 years (the Holocene period) (Mack and Thompson 1982, Lyman and Wolverton 2002, Martin and Szuter 2002) and so are impacted more severely by adverse livestock grazing and trampling (Milchunas and Lauenroth 1993). Both *Pseudoroegneria spicata* (bluebunch wheatgrass) and *Festuca idahoensis* (Idaho fescue) are poorly adapted to herbivory by comparison with other grass species, having little compensatory growth such as tiller production (Caldwell *et al.* 1981, p. 14). This evolutionary phenomenon, its mechanisms, and its ecological implications has been the subject of considerable discussion (Burkhardt 1996; Lyman and Wolverton 2002; Martin and Szuter 2002; Moore 2002; Williams 2005; Adler *et al.* 2006). Disturbances, most frequently linked to adverse livestock grazing and trampling, have dramatically altered Western arid ecosystems in a progression from native perennial bunchgrass communities to invasive nonnative annual grasslands that are then susceptible to more invasive perennial plant invasions (DiTomaso 2000, p. 257). For example, the initial introduction and spread of the most prevalent invasive nonnative annual grass, *Bromus tectorum* (cheatgrass), throughout the range of *Silene spaldingii* is attributed to the grain industry as well as adverse grazing and trampling by livestock that occurred at the end of the 19th century and early 20th century (Mack 1981, p. 10) (see the section "Invasive Nonnative Plants" above for a better discussion on the effects of *B. tectorum*).

Preliminary monitoring numbers from Washington suggest that properly managed livestock grazing may be compatible with the conservation of *Silene spaldingii* (USBLM, *in litt.* 2006, p. 5, Tables 1 and 2). However, this monitoring was not designed as a paired experiment with grazed vs. ungrazed treatments, nor does it monitor the vegetative community. Additional research is needed relating to herbivore impacts from both domestic and wild ungulates as well as more intensive monitoring at populations that are being grazed. It has been suggested that livestock grazing could be used at some sites where grasses produce large amounts of litter and fire is not practical as a management option; in such cases moderate grazing could create safe sites for germination and seedling establishment (P. Lesica, *in litt.* 2006, p. 3).

6. Herbicide and Insecticide Spraying (Factor E)

Herbicide and insecticide spraying is thought to be a problem for *Silene spaldingii* both within contiguous wild lands as well as more fragmented landscapes. Herbicide use has escalated in recent years as landowners and managers have realized that a large scale conversion to invasive nonnative plant populations is occurring, and have in turn resorted to more aggressive control measures. Herbicide spraying for invasive nonnative plants is occurring across the range of *S. spaldingii* via aerial (airplane or helicopter) spraying, boom spraying off a vehicle, and hand application on large tracts of wild lands as well as on more developed areas. On Federal lands and some State, Tribal, and private lands, surveys for *S. spaldingii* are occurring prior to spraying and if the plant is found actions are adjusted accordingly (see “Invasive Nonnative Plant Control Efforts” below). Other lands, particularly State, private, and highway right-of-ways, are sprayed with herbicides and pesticides without first surveying for *S. spaldingii*. Landowners may or may not be aware that *S. spaldingii* occurs within their ownership.

Accidental herbicide spraying is also a possibility. One site at Cave Gulch on Craig Mountain, Idaho, was aerially sprayed in 1997; *Silene spaldingii* was later found near this site and may have been affected by this spraying (K. Gray, *in litt.* 2004, p. 4). Another listed Canyon Grassland plant species, *Mirabilis macfarlanei* (Macfarlane’s four-o’clock), was accidentally aerially sprayed in 1997 (C. Johnson, USBLM, *in litt.* 1997, p. 3). Herbicide spraying effects on *S. spaldingii* have not been researched, although it is reasonable to assume that broad spectrum herbicides such as glyphosate, picloram, and 2,4-D that kill most herbaceous perennials will also kill *S. spaldingii*. Furthermore, invasive nonnative plant control activities, if not conducted carefully, can impact other native species and so result in habitat degradation (Lass *et al.* 1999, p. 3).

Smaller populations of *Silene spaldingii* that exist within small pieces of remnant habitat are often found along roads, in between fields, or in cemeteries. These small pieces of habitat are susceptible to direct herbicide application, such as those occurring along roadsides to control invasive nonnative plants. They are also susceptible to herbicide drift, which occurs when herbicides are sprayed nearby and float through the air impacting adjacent areas. Herbicide drift is especially a problem on windy days or with aerial applications where there is more opportunity for drift to occur. Herbicide or pesticide drift threatens populations in Idaho (Lichthardt 1997, p. 12; J. Hill, *in litt*. 1999, p. 2), Oregon (J. Hustafa, U.S. Forest Service, pers. comm. 1999, p. 1; J. Kagan, ONHP, pers. comm. 1998, p. 1), and Washington (WNHP 2007, Element Occurrences 7, 8, 10, 11, 18, 45, 51). For example, at least two *S. spaldingii* sites in Idaho are particularly vulnerable to herbicide drift because of their close proximity to cropland (Lichthardt 1997, p. 12). The sticky hairs blanketing the surface of *S. spaldingii* may help to protect the plant from some herbicide drift, as observed in other hairy plant species (Miller and Westra 2004, p. 3).

Grasshopper and other insect control programs generally utilize broad spectrum insecticides that will affect native bee species (Johansen *et al.* 1983, p. 1517). The effects of insect control programs on the pollinators of *S. spaldingii* are unknown at this time. Because the species requires pollinators to reproduce, deleterious effects to the primary pollinators of *S. spaldingii* will translate into decreased reproductive output (Tepedino 1996, pp. III.5-2 to III.5-4; Lesica and Heidel 1996, p. 9).

7. Adverse Grazing (Herbivory) and Trampling by Wildlife Species (Factor C)

Adverse grazing or browsing of *Silene spaldingii* inflorescences by native herbivores and livestock has been observed and is considered a threat to the species (Kagan 1989, p. 7; Heidel 1995, p. 4; B. Benner, *in litt*. 1999, p. 4; Hill and Weddell 2003, pp. 8-9; Hill and Gray 2004a, pp. 75-78; 2004b, pp. 15-19).

While grazing or browsing of *S. spaldingii* by native herbivores has occurred historically, problems may arise when numbers of native ungulates (deer and elk) are at levels significantly higher than those to which the plant has adapted. Long-term demography monitoring transects at Garden Creek Ranch, Craig Mountain, Idaho, found 50 percent of *S. spaldingii* reproductive stems were grazed in 2002 and 70 percent in 2003 in areas where livestock were absent, therefore native ungulates were likely responsible (Hill and Weddell 2003, p. 9; Hill and Gray 2004b, p. 17). At the Kramer Prairie site in Washington, heavy grazing has occurred where livestock is excluded; deer are thought to be the cause (Wentworth 1996, p. 5).

Rodent activity is also considered a significant factor affecting the persistence of *S. spaldingii* at several sites in eastern Washington and Idaho (B. Benner, *in litt.* 1999, p. 4; Caplow 2001, p. 5; Hill and Gray 2004b, pp. 15-19; P. Lesica, *in litt.* 2006, p. 3). For example, numerous *S. spaldingii* plants were marked with stakes and metal tags as part of a monitoring study on land managed by the Bureau of Land Management in Washington. On a site visit, the Bureau of Land Management botanist discovered that many of these plants were either broken off or missing completely and likely consumed by rodents, as evidenced by rodent burrowing activity in the area (B. Benner, *in litt.* 1999, p. 3). A monitoring plot at the Lamona site in Washington had intense adverse grazing in 2005 that was attributed to rabbits or pocket gophers (P. Lesica, *in litt.* 2006, p. 3; 2007b, p. 2). A Canyon Grassland demography study showed high mortality of *S. spaldingii* plants caused primarily by voles that appeared to prefer the plant, eating not only aboveground parts but also the caudex, which likely killed the plants. Rodents often tunneled under the plants and pulled several *S. spaldingii* stems down their holes (Hill 2006, p. 26).

8. Off-Road Vehicle Use (Factors A, E)

Off-road vehicle impacts are known to occur at two *Silene spaldingii* populations, one in Idaho and one in Washington (ICDC 2007, Element Occurrence 3; WNHP 2007, Element Occurrence 51). At the site in Idaho, off-road vehicle use is thought to be the primary threat to *S. spaldingii* (ICDC 2007, Element Occurrence 3). Because the habitat where *S. spaldingii* occurs is made up of flat or rolling hills, the plant is susceptible to off-highway vehicle use at many sites rangewide. Off-highway vehicles may damage the caudex of *S. spaldingii*, likely killing the plant.

9. Insect Damage and Disease (Factor C)

Insect predation of foliage, flowers, and fruits of *Silene spaldingii* has been documented on numerous occasions (Heidel 1979, p. 69; Lesica 1988b, pp. 2-5; Kagan 1989, p. 7; Youtie 1990, p. 4; Gamon 1991, p. 28; Lichthardt 1997, p. 13; B. Benner, *in litt*. 1999, pp. 3-4; S. Riley, U.S. Forest Service, pers. comm. 1999, p. 1; Hill and Gray 2000, p. 12; 2004b, p. 16; Hill and Weddell 2003, p. 8; R. Taylor, The Nature Conservancy of Oregon, *in litt*. 2003, p. 5; P. Lesica, *in litt*. 2004, pp. 3-4). Predation on seed capsules has been documented to be as high as 90 percent at the Kramer Prairie, Washington, site (Heidel 1979, p. 69), although lower percentages are more common. Most insect predation seems to be from larva (Hill and Gray 2000, p. 7; P. Lesica, *in litt.* 2004, pp. 3-4), although a seed weevil (Kagan 1989, p. 7; Youtie 1990, p. 4), and some other beetles (Heidel 1979, p. 69) have also been implicated. *Silene spaldingii* has coevolved with insect predation, and so some level of predation is part of the ecosystem balance. However, small population sizes and a decrease in genetic diversity, or the presence of invasive nonnative plants, may exacerbate problems with insect predation.

A fungal rust has been found on *Silene spaldingii* plants in Washington (B. Benner, *in litt*. 2004, p. 26). It is unknown how this rust may be affecting the species or how often it occurs.

10. Impacts from Prolonged Drought and Climate Change (Factor E)

Silene spaldingii has adapted to drought, evident in its prolonged dormancy response. Prolonged dormancy in *S. spaldingii* has been shown to increase reproduction (Lesica and Crone in review, p. 10) and could increase the likelihood of adult survival, therefore lessening the effect of drought. Perennial plants that are adapted to arid environments, such as *S. spaldingii*, are negatively impacted by prolonged and severe droughts (Schultz and Ostler 1995, p. 233). Prolonged periods of drought may increase the numbers of dormant individuals at a *S. spaldingii* site (Heidel 1995, p. 3; Lesica 1997, p. 356; B. Benner, *in litt.* 1999, p. 3; Lesica and Crone in review, p. 13), limiting the number of individuals reproducing, which could make small populations more susceptible to extinction. A demography study in Idaho found that fewer plants were present at the later sampling period during drier years but earlier monitoring did not find a noticeable difference in individuals between years (J. Hill, *in litt.* 2007b, pp. 9-10). Based on demographic studies of mapped individuals of *S. spaldingii*, Lesica (1997, p. 349) considered plants that failed to reappear after 3 consecutive years to be dead. However, some *S. spaldingii* bouts of prolonged dormancy have lasted up to 6 years (Lesica and Crone in review, pp. 9-10).

Causes aside, global temperatures are increasing (USEPA, *in litt.* 2000, p. 1). The effects of this climate change are speculative, but it has the potential to affect rare plants such as *Silene spaldingii*. Researchers speculate that this warming will alter rainfall patterns, with some regions becoming drier and others wetter (Given 1994, pp. 33-34). Within the Pacific Northwest a recent model predicts warmer and wetter winters in 80 years (U.S. Department of Energy 2004, p. 1). Plants are stationary, moving through dispersal, colonization, and recruitment events. Because plants are stationary and move slowly through the aforementioned events, it is thought they can't move quick enough to keep up with a shifting climate, and are more susceptible to global warming than are wildlife species (Wilson 1989, p. 114). Furthermore, fragmentation and isolation limits movement opportunities.

11. Inadequacy of Existing Regulatory Mechanisms (Factor D)

Silene spaldingii, because of its threatened status, is protected on Federal lands where it occurs. Of the four states and one Canadian province where *S. spaldingii* resides, legal protection is provided only by the State of Oregon, where the species is listed as endangered by the Oregon Department of Agriculture (Oregon Department of Agriculture 2004, p. 11). Plants listed as threatened or endangered in Oregon are protected only on State lands; however, no *S. spaldingii* plants are currently found on State lands in Oregon. Although not granted any legal protection, *S. spaldingii* is on the State of Washington's threatened species list and the red list in British Columbia. *Silene spaldingii* is not legally protected on any State or private lands.

Special Federal land designations such as Areas of Critical Environmental Concern, Research Natural Areas, and Botanical Special Interest Areas have not been designated within *Silene spaldingii* habitat except at Coal Creek, Washington, where an Area of Critical Environmental Concern has been established.

The status assigned by State Natural Heritage Programs and Conservation Data Centers do not convey regulatory protection. However, their ranking system can help raise awareness for rare species. All four states and British Columbia rank the species as a G2 (imperiled globally because of rarity or because other factors demonstrably make it very vulnerable to extinction) S1 (critically imperiled in the applicable states or province because of rarity or some factor of its biology makes it especially vulnerable to extinction), except Washington where the State rank is S2, similar to the global (G) rank.

H. Conservation Efforts

1. Inventory Efforts

Inventories for *Silene spaldingii* are being conducted on all lands managed by the Federal government where the plant currently resides or where there is suitable habitat. Surveys for the species should be done to complete consultation under section 7 of the Endangered Species Act for projects such as invasive nonnative plant control activities, right-of-ways, power lines, Federal highway projects, military activities, prescribed burns, and land acquisitions. In general, grazing allotments on federally managed lands have not been inventoried, although grazing lease renewals are being surveyed in Washington (B. Benner, *in litt.* 2004, p. 28) and in Oregon (G. Yates, U.S. Forest Service, *in litt.* 2004, p. 1). The Endangered Species Act does not require inventories for plants on State or private lands unless there is a Federal nexus.

(a) Idaho. Within Idaho, extensive inventories have been conducted in the Craig Mountain Canyon Grasslands at Garden Creek Ranch by The Nature Conservancy, by the Bureau of Land Management both through annual surveys (Hill *et al.* 2001, p. 1) as well as during the course of a master's thesis project (Menke 2003, p. 15), and in the Canyon Grasslands of Idaho by the Idaho Conservation Data Center (Hill *et al.* 2006, Figure 2). The Idaho Conservation Data Center has also done some inventory work on the Craig Mountain Wildlife Management Area owned by the Idaho Department of Fish and Game. However, the majority of the known sites of *S. spaldingii* on Craig Mountain are located on Federal or Nature Conservancy lands. State owned lands are spread within and around these known sites and have generally not been inventoried. Surveys within the Craig Mountain area on State lands (Idaho Department of Fish and Game lands) are being planned in the near future. Surveys within grazing allotments and prescribed burning projects are ongoing on the Nez Perce National Forest and have led to several recently discovered populations (M. Hays, U.S. Forest Service, *in litt.* 2007, p. 1). Surveys on Nez Perce Tribal lands were initiated in 2005. No new populations were documented by this effort but work will continue in 2006 on Palouse Grassland remnants and in Canyon Grassland habitats (R. Miles, Nez Perce Tribal Executive Committee, *in litt.* 2006, p. 3). Palouse Grasslands have generally been surveyed only in association with section 7 consultation projects, although increased attention to Palouse Grassland fragments is leading to an increase in non-project specific inventory efforts.

(b) Montana. In Montana, the Montana Natural Heritage Program conducted a status report that was completed in 2005; this report included visits to all existing populations and searching some suitable habitat (Mincemoyer 2005). In 2003, *Silene spaldingii* was discovered at the Lost Trail National Wildlife Refuge outside of areas delineated as suitable habitat in Figure 4. This discovery indicates that other isolated grasslands in Montana may be capable of supporting *S. spaldingii* and should be further inventoried. The Plum Creek Timber Company, already working on conservation efforts for fish species, is a large landowner in the northwestern portion of Montana. Plum Creek Timber Company grasslands have not yet been searched for *S. spaldingii* (A. Wick, USFWS, *in litt.* 2004, p. 1). Surveys were conducted on Tribal lands within Montana in association with a status report (Mincemoyer 2005, pp. 13-14, 18, 24-25). All suitable habitat on the Flathead National Forest was intensely surveyed for *S. spaldingii* in 2000 (M. Mantas, The Nature Conservancy of Montana, *in litt.* 2007, p. 2).

(c) Oregon. In Oregon, The Nature Conservancy is in the process of inventorying its recently acquired Zumwalt Prairie Preserve and their Clear Lake Ridge Preserve lands have been inventoried (R. Taylor, *in litt.* 2003, p. 3). The Wallowa-Whitman National Forest has begun surveying active grazing allotments including areas within the Imnaha River Canyon and the lower Joseph Creek area (G. Yates, *in litt.* 2004, p. 2). Inventories on Nez Perce Tribal Land were initiated in 2005 and will continue in 2006. No new populations were reported after the 2005 effort (R. Miles, *in litt.* 2006, p. 3).

(d) Washington. In Washington, inventories are being conducted on lands owned by the Bureau of Land Management (B. Benner, *in litt.* 2003, p. 6; C. Button, USBLM, *in litt*. 2004, p. 1), at the Fairchild Air Force Base (Caplow 2001, p. 2), and at Turnbull National Wildlife Refuge (Weddell 2002, p. 3). Swanson Lake Wildlife Area, managed by the Washington Department of Fish and Wildlife, has been partially inventoried and Wawawai Canyon near the Snake River, managed by the Washington State Department of Natural Resources, has been inventoried (Caplow 2002b, p. 1). Inventories for *Silene spaldingii* have been done at the Lime Hill Area of Critical Environmental Concern and in Joseph Canyon, in Asotin County, Washington (C. Button, *in litt*. 2005, p. 1). Inventories on Nez Perce Tribal Land were initiated in 2005 and will continue in 2006. No new populations were reported after the 2005 effort (R. Miles, *in litt.* 2006, p. 3).

Many areas still remain to be inventoried where suitable habitat for *Silene spaldingii* exists. Because the Canyon Grasslands are extremely steep and quite remote, there are still significant portions of suitable habitat to be searched, particularly on the Oregon side of the Snake River directly across from Craig Mountain, along the lower Grande Ronde River in Oregon and Washington, the Imnaha River in Oregon, and the lower Clearwater and Salmon Rivers in Idaho (please see Hill and Gray 2004a, pp. 17-21 for a summary of areas to be surveyed). Over 40 percent of known *S. spaldingii* sites are on private land; in general, these private lands have had much less inventory effort. The possibility for large populations residing on private property can not be overlooked. Several recent Bureau of Land Management land acquisitions in Washington (B. Benner, *in litt.* 2003, p. 3), as well as The Nature Conservancy's acquisition in 2000 of the Zumwalt Prairie Preserve, have led to the discovery of large, previously unknown *S. spaldingii* populations.

2. Monitoring Efforts and Demographic Studies

(a) Idaho. Two long-term demographic studies have been tracking permanent plots from 2002 to 2006 on Craig Mountain in the Canyon Grasslands: **1)** A cost-share project conducted at Garden Creek Ranch and funded by the

Bureau of Land Management's Cottonwood Field Office in Idaho, the Idaho Conservation Data Center, and the Palouse-Clearwater Environmental Institute with seven permanent belt transects (four at a burned site and three at an unburned site) (Hill and Weddell 2003, p. 2; Hill and Gray 2004b, p. 1; Hill and Gray 2005a, p. 2; Hill 2006, p. 2; J. Hill, *in litt.* 2007b, p. 10); and **2)** a U.S. Fish and Wildlife Service and Idaho Conservation Data Center project with 10 permanent 10 by 10 meter (33 by 33 foot) plots (4 on Bureau of Land Management's Cottonwood Field Office lands at Garden Creek Ranch, 4 on State and 1 on Bureau of Land Management's Cottonwood Field Office lands on Craig Mountain, and one on Bureau of Land Management's Cottonwood Field Office lands along the lower Salmon River (Lichthardt and Gray 2002, p. 7; 2003, p. 5; Gray and Lichthardt 2004, p. 6; Hill and Gray 2005a, pp. 5-6; Gray and Hill 2006, pp 5-7).

Trend monitoring where all aboveground stemmed plants were censused at both a 0.8-hectare (2-acre) and a 1.6 hectare (4–acre) site at the Garden Creek Ranch funded by The Nature Conservancy and the Idaho Bureau of Land Management occurred from 1999 to 2002 (Hill and Gray 2000, p. 4; Hill *et al.* 2001, p. 4; Hill and Fuchs 2002, pp. 3-4; 2003, p. 3). This study also includes three permanent belt transects that monitor invasive nonnative plants (two *Centaurea solstitialis* sites and one *Poa pratensis* site), and accurate mapping of seven *S. spaldingii* locales and invasive nonnative plants at these sites (Hill and Gray 2000, pp. 1-4; Hill *et al.* 2001, pp. 1, 3-4). Plots were established and monitored in 2001 and 2002 at Garden Creek Ranch in conjunction with a Master's thesis to monitor invasive nonnative plant invasions and fire effects (Menke 2003, pp. 15-17, 44-46). One permanent monitoring transect was established in 1998 by the Idaho Bureau of Land Management (U.S. Bureau of Land Management 1998, p. 2).

(b) Montana. In Montana, monitoring occurred at Wild Horse Island from 1986 to 1992 (P. Lesica, *in litt.* 2003, p.2). A demography study has been ongoing at The Nature Conservancy's Dancing Prairie Preserve since 1987 (Lesica 1988c, pp. 1-2; 1997, p. 349; 2005, p. 1; P. Lesica, *in litt.* 2003, p. 2; Lesica and Crone 2007, p. 1; Lesica and Crone in review, p. 5) and at the Lost Trail National Wildlife Refuge since 2003 (P. Lesica, *in litt.* 2003, p. 3; Lesica and Crone 2007, pp. 2). Trend monitoring has been conducted at The Nature Conservancy's Dancing Prairie Preserve since 1991 (Lesica 2005, p. 2).

(c) Oregon. In Oregon, monitoring plots were established at Clear Lake Ridge in 1990, but were not revisited until 2002 (Youtie 1990, pp. 1-5; Elseroad and Taylor 2002, p. 3). The Wallowa-Whitman Forest has funding to design a set of monitoring methodologies on their land as well as Nature Conservancy lands in Oregon (J. Hustafa, *in litt*. 2004a, p. 1). Three permanent monitoring plots have been established on The Nature Conservancy's Zumwalt Prairie Preserve to collect baseline abundance data and examine the effects of burning and grazing treatments (Taylor *et al.* 2006, pp. 1-4). In addition, phenology of *S. spaldingii* was tracked during 2006 on the Zumwalt Prairie Preserve (Dingeldein *et al.* 2006, p. 1).

(d) Washington. In Washington, monitoring of individual plants has occurred at 10 sites in Lincoln County since 1995 in conjunction with habitat monitoring on lands where livestock grazing occurs (B. Benner, *in litt*. 1999, p. 3; 2003, p. 6; USBLM, *in litt.* 2006, Table 1). Plots have been monitored at Fairchild Air Force Base since 1995 (F. Caplow, WNHP, *in litt.* 2003, p. 5). Demography transects were established at Lamona and in the Blue Mountains in 2003 and have been monitored yearly since (Lesica and Crone 2007, pp. 3-4).

3. Additional Sources of Scientific Information on *Silene spaldingii*

- Preliminary pollination biology for *Silene spaldingii* in Montana (Lesica 1988b, p. 1)
- Germination requirements and seedling biology of *Silene spaldingii* (Lesica 1988a, pp. 1-2; 1993, pp. 196, 198-200; A. Raven, pers. comm. 2004, p. 1)
- Importance of pollinators for reproduction in *Silene spaldingii* in Montana (Lesica 1991, pp. 4-11; 1993, pp. 196-200)
- The effect of fire on *Silene spaldingii* in Montana (Lesica 1991, 1994, 1995, 1999)
- Preliminary genetic investigation of *Silene spaldingii* done at five locations, one in Idaho, one in Montana, one in Oregon, and two in Washington (Baldwin and Brunsfeld 1995)
- Pollination biology of *Silene spaldingii* at one site in Idaho, one in Montana, one in Oregon, and two in Washington (Lesica and Heidel 1996)

- An investigation of the utility of remote sensing techniques for mapping *Centaurea solstitialis* infestations in Idaho (Hill 2002a; 2002b)
- Effects of invasive nonnative plants and fires on *Silene spaldingii* at Garden Creek Ranch, Idaho (Hill and Gray 2000, pp. 8-10, 13-16; Hill *et al.* 2001, pp. 6-7, 10-11; Hill and Fuchs 2002, pp. 3-5; 2003, pp. 3, 6-7, 9-12; Lichthardt and Gray 2002, p. 6; Menke 2003; Gray and Lichthardt 2004, pp. 16-19)

4. Invasive Nonnative Plant Control Efforts

At the Craig Mountain Wildlife Management Area in Idaho spraying for *Centaurea solstitialis* (yellow starthistle) with 2,4-D and Tordon has occurred during the last 10 years, with approximately 20 to 220 hectares (50 to 550 acres) being treated each year. *Centaurea solstitialis* biocontrol agents have been released and monitored for the last 10 years. Approximately 4 hectares (10 acres) of *Onopordum acanthium* (Scotch thistle) have been treated for the last 15 years. Other invasive nonnative plants being treated include *Crupina vulgaris* (common crupina) and *Linaria* (toadflax). These spraying activities are expected to continue into the future. Known populations of *Silene spaldingii* are not sprayed; however, until 2004, surveys for *S. spaldingii* were not conducted prior to spraying (J. White, pers.comm. 2003, p. 1).

Cooperative Weed Management Areas and County Weed Boards that work to control invasive nonnative plants have been established across much of *Silene spaldingii*'s range. For example, the Tri-State Weed Management Area, established by the Bureau of Land Management in 1996, encompasses 101,170 hectares (250,000 acres) on the Idaho, Oregon, and Washington borders. The intent of this Cooperative Weed Management Area is to bring together Federal, State, County, Tribal, and private organizations to control invasive nonnative plants, primarily *Centaurea solstitialis*, and educate the public about the threat invasive nonnative plants pose. The Tri-State Weed Management Area treated over 1,010 hectares (2,500 acres) of invasive nonnative plants in 2003, surveyed over 5,670 hectares (14,000 acres), and informed over 950 individuals about the dangers invasive nonnative plants pose (L. Danly, USBLM, *in litt.* 2004).

The Nature Conservancy's Dancing Prairie Preserve in Montana has been the site of a research project looking at the effects of herbicides and fire on control of *Potentilla recta* (sulfur cinquefoil) (Lesica and Martin 2003). Annual and sometimes biannual spot-spraying from a backpack or ATV (all-terrain vehicle) of *Potentilla recta*, *Hypericum perforatum* (St. Johnswort), *Hieracium pratense* (meadow hawkweed), and *Centaurea maculosa* (spotted knapweed) has occurred for the last 9 years (P. Lesica, *in litt.* 2003, p. 3). Biocontrol agents were released on *Hypericum perforatum* in the late 1990s. Invasive nonnative plant control efforts are expected to continue into the future (M. Mantas, *in litt.* 2007, p. 2). A 2-year Integrated Pest Management Plan was prepared for the Dancing Prairie Preserve in 2006 and will be revisited after the next inventory in 2008 (M. Mantas, *in litt.* 2007, p. 2). Control of *Potentilla recta* is occurring adjacent to *Silene spaldingii* populations at The Nature Conservancy's Zumwalt Preserve in Oregon (R. Taylor, *in litt.* 2004, p. 1).

Invasive nonnative plant control is an ongoing activity on most Federal lands. Because *Silene spaldingii* is a threatened species under the Endangered Species Act, Federal agencies are required to consider *S. spaldingii* in developing guidelines for all invasive nonnative plant control activities within the plant's range. The Bureau of Land Management in Spokane first surveys suitable habitat and does not treat invasive nonnative plants near *S. spaldingii* (USBLM 2002a, pp. 5-8). The Bureau of Land Management's Vale District in Oregon limits aerial herbicide treatment of invasive nonnative plants to distances greater than 152 meters (500 feet), broadcast spraying would be done no closer than 8 meters (25 feet), directed hand spraying no closer than 3 meters (10 feet), and by wicking applications only, if necessary, if within 3 meters (10 feet) of *S. spaldingii* (USFWS, *in litt*. 2002, pp. 7-13). The Bureau of Land Management's Cottonwood Field Office in Idaho has all plants flagged within 30 meters (100 feet) of *S. spaldingii* and stipulates no boom spraying within 15 meters (50 feet) of *S. spaldingii*, hand spraying/wick/wipe applications only at a distance from 1.5 to 15 meters (5 to 50 feet), wipe or wick spraying from 1 to 1.5 meters (3 to 5 feet), and manual control only within 1 meter (3 feet). Picloram may not be used within 15 meters (50 feet) of *S. spaldingii* (USFWS, *in litt*. 2003, pp. 5-7).

Invasive nonnative plant control and management specific to *Silene spaldingii* has occurred at Craig Mountain, Idaho, on Bureau of Land Management land. General mapping of invasive nonnative plants at all *S. spaldingii* locales, specific mapping of *Centaurea solstitialis* patches at seven of these locales, and manual control of *Centaurea solstitialis* and planting of native seed in disturbed areas at two of these locales has been done for 4 years at Garden Creek Ranch (Hill and Gray 2000, pp. 1, 4; Hill *et al.* 2001, pp. 1, 3-4; Hill and Fuchs 2002, pp. 2-3; 2003, pp. 1-2). The Bureau of Land Management's Cottonwood Field Office in Idaho has released biocontrol insects for *Centaurea solstitialis* at *S. spaldingii* sites on Craig Mountain (Danly 1999).

Other control measures have included the release of biological invasive nonnative plant control agents for *Cirsium arvense* (Canada thistle), *Centaurea disffusa* (diffuse knapweed), and *Centaurea maculosa* (spotted knapweed) in 1996 at Fairchild Air Force Base in Washington (Rush and Gamon 1999, p. 7; Caplow 2001, p. 9). A limited amount of invasive nonnative plant control has also occurred at the Chief Joseph Gravesite monument near Joseph, Oregon and an Integrated Pest Management plan has been established for the site (T. Nitz, U.S. National Park Service, pers. comm. 2004, p. 1).

Annual grasses exist near *S. spaldingii* sites at Crow Creek on the Wallowa-Whitman National Forest in Oregon where grazing practices are being altered to improve range condition. One *Centaurea solstitialis* patch, located on private land, is within 0.8 kilometer (0.5 mile) of one *S. spaldingii* site at Crow Creek and has been treated for 5 years by U.S. Forest Service personnel (J. Hustafa, pers. comm. 1999, p. 1). *Centaurea maculosa* is being treated along the road to the above *S. spaldingii* site (J. Hustafa, *in litt.* 2004b, p. 2).

The Joseph Creek population managed by the Nez Perce Tribe does not have significant noxious weed issues. The bunchgrass community is nearly pristine with very limited amounts of *Bromus tectorum* (cheatgrass) present. A small *Crupina vulgaris* population exists within 0.4 kilometer (0.25 mile) of the site and will continue to be hand pulled by tribal staff. No domestic livestock grazing is currently allowed at this site (R. Miles, *in litt.* 2006, p. 3).

5. Additional Conservation Actions

- *Silene spaldingii* seeds have been collected at 1 population in Idaho (Garden Creek), 1 population in Montana (Wild Horse Island), 3 populations in Oregon (Clear Lake Ridge, Crow Creek, and Joseph Creek), and 1 population in Washington (Coal Creek) in the following quantities: 400 seeds were collected in Oregon in 1989, 2,500 seeds in Oregon in 1990, almost 3,000 seeds from Montana in 1990, almost 2,000 seeds from Oregon in 1995, 2,300 seeds from Idaho in 1999, 3,400 seeds from Washington in 2000, 2,200 seeds from Idaho in 2000, over 31,000 seeds from Oregon in 2001, and 1,048 seeds from Oregon in 2005 (R. Miles, *in litt.* 2006, p. 3). All seeds are stored at the Berry Botanic Garden in Portland, Oregon (A. Raven, *in litt.* 2004).
- A draft management plan has been developed for Garden Creek Ranch, Idaho, where *Silene spaldingii* locations have been identified and protection methodologies have been outlined (Hill 1998).
- A management plan for *Silene spaldingii* has been developed for Fairchild Air Force Base in Washington (Rush and Gamon 1999).
- A management plan has been developed for BLM lands along Coal Creek in Washington, emphasizing protection of *Silene spaldingii* and the state threatened plant *Polemonium pectinatum* (USBLM 2002b).
- A land acquisition through the Land and Water Conservation Fund and other land exchanges are ongoing for Bureau of Land Management land within *Silene spaldingii* habitat in Washington (B. Benner, *in litt.* 2003, p. 6) (see Section H-1, “Inventory Efforts”).
- A Conservation Easement at Pocket Creek Ranch is being funded using U.S. Fish and Wildlife Service Recovery Land Acquisition Grant money. The (2,354-hectare) (5,817-acre) conservation easement is adjacent to The Nature Conservancy’s Zumwalt Prairie Preserve.
- A prescribed burning plan has been developed at The Nature Conservancy’s Dancing Prairie Preserve in Montana that recommends burning similar size patches every other year. In 2003 39 hectares (97 acres), in 2005 54 hectares (134 acres), and in 2007 82 hectares (203 acres) of *Silene spaldingii* habitat were burned (M. Mantas, *in litt* 2007, p. 2).

- Montana Fish, Wildlife, and Parks has tried for several years to burn the grasslands on Wildhorse Island but residents have opposed these efforts (P. Lesica, *in litt.* 2006, p. 3).
- A management plan is being developed for The Nature Conservancy's Zumwalt Preserve that will include conservation strategies for *Silene spaldingii* (R. Taylor, *in litt.* 2003, p. 6).
- An amendment to the Nez Perce Precious Lands Wildlife Management Plan is under development to incorporate conservation measures for the Joseph Creek population (R. Miles, *in litt.* 2006, p. 4).
- An ordination study of *Silene spaldingii* habitat at Garden Creek Ranch is underway (J. Hill, *in litt.* 2007b, p. 11).

I. Biological Constraints

The long-lived nature of *Silene spaldingii*, in conjunction with sporadic and rare recruitment, delayed maturity, cryptic rosettes that may disappear before monitoring, prolonged dormancy, and difficulties identifying seedlings, make it challenging to measure changes in numbers of individuals of this species. For plants exhibiting prolonged dormancy, population trend monitoring needs to occur for 3 or more consecutive years every 5 to 20 years to adequately assess trends at a given site (Lesica and Steele 1994; see details in Section II-A, Recovery Strategy and Rationale). Although population trend and demographic monitoring is occurring at a number of sites, long-term monitoring of this kind has occurred at only one *S. spaldingii* site, the Dancing Prairie Preserve in Montana (see section H, Conservation Efforts). Monitoring efforts to date have not used consistent methodologies so comparisons of key life history parameters across the range of the species are difficult.

Ground disturbing activities including fires, adverse livestock grazing and trampling, and off-road vehicle use impact *Silene spaldingii* the most during the flowering and seeding period (late July to September) and during seedling and shoot emergence in early spring.

Small, isolated populations relegated to remnant fragments of native habitat pose a problem as their viability into the future is questionable. *Silene spaldingii* requires grasslands dominated by native vegetation, with adequate numbers of pollinators available and other *S. spaldingii* populations close enough (within 1.6 kilometers [1 mile]) to provide for pollen exchange and enhance gene flow and genetic variability.

II. Recovery Strategy and Goals

A. Recovery Strategy and Rationale

The fragmentation of much of *Silene spaldingii*'s habitat by human related activities has reduced the species to a mosaic of small populations (67 percent of the known remaining populations are composed of fewer than 100 individuals) occurring in isolated habitat remnants. Many of these small populations may not be viable into the future. Populations with few individuals and low effective population size are likely to suffer from low genetic diversity (Loveless and Hamrick 1984, p. 72, Table 1; Karron *et al.* 1988, p. 1118; Ellstrand 1992, pp. 77; Ellstrand and Elam 1993, pp. 219, 221, 226-227). As population size diminishes, the chance of loss of genetic diversity increases and the likelihood that gene flow from distant populations will replenish genetic variability decreases (Loveless and Hamrick 1984, pp. 72-73, Table 1). The fragmented distribution of small populations further contribute to the positive feedback loop that Gilpin and Soulé (1986, pp. 25-26) have termed an "extinction vortex." These depleted populations, and the species that they constitute, are more susceptible to both predictable and unexpected genetic, environmental, and demographic vagaries (Shaffer 1987, pp. 73-75; Simberloff 1988, p. 499-501; Ellstrand 1992, p. 79; Ellstrand and Elam 1993, pp. 222, 228-229, 232).

Because small, fragmented populations with limited gene flow and susceptibility to inbreeding face a greater risk of extinction (Frankham 2003, p. S22-S29), increasing the size and connectivity of the larger remaining *Silene spaldingii* populations will be an important component of the recovery strategy for the species. Preserving representative populations from across the range of *S. spaldingii*, throughout all of the physiographic regions in which it occurs, is also a key element of the recovery strategy. Reciprocal transplant studies have shown that there is often a high degree of local adaptive differentiation in plant populations (Ellstrand and Elam 1993, pp. 233-234 and references therein). Frankham (2003, p. S22-S29) points to a substantial need for the effective genetic management of fragmented populations of threatened species, but also notes that only rarely does such management take place. The preservation of genetic diversity across populations is important not only to short-term persistence (*e.g.*, Huenneke 1991, p. 36; Newman and Pilson 1997, p. 360; Neel and Cummings 2003, pp. 227-228), but also provides the material for future adaptation and evolutionary potential, thereby increasing the species' probability of persistence over the long-term (Lande and Barrowclough 1987, p. 87; Shaffer 1987, pp. 74-75 and references therein; Simberloff 1988, p. 495; Nunney and Campbell 1993, p. 238; Neel and Cummings 2003, p. 228).

As to how many populations are necessary, if specific genetic data on the populations selected for conservation are lacking, a recent evaluation demonstrated that anywhere from 53 to 100 percent of the remaining populations must be preserved to meet the genetic diversity conservation standard of the Center for Plant Conservation (Neel and Cummings 2003, p. 228). In the absence of data, it is extremely difficult to determine the number of populations needed for long-term persistence. Especially when populations have become isolated as the result of relatively recent habitat fragmentation events, Hanski *et al.* (1996, p. 535) noted that even the number of extant populations may not necessarily be sufficient, as it is possible these populations have not yet reached a steady state equilibrium. Given these considerations and based on the recommendations of species experts, in this plan we propose the preservation of a minimum of 3 key conservation areas per physiographic region, and higher numbers where it is believed that suitable habitat either does or potentially exists, to reach the total number of 27 key conservation areas across the historical range of *Silene spaldingii* intended to preserve the available genetic variability within the species and provide for its long-term persistence. It is preferable that these key conservation areas be spread across each physiographic region.

Estimating minimum population sizes needed to ensure long-term viability is also a challenge. Population viability analyses utilize computer modeling to estimate a population's viability into the future under various threats and management scenarios. A population viability analysis that incorporates threats such as fire management, genetic data, and pollinator success, as well as demographic data (transition probabilities), has not been done for *Silene spaldingii* rangewide and is needed to identify those populations that should be the focus of conservation efforts and which management scenarios will best preserve these populations (Menges 2000, pp. 51-56; Oostermeijer *et al.* 2003, pp. 389-398). Detailed information on parameters such as recruitment, growth, mortality, and age structure of the population are required to model population persistence (Menges 1990, p. 54; Schemske *et al.* 1994, pp. 590-591; Lesica 1997, p. 347; Menges 2000, p. 55), consequently many years of monitoring will be needed to acquire the data necessary to conduct a population viability analysis for *S. spaldingii*. Without a population viability analysis, minimum viable population numbers for plants must be estimated utilizing data from the general literature and comparisons with similar species.

Minimum viable population size is most frequently and broadly estimated at 250 to 500 reproductive individuals (summarized in Schonewald-Cox *et al.* 1983, p. 392). However, caution is needed when applying a standard minimum viable population number, especially to plants, since different life strategies may make them more or less susceptible to extinction (Menges 1991b, p. 49). For example, in one study, researchers determined that populations with fewer than 100 breeding individuals are highly vulnerable to extinction through mutations, although this extinction may take 100 generations (Lynch *et al.* 1995, p. 509). Another study found plants that were primarily outcrossing species were more prone to extinction than other selfing species (Lennartsson 2002, p. 3069). Depending on factors such as population growth rates and the degree of environmental variation, some estimates of minimum viable populations range into the thousands or tens of thousands (Soulé and Simberloff 1986, p. 30; Shaffer 1987, pp. 73-75; Nunney and Campbell 1993, p. 235; Lande 1995, pp. 784-789). Researchers examining *Silene regia* found that population size was not the primary influencing factor, but that fire management most significantly affected survivability into the future (Menges and Dolan 1998, pp. 74-75). A population viability analysis has not been done for *S. spaldingii* but would help to direct management, identify what factors are important for conservation of *S. spaldingii*, and which *S. spaldingii* populations are most important for conservation. In contrast to this utility of population viability analyses, establishing minimum viable population sizes can be difficult and problematic. For example, a recent review study predicting minimum viable population sizes for 1198 species found estimates were unrelated to the anthropogenic threats and were unrelated to extinction risk (Brook *et al.* 2006, p. 375). We suggest utilizing the standard minimum of at least 500 reproductive individuals. This number may be revisited with input from species experts upon the completion of a population viability analysis. More importantly, populations identified as key conservation areas will need to demonstrate stable or increasing trends. Sites with more than 500 plants will be maintained at or above current population numbers.

This recovery plan emphasizes conservation efforts for larger populations of *Silene spaldingii* while attempting to preserve the genetic diversity within each of the five physiographic regions where the plant resides. This is in line with the conservation strategy suggested by Nunney and Campbell (1993, p. 237-238), which focuses on the preservation of several populations, each supporting a density of at least the minimum viable population size, across heterogeneous habitats. Until additional information on the population viability of *S. spaldingii* is available, all existing habitat supporting *S. spaldingii* should be protected and managed. In particular, emphasis should be placed on populations or areas that have the potential of supporting at least 500 individuals. We have defined such populations or areas as **key conservation areas**. A key conservation area possesses the following qualities:

- Composed of intact habitat (not fragmented), preferably 40 acres (16 hectares) in size or greater[7]
- Native plants comprise at least 80 percent of the canopy cover of the vegetation community
- Adjacent habitat sufficient to support pollinating insects
- Habitat is of the quality and quantity necessary to support at least 500 reproducing individuals of *Silene spaldingii*

The protection and management of these key conservation areas, or areas that have the potential to serve as key conservation areas, forms the foundation of the recovery strategy for *Silene spaldingii*. When possible, these key conservation areas should be surrounded by 300 acres of habitat that is intact or can be restored to eventually support *S. spaldingii*. Details regarding the identified key conservation areas for *S. spaldingii* are provided in the Recovery Actions Narrative (Section III-B), and the key conservation areas for each physiographic region are identified in Figures 6 through 10 of that section.

The wide range of *Silene spaldingii* creates a suite of various habitats where a complex list of threats to the species interacts. This recovery plan seeks to address these threats and makes recommendations to ensure the persistence of the species. As described in detail in the Threats Assessment (Section I-G of this plan), the threats addressed include invasive nonnative plants, small populations and habitat fragmentation, livestock use, wildlife herbivory, fire suppression and

[7] In some regions, such as the already severely fragmented Palouse prairie, reaching a minimum size of 40 acres (16 hectares) of contiguous habitat may not be feasible.

increases, habitat loss, and off-road vehicle use. The aim of the recovery strategy for *S. spaldingii* is to first manage its habitat on an ecosystem basis — maintaining the habitat so that *S. spaldingii* and its natural interactions within the ecosystem (*e.g.* pollinators, fire) may be maintained. This will be accomplished by developing and implementing habitat management plans at all key conservation areas that provide guidance in managing *S. spaldingii*, and that also address the threats to the species. To accomplish conservation and recovery of *S. spaldingii* a series of actions need to be implemented. Invasive nonnative plants need to be controlled and managed within *S. spaldingii* habitat with minimal impact to the species itself. Larger populations where small population size and fragmentation are less of a problem should be a higher priority for protection than smaller, more fragmented populations. In addition, in order to preserve the full array of genetic variability within the species, large populations are needed in each of the five geographic regions where the plant resides. Because successful recruitment events are sporadic and may be separated by several years, *ex situ* propagation and restoration to supplement existing populations will probably be necessary in order to meet the recovery goals. Fire management and prescribed burning need to be conducted carefully, with sound monitoring strategies and guided by the best available scientific information. Conservation actions should be implemented for those sites that occur on lands targeted for development. Off-road vehicle use within *S. spaldingii* populations should be prevented. Wildlife should be managed at levels that are compatible with *S. spaldingii* conservation, and livestock grazing and trampling should be managed so that *S. spaldingii* and its habitat are not adversely affected.

Because *Silene spaldingii* has a long life span, takes several years to reach reproductive maturity, exhibits prolonged dormancy, and has sporadic recruitment events, long-term monitoring data are necessary to adequately assess trends within populations. Lesica and Steele (1994, p. 211) assessed the implications of prolonged dormancy in plants for monitoring, and point out that long-term monitoring is necessary to distinguish real population trends from the variation that may be observed over the short term due to recording error, prolonged dormancy, or other changes related to climatic fluctuations. They suggest that repeated sampling of permanent plots for 3 or more consecutive years (short-term sample) would be needed every 5 to 20 years (long-term period) to overcome the natural variability in population counts and make any statistically significant estimate of the population trend. Thus for a plant such as *S. spaldingii*, it will take at least 3 years of repeated sampling to get a single data point from which to assess trends. Monitoring 3 out of every 5 years over a 20 year time period would yield a total of four data points for each permanent monitoring plot. We considered this to be the minimum amount of data required from which to estimate long-term population trends in *S. spaldingii*, leading to our recommendation that delisting be considered only after populations have been monitored for at least 20 years.

Silene spaldingii should be closely monitored: 1) to determine population trends, reproductive success, and habitat conditions; and 2) to assess the effects of existing or potential threats on *S. spaldingii* and its important habitat. Effectiveness monitoring should also be developed to address management actions and ensure that the factors affecting *S. spaldingii* are being adequately addressed. Survey efforts are needed to identify other *S. spaldingii* populations that need conservation. Outreach will inform the public about the species so they may assist in conservation, and seed banks will help to protect the species from catastrophic losses. Funding is required to implement all of these actions. Finally, a regular review of this recovery plan is needed so that new information may be incorporated and management adjusted accordingly.

B. Recovery Goals, Objectives, and Criteria

The goal of the recovery program is to recover *Silene spaldingii* to the point where it can be delisted, *i.e.*, to remove the species from threatened status. The primary objectives to meet this goal are to reduce or eliminate the threats to the species, and protect and maintain multiple reproducing, self-sustaining populations distributed across each of the five distinct physiographic regions where it resides sufficient to ensure the long-term persistence of the species (Figures 4 and 5).

Box 2. Definitions according to section 3 of the Endangered Species Act.

Endangered Species
Any species that is in danger of extinction throughout all or a significant portion of its range

Threatened Species
Any species that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range

Delisting of *Silene spaldingii* will be warranted when the species no longer meets the definition of threatened or endangered under the Endangered Species Act (Act) (Box 2). We set recovery criteria to serve as objective, measurable guidelines to assist us in determining when a species has recovered to the point that the protections afforded by the Act are no longer necessary. However, the actual change in status is not solely dependent upon achieving the recovery criteria set forth in a recovery plan; it requires a formal rulemaking process based upon an analysis of the same five factors considered in the listing of a species (see pages 25 and 26). The recovery criteria presented in this recovery plan thus represent our best assessment of the conditions that would most likely result in a determination that delisting of *S. spaldingii* is warranted as the outcome of a formal five factor analysis in a subsequent regulatory rulemaking. The recovery criteria and actions outlined here reflect the information currently available on this species, and identify information needs that are pertinent to the long-term conservation and management of *S. spaldingii*. The rationales for the following criteria are contained below and within the following "Recovery Action Narrative."

Delisting Criteria

Delisting of *Silene spaldingii* will be considered when all the following criteria are met:

1. Twenty-seven populations, with at least 500 reproducing *Silene spaldingii* individuals in each and with intact habitat, occur rangewide at key conservation areas and are distributed throughout the 5 identified physiographic provinces as follows: 5 within the Blue Mountain Basins, 7 within the Canyon Grasslands, 8 within the Channeled Scablands, 4 within the Intermontane Valleys, and 3 within the Palouse Grasslands. Given the uncertainty associated with creating new key conservation areas (*i.e.* transplanting) and the limited available habitat within the Palouse physiographic region, the delisting criteria of three key conservation areas within the Palouse will be evaluated within 10 years (2017) based on new information. Populations with more than 500 plants will be maintained at or above current population numbers.

   The number of populations/key conservation areas for each physiographic province was set at a minimum of three to preserve genetic diversity. For some regions, a greater number of key conservation areas are proposed to reflect the number of populations needed to maintain connectivity and, to the extent possible, preserve historical distribution across the remaining potential habitat estimated to be available (Factors A-E).

2. All 27 key conservation areas of *Silene spaldingii* are composed of at least 80 percent native vegetation (by canopy cover), have adjacent habitat sufficient to support pollinating insects, and are not fragmented (*i.e.*, intact; see criterion #1) (Factor A).

3. Populations of *Silene spaldingii* at key conservation areas demonstrate stable or increasing population trends (less than a 10 percent chance that the population is declining) for at least 20 years. To address this criterion, consistent range-wide long-term monitoring methodologies that identify what parameters will be monitored, how, and at what frequency need to be developed. Acceptable statistical power and false-change error rates will be established at a later date when a standardized rangewide monitoring protocol is developed (Factors A-E).

4. Habitat management plans have been developed and implemented for all key conservation areas. These management plans will provide for the protection of *Silene spaldingii* habitat, and will also protect the ecosystem by addressing conservation of other rare species, reducing the identified threats (*e.g.*, off-road vehicle use, adverse grazing and trampling by wildlife and domestic stock, herbicide application, etc.), protecting pollinators, enacting monitoring strategies, incorporating integrated pest management strategies, and incorporating appropriate fire management activities (Factors A, C, D).

5. Invasive nonnative plants with the potential to displace *Silene spaldingii* have been continually controlled or eradicated within 100 meters (328 feet) of all *S. spaldingii* populations within key conservation areas (Factor A). Certain invasive plants that are established and difficult to eradicate, as detailed for each physiographic province under Recovery Actions 1.1.4, 1.2.4, 1.3.4, 1.4.4, and 1.5.5, may be controlled within 25 meters (82 feet) of *S. spaldingii* populations.

6. Prescribed burning is conducted, whenever possible, to mimic historical fire regimes within a particular physiographic region in *Silene spaldingii*

habitat. Prior to burning, presence/absence surveys for the plant will be completed. Prescribed burning of more than 30 percent of the individuals at a *S. spaldingii* population should not occur at any one time and should not take place when it may exacerbate invasive nonnative plant populations unless invasive nonnative plant control measures, monitoring, and a management strategy are in place prior to the prescribed burn. Where *S. spaldingii* is present, monitoring is enacted prior to and following the prescribed burn. Historical fire regimes are carefully analyzed utilizing the best available technology (Factors A, E).

7. Seed banking occurs *ex situ* first at all smaller *Silene spaldingii* populations (not key conservation areas or potential key conservation areas) and second at all larger *S. spaldingii* populations (key conservation areas or potential key conservation areas) to preserve the breadth of genetic material across the species' range (Factor A).

8. A post-delisting monitoring program for the species will be developed and ready for implementation. This program will be developed through coordination with the Bureau of Land Management, U.S. Forest Service, U.S. Fish and Wildlife Service, Tribes, States, The Nature Conservancy, and other interested parties (Factors A-E).

III. Recovery Program

The recovery program presented here is separated into two parts: (1) recovery actions specific to each of the physiographic regions; and (2) general recovery actions. Because differences are considerable between physiographic regions, this split is needed to address recovery actions specific to a physiographic region while still identifying recovery actions that are applicable rangewide.

A. Stepdown Outline of Recovery Actions

1. Conserve, identify, develop, and expand *Silene spaldingii* populations and habitat in each of the five physiographic regions where *S. spaldingii* resides.
   - 1.1. Conserve, identify, and expand *Silene spaldingii* populations and habitat within the Blue Mountain Basins (goal: five key conservation areas).
     - 1.1.1. Conserve and work to enhance the four *Silene spaldingii* populations within the Blue Mountain Basins identified here as potential key conservation areas.
     - 1.1.2. Conduct further surveys to identify, or work to create, at least one new population and key conservation area within the Blue Mountain Basins with over 500 individuals.
     - 1.1.3. Conserve and protect smaller populations within the Blue Mountain Basins.
     - 1.1.4. Control and manage invasive nonnative plant species specific to the Blue Mountain Basins.
   - 1.2. Conserve, identify, and expand *Silene spaldingii* populations and habitat within the Canyon Grasslands (goal: seven key conservation areas).
     - 1.2.1. Conserve and work to enhance the five *Silene spaldingii* populations within the Canyon Grasslands identified here as potential key conservation areas.
     - 1.2.2. Conduct further surveys to identify at least two new populations and potential key conservation areas within the Canyon Grasslands with over 500 individuals.
     - 1.2.3. Conserve and protect smaller populations within the Canyon Grasslands.
     - 1.2.4. Control and manage invasive nonnative plant species specific to the Canyon Grasslands.

1.3. Conserve, identify, and expand *Silene spaldingii* populations and habitat within the Channeled Scablands (goal: eight key conservation areas).
   1.3.1. Conserve, survey, and work to enhance the seven *Silene spaldingii* populations within the Channeled Scablands identified here as potential key conservation areas.
   1.3.2. Conduct further surveys to identify, or work to create, at least one new population and key conservation area within the Channeled Scablands with over 500 individuals.
   1.3.3. Conserve and protect smaller populations within the Channeled Scablands.
   1.3.4. Control and manage invasive nonnative plant species specific to the Channeled Scablands.

1.4. Conserve, identify, and expand *Silene spaldingii* populations and habitat within the Intermontane Valleys (goal: four key conservation areas).
   1.4.1. Conserve and work to enhance the three *Silene spaldingii* populations within the Intermontane Valleys identified here as potential key conservation areas.
   1.4.2. Conduct further surveys or work to supplement existing populations within the Intermontane Valleys to achieve at least one additional potential key conservation areas with over 500 individuals.
   1.4.3. Conserve and protect smaller populations within the Intermontane Valleys.
   1.4.4. Control and manage invasive nonnative plant species specific to the Intermontane Valleys.

1.5. Conserve, identify, develop, and expand *Silene spaldingii* populations and habitat within the Palouse Grasslands (goal: three key conservation areas).
   1.5.1. Conserve and work to enhance the three *Silene spaldingii* populations within the Palouse Grasslands identified here as a potential key conservation areas.
   1.5.2. Conduct a study identifying intact habitat within the Palouse Grasslands where *Silene spaldingii* may occur and follow with surveys for the plant.
   1.5.3. Supplement existing populations and conduct a restoration and reintroduction program within the Palouse Grasslands to achieve

the goal of three key conservation areas of *Silene spaldingii* with over 500 individuals.

1.5.4. Conserve and protect smaller populations within the Palouse Grasslands.

1.5.5. Control and manage invasive nonnative plant species specific to the Palouse Grasslands.

2. Conduct general recovery actions across the range of *Silene spaldingii*.

2.1. Revise and implement general management plans to include *Silene spaldingii* where the species resides.

2.2. Develop *Silene spaldingii* specific habitat management plans at all key conservation areas.

2.3. Habitat management plans and recovery actions should manage for impacts and threats to *Silene spaldingii* populations and habitat both at key conservation areas as well as at smaller populations.

2.3.1. Implement invasive nonnative plant control and integrated pest management programs at all *Silene spaldingii* sites, taking care not to impact *S. spaldingii*.

2.3.1.1. Incorporate integrated pest management programs into habitat management plans for *Silene spaldingii* at all key conservation areas and other areas as needed.

2.3.1.2. Conduct invasive nonnative plant control and management measures at all key conservation areas and other populations as needed.

2.3.1.3. Ensure invasive nonnative plant control and management measures are coordinated with appropriate agencies.

2.3.1.4. Conduct outreach activities for individuals or organizations that are involved in controlling and managing invasive nonnative plants.

2.3.1.5. Conduct surveys for *Silene spaldingii* before invasive nonnative plant control measures are implemented.

2.3.1.6. Develop and implement guidelines for herbicide applications around *Silene spaldingii* plants.

2.3.1.6.1. Develop set distances where various herbicide application techniques may be used near *Silene spaldingii* plants.

2.3.1.6.2. Develop set distances for specific herbicides that may be employed near known *Silene spaldingii* sites.

2.3.1.6.3. Develop guidelines for the timing of herbicide applications.

2.3.2. Conduct fire management activities within *Silene spaldingii* habitat.

2.3.2.1. Incorporate fire management plans into habitat management plans for all *Silene spaldingii* populations identified as key conservation areas and other areas as needed.

2.3.2.2. Carefully conduct prescribed burns within *Silene spaldingii* habitat.

2.3.2.2.1. Conduct surveys for *Silene spaldingii* before prescribed burns are implemented.

2.3.2.2.2. Monitor the effects to *Silene spaldingii* and its habitat from all burns.

2.3.2.2.3. Do not conduct prescribed burns where invasive nonnative plant infestations exist unless accompanied by an integrated pest management program and monitoring.

2.3.3. Protect *Silene spaldingii* sites from development on public and private lands.

2.3.4. Monitor and manage livestock grazing and associated management activities to avoid impacts to *Silene spaldingii* and its habitat.

2.3.4.1. Manage and mitigate livestock grazing and associated management activities to avoid and minimize impacts to *Silene spaldingii* and its habitat.

2.3.4.2. Monitor livestock grazing and associated management activities to measure and manage impacts to *Silene spaldingii* and its habitat.

2.3.5. Implement effective off-road vehicle use control measures.

2.3.6. Monitor and manage wildlife populations and associated management activities to avoid impacts to *Silene spaldingii* and its habitat.

2.3.7. Avoid herbicide use not related to controlling invasive nonnative plant infestations specific to protecting *Silene spaldingii* and all insecticide use within a 1.6 kilometer (1 mile) radius of all *S. spaldingii* populations.

2.4. Monitor population trends and habitat conditions.

- 2.4.1. Monitor *Silene spaldingii* populations at key conservation areas periodically to determine population trends.
- 2.4.2. Conduct demographic monitoring across the range of *Silene spaldingii*.
- 2.4.3. Monitor and evaluate the response of *Silene spaldingii* to fire and invasive nonnative plants.
- 2.4.4. Obtain permission from private landowners to conduct population trend monitoring for *Silene spaldingii* on private lands.
- 2.4.5. Determine if sites with no plants have been extirpated.

2.5. Conduct research essential to the conservation of *Silene spaldingii*.

- 2.5.1. Determine population viabilities for *Silene spaldingii* populations.
- 2.5.2. Develop new populations or supplement existing populations of *Silene spaldingii* where appropriate.
  - 2.5.2.1. Utilize existing potential key conservation areas and identify new key conservation areas with good habitat where new populations should be developed or where existing populations could be supplemented.
  - 2.5.2.2. Determine the best techniques and develop guidelines for creating new populations or supplementing existing populations of *Silene spaldingii*.
  - 2.5.2.3. Develop guidelines to ensure genetic conservation during supplementation, re-introduction, and introduction activities.
  - 2.5.2.4. Determine the best techniques to restore *Silene spaldingii* habitat.
- 2.5.3. Conduct research essential to controlling and managing invasive nonnative plants within *Silene spaldingii* habitat.
- 2.5.4. Conduct research essential to managing livestock, wildlife, and insect herbivory at *Silene spaldingii* populations.
- 2.5.5. Conduct research to better determine the effects of fire on *Silene spaldingii* and identify when and where prescribed fire should occur, particularly outside of Montana.
- 2.5.6. Conduct further research regarding reproductive biology and essential pollinators for *Silene spaldingii*.
- 2.5.7. Conduct research investigating seed dispersal mechanisms for *Silene spaldingii*.

2.5.8. Conduct research on soil seed bank ecology including seed longevity, seed viability, and genetics.

2.5.9. Conduct further genetic research including genetic diversity and gene flow across *Silene spaldingii*'s range.

2.6. Conduct surveys in potential habitat areas. Manage and protect any newly discovered *Silene spaldingii* populations.

2.6.1. Conduct surveys on Federal lands for *Silene spaldingii*.

2.6.2. Conduct surveys on State and Tribal lands, especially where activities may affect *Silene spaldingii* habitat.

2.6.3. Obtain permission from private landowners to conduct surveys for *Silene spaldingii* on private lands.

2.6.4. Protect newly discovered *Silene spaldingii* populations.

2.7. Support conservation on privately owned lands.

2.7.1. Support conservation actions on lands owned by The Nature Conservancy.

2.7.2. Support conservation activities on other private lands.

2.7.3. Conduct outreach and awareness efforts with the public regarding *Silene spaldingii*'s plight and its conservation.

2.8. Pursue land and species designations that will help facilitate conservation of *Silene spaldingii*.

2.9. Establish propagule banks, including a long-term seed storage facility for *Silene spaldingii*.

2.10. Secure funding for implementation of recovery tasks.

2.11. Validate and revise recovery objectives as needed.

2.12. Convene annual meetings of the *Silene spaldingii* technical team.

3. Develop a post-delisting monitoring plan.

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Box 3. Interpretation of Figures 6 thru 10, key conservation areas for *Silene spaldingii* in each of the five physiographic regions.

Buffers were computer generated using element occurrence record (or site) data.
If 0.8 kilometer (0.5 mile) buffers around element occurrence records (sites) overlapped, sites were grouped together into a single population. Overlap indicated two sites were within 1.6 kilometers (1 mile) of one another.
Physiographic regions as delineated in Figure 4 are repeated within these figures for the specific physiographic region pictured.
One-mile and 2-mile buffers have been included to indicate satellite populations with the potential to become part of adjacent populations, depending upon further surveys.
Population numbers and key conservation areas are identified in each figure only for the physiographic region delineated within the dashed line.
Potential key conservation areas are indicated with labeled boxes.

B. Recovery Action Narrative

1. **Conserve, identify, develop, and expand *Silene spaldingii* populations and habitat in each of the five physiographic regions where *S. spaldingii* resides.** In general, large populations have higher genetic diversity than smaller populations and so have a higher survivability (Barrett and Kohn 1991, pp. 5-6). In addition, genes in wide ranging taxa also vary across the larger landscape (Huenneke 1991, pp. 32-33). To preserve the genetic integrity of *Silene spaldingii*, larger populations are prioritized before smaller populations, and representative populations from each of the five physiographic regions are identified. Until a population viability analysis has been done for *S. spaldingii* that models which populations are viable under various management strategies, a minimum of 500 reproducing individuals — assumed to represent the minimum viable population size — will be the default goal for all key conservation areas in each of the five physiographic regions (identified below and in Figures 6 through 10). Within regions, attempts should be made to develop key conservation areas so that they are distributed across each physiographic region. Several physiographic regions (the Blue Mountain Basins, Canyon Grasslands, and Channeled Scablands) will likely reach their key conservation area goals through further survey efforts, whereas the Intermontane Valleys and Palouse Grasslands may require the creation or supplementation of populations such that their key conservation area goals can be met.

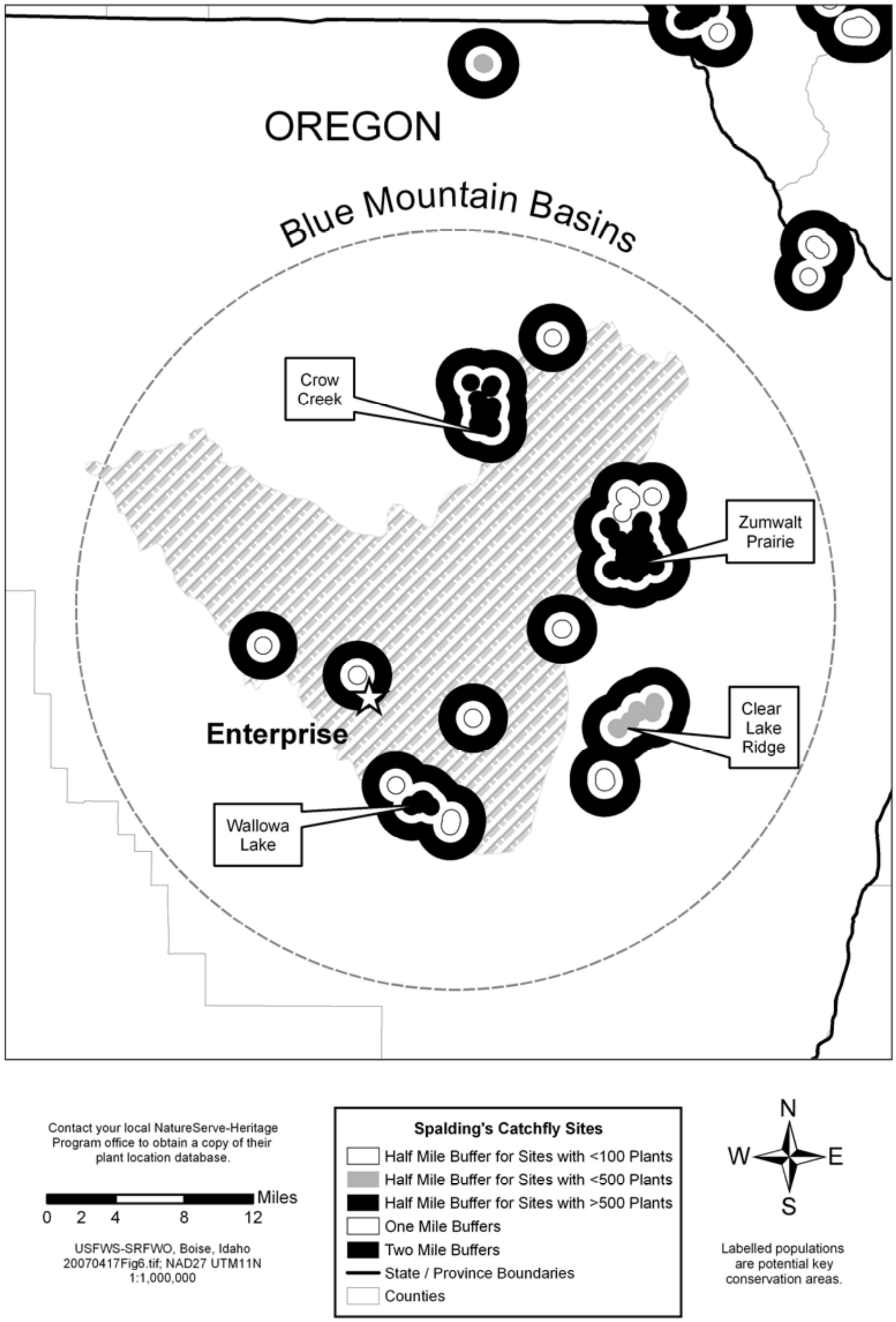

Figure 6. The 14 known *Silene spaldingii* populations and 4 potential key conservation areas within the Blue Mountains physiographic region.

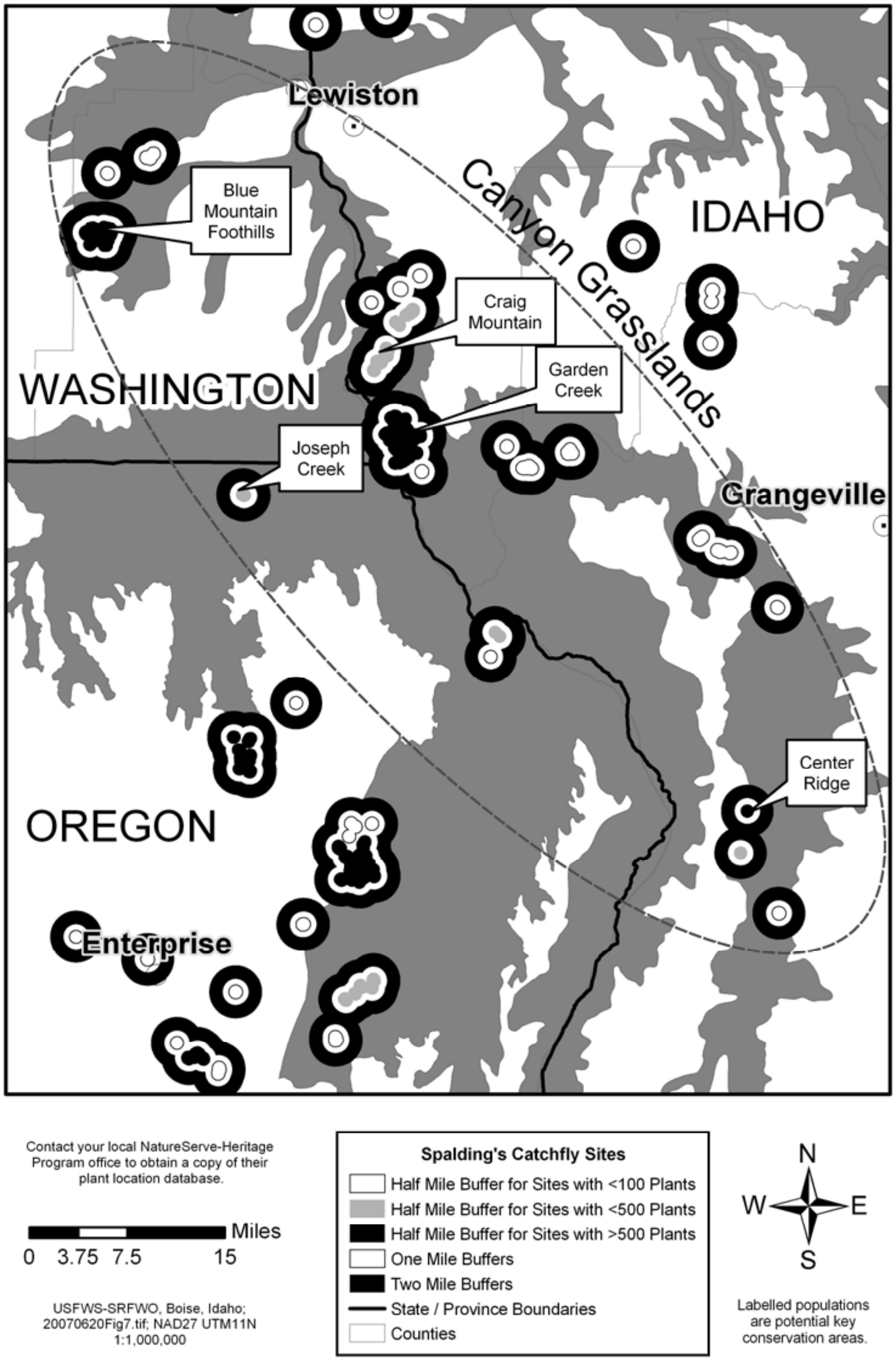

Figure 7. The 22 known *Silene spaldingii* populations and 5 potential key conservation areas identified within the Canyon Grasslands physiographic region.

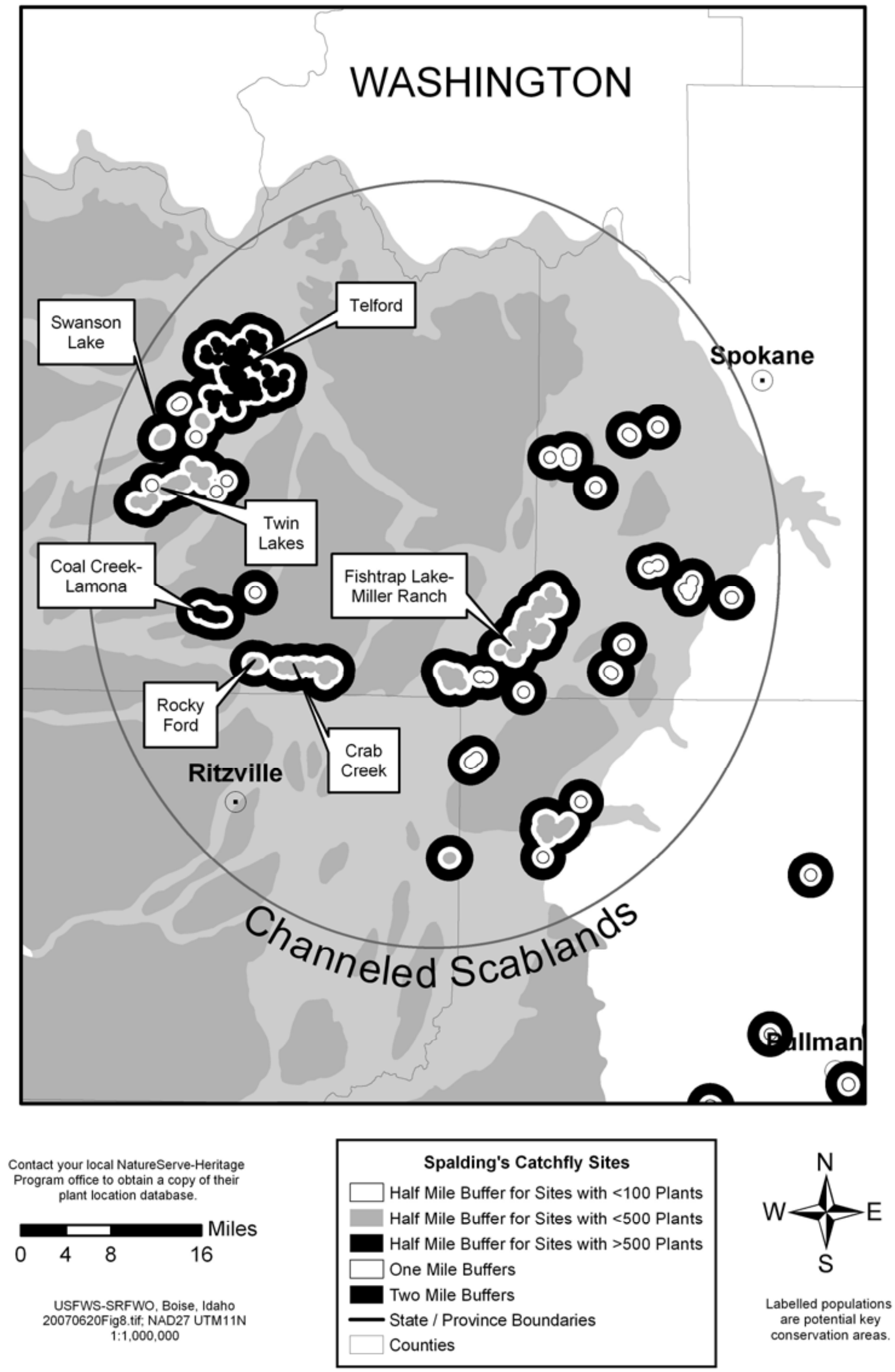

Figure 8. The 33 known *Silene spaldingii* populations and 7 potential key conservation areas identified within the Channeled Scablands physiographic region.

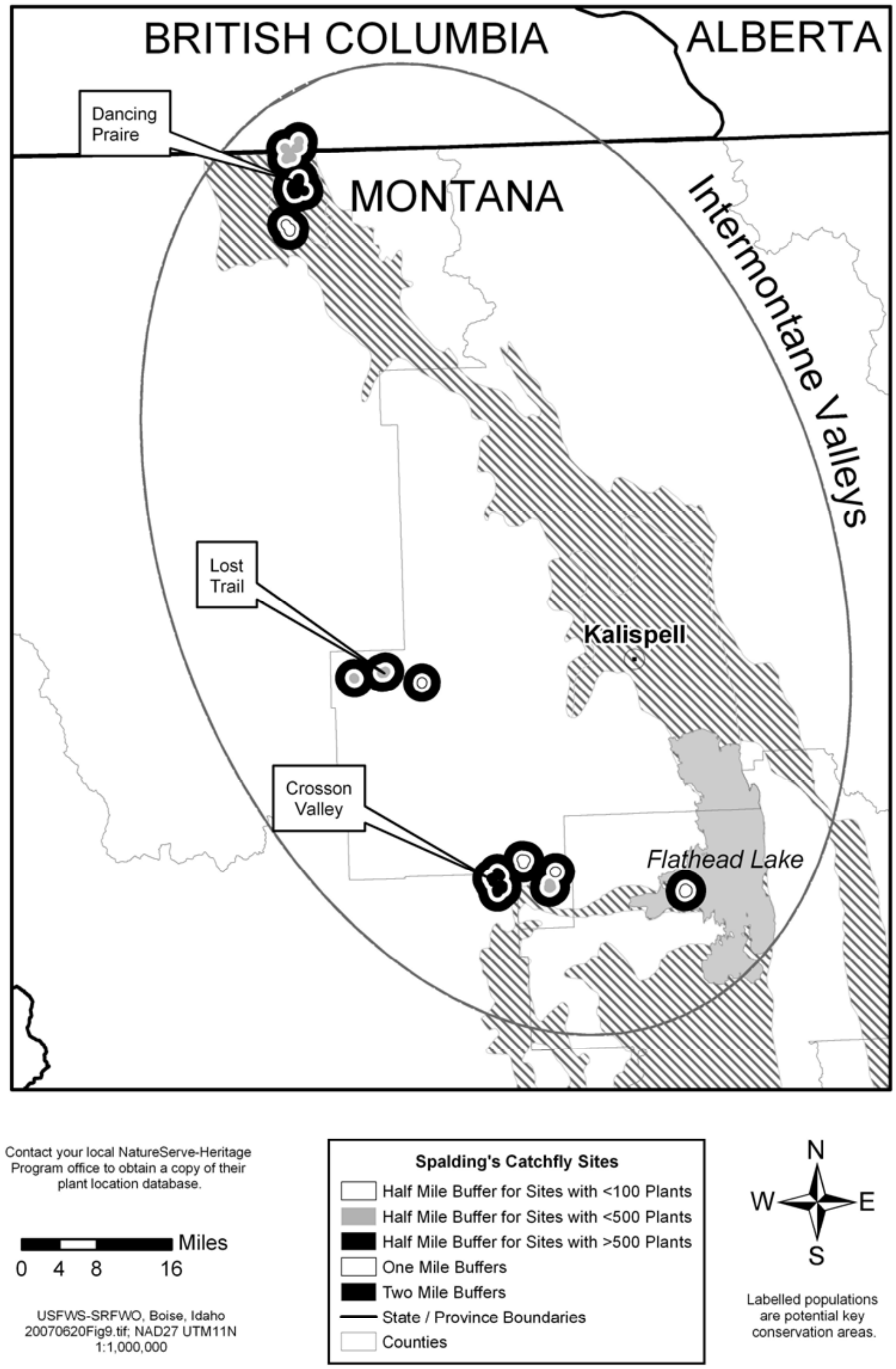

Figure 9. The 10 *Silene spaldingii* populations and 3 potential key conservation areas identified within the Intermontane physiographic region.

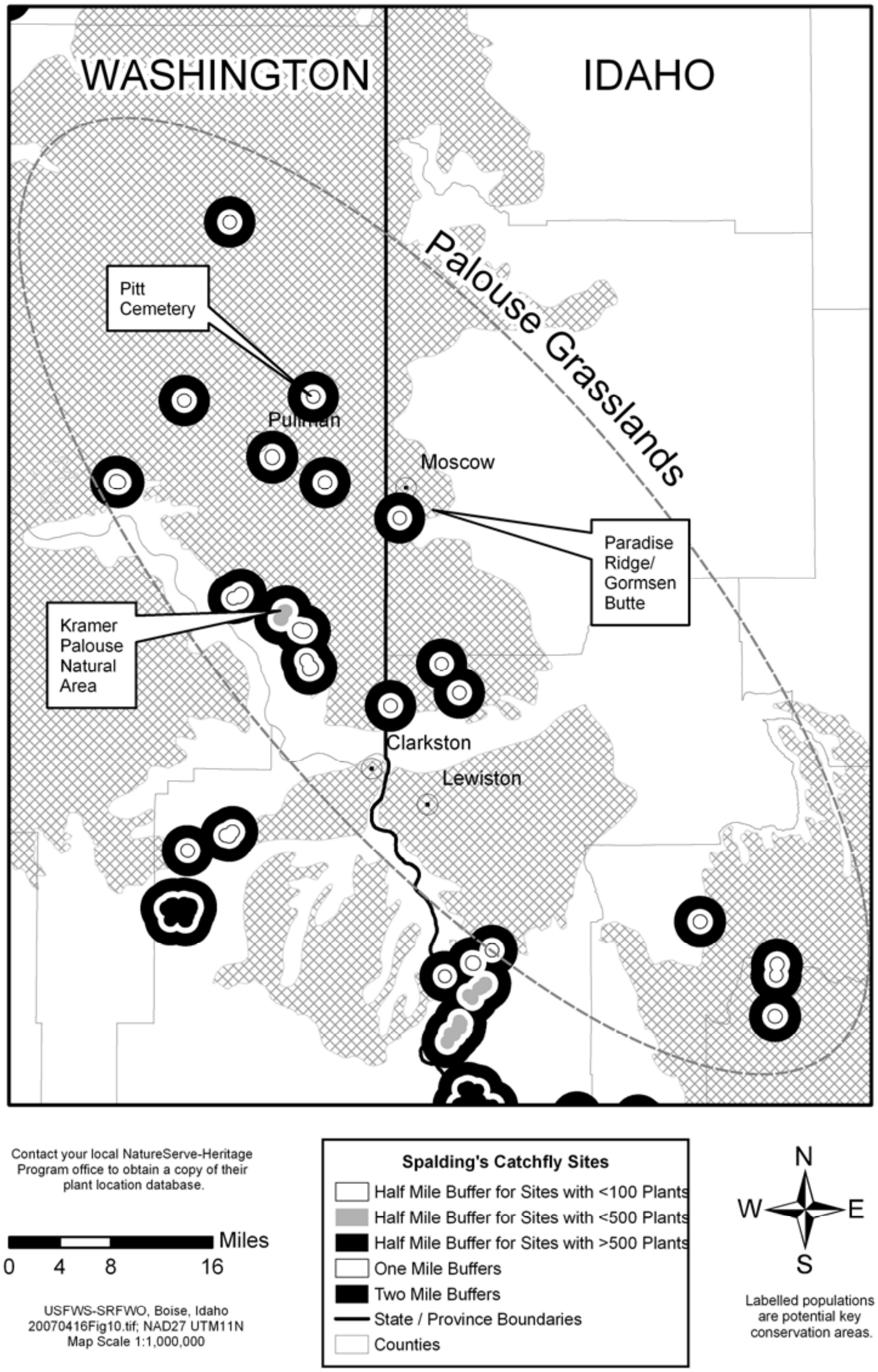

Figure 10. The 18 *Silene spaldingii* populations and 3 potential key conservation areas within the Palouse Grasslands physiographic region.

1.1. Conserve, identify, and expand *Silene spaldingii* populations and habitat within the Blue Mountain Basins (goal: five key conservation areas). The Blue Mountain Basins of Oregon, with 14 *Silene spaldingii* populations, have 4 potential key conservation areas identified here: Clear Lake Ridge, Crow Creek, Wallowa Lake, and the Zumwalt Prairie (Figure 6). The populations on The Nature Conservancy's Zumwalt Prairie Preserve were not discovered until the land was purchased in 2000, and there appear to be substantial tracts of suitable habitat on unsurveyed private, Tribal, and public lands, so it is reasonable to assume there are most likely other populations of *S. spaldingii* within the Blue Mountain Basins. Therefore, the goal of 5 populations of *S. spaldingii* with both intact habitat and a minimum of 500 reproducing individuals within the Blue Mountain Basins is justified. Populations with fewer than 500 individuals, not identified as potential key conservation areas, should be conserved where possible, particularly on federally managed land.

1.1.1. Conserve and work to enhance the four *Silene spaldingii* populations within the Blue Mountain Basins identified here as potential key conservation areas. The population at Clear Lake Ridge (considered here as part of the Blue Mountain Basins and not the Canyon Grasslands) has at least 331 individuals, Crow Creek has at least 2,385 individuals, Wallowa Lake has at least 506 individuals, and the Zumwalt Prairie has at least 1,917 individuals. Furthermore, all four populations have other satellite populations nearby (generally within 5 kilometers [3 miles]) with intact habitat between; *S. spaldingii* could be found in these intervening spaces in the future. Three of the four potential key conservation areas already have more than 500 individuals; only Clear Lake Ridge has fewer. This population should be better surveyed to potentially locate more individuals. If no more individuals can be located, supplementing the population with individuals grown from local seed sources should be considered (see Recovery Action 2.5.2). The Clear Lake Ridge population is predominantly managed by The Nature Conservancy and the Wallowa-Whitman National Forest, although some sites are on private land. Crow Creek is predominantly managed by the Wallowa-Whitman National Forest, with a small site or portions of sites on private land. The Wallowa Lake population is almost entirely privately owned with the exception of a site at the Chief Joseph Gravesite managed by the National Park Service. The Zumwalt Prairie is within the confines of The Nature Conservancy's Zumwalt Prairie Preserve. The recent acquisition of an unsurveyed conservation easement on property adjacent to the Zumwalt Prairie Preserve may add additional *S. spaldingii* individuals in the future. The numerous landowners involved will provide an additional challenge in conserving the species within the Blue Mountain Basins.

1.1.2. Conduct further surveys to identify, or work to create, at least two new populations and key conservation area within the Blue Mountain Basins with over 500 individuals. With additional survey work, particularly on private land, it is expected that additional populations of *S. spaldingii* will be located within the Blue Mountain Basins. If new populations are not identified, supplementing existing populations (see Recovery Action 2.5.2) should be considered to achieve the recovery goal of five key conservation areas in this region.

1.1.3. Conserve and protect smaller populations within the Blue Mountain Basins. Several smaller populations exist within the Blue Mountain Basins. These populations should also be protected from threats (see recovery actions listed under 2). Those populations that occur on private lands may benefit from education and outreach activities (see actions 2.3.1.4 and 2.7.3), conservation easements and voluntary cooperation (see action 2.7).

1.1.4. Control and manage invasive nonnative plant species specific to the Blue Mountain Basins. Invasive nonnative plant species vary by physiographic region. Within the Blue Mountain Basins, invasive nonnative plant species of concern include: *Centaurea maculosa* (spotted knapweed), *C. diffusa* (diffuse knapweed), *C. solstitialis* (yellow starthistle), *Cirsium arvense* (Canada thistle), *Poa pratensis* (Kentucky bluegrass), and *Potentilla recta* (sulfur cinquefoil). These invasive nonnative plant species, and others as they are discovered, should be controlled or eliminated utilizing integrated pest management practices (Bottrell 1979; Luken and Thieret 1997) within 100 meters (328 foot) of *Silene spaldingii* populations (see Recovery Action 2.3.1). Other invasive nonnative grass species including *Bromus tectorum* (cheatgrass), and *Ventenata dubia* (ventenata), should be controlled using integrated pest management practices to within 25 meters (82 feet) of *Silene spaldingii* populations.

1.2. Conserve, identify, and expand *Silene spaldingii* populations and habitat within the Canyon Grasslands (goal: seven key conservation areas). The Canyon Grasslands of Idaho, Oregon, and Washington, with 22 *Silene spaldingii* populations, have 5 potential key conservation areas identified here: the Blue Mountain Foothills, Center Ridge, Craig Mountain, Garden Creek, and Joseph Creek (Figure 7). The Joseph Creek site is included here despite its small population size (161 plants) because of the quality and extent of intact habitat, the potential to discover more sites in the immediate area, and because it occurs on the Nez Perce Precious Lands Wildlife Management Area which offers permanent protection (R. Miles, *in litt.* 2006, p. 4). The Canyon Grasslands are steep and therefore difficult to survey and there remain large tracts of unsurveyed intact habitat, so it is expected there may be many more populations of *S. spaldingii* within this physiographic region. Therefore, the goal of seven populations of *S. spaldingii* with intact habitat and a minimum of 500 reproducing individuals within the Canyon Grasslands is justifiable. Populations with fewer than 500 individuals, not identified as key conservation areas, should be conserved where possible, particularly on federally managed land.

1.2.1. Conserve and work to enhance the five *Silene spaldingii* populations within the Canyon Grasslands identified here as potential key conservation areas. Three of these populations already number more than 500 individuals: the Blue Mountain Foothills has at least 997, Center Ridge has an estimated 500 individuals, and Garden Creek has at least 3,987 individuals. Two separate populations comprise the Craig Mountain key conservation area as shown in Figure 7: Captain John Creek with at least 223 individuals to the north, and Billy Creek with at least 220 individuals to the south. Much of the land between these two sites remains unsurveyed and it is expected that with further survey effort this may become one larger population. With still further surveys, it is possible that the Garden Greek and Craig Mountain key conservation areas may constitute one single large population. The Joseph Creek site contains at least 161 individuals with a high potential to discover more within one mile of the known site. There is extensive habitat in the immediate area with good opportunity to discover or create additional populations. The Blue Mountains Foothills population is managed by the Umatilla National Forest. The Center Ridge population is managed by the Nez Perce National Forest. Craig Mountain is managed by the Bureau of Land Management Cottonwood Field Office in the south and the Idaho Department of Fish and Game in the north. Garden Creek is managed by the Bureau of Land Management and The Nature Conservancy. The Nez Perce Tribe manages the Joseph Creek population with support from the Bonneville Power Administration (R. Miles, *in litt.* 2006, p. 5).

1.2.2. Conduct further surveys to identify at least two new potential key conservation areas within the Canyon Grasslands with over 500 individuals. All of the populations within the Canyon Grasslands have been discovered within the last 15 years, and most within the last 10 years. Prior to the discovery of these populations, the Canyon Grasslands had not been searched for *Silene spaldingii*. The Canyon Grasslands are extremely steep and difficult to access, which has kept the habitat relatively intact and under surveyed. For these reasons, it is expected that there are many more populations of *S. spaldingii* within this physiographic region with intact habitat. In addition to the three potential key conservation areas already identified (Recovery Action 1.2.1), at least three additional potential key conservation areas must be established to meet the recovery goal for this region. If two new populations cannot be discovered with increased survey effort, the establishment of new populations should be considered (see Recovery Action 2.5.2).

1.2.3. Conserve and protect smaller populations within the Canyon Grasslands. Several smaller populations exist within the Canyon Grasslands. These populations should also be protected from threats (see recovery actions listed under 2). Those populations that occur on private lands may benefit from education and outreach activities (see actions 2.3.1.4 and 2.7.3), conservation easements and voluntary cooperation (see action 2.7).

1.2.4. Control and manage invasive nonnative plant species specific to the Canyon Grasslands. Within the Canyon Grasslands, invasive nonnative plants of concern include: *Acroptilon repens* (Russian knapweed), *Cardaria draba* (whitetop), *Centaurea diffusa* (diffuse knapweed), *Centaurea maculosa* (spotted knapweed), *Crupina vulgaris* (common crupina), *Euphorbia esula* (leafy spurge), *Lepidium latifolium* (perennial pepperweed), *Linaria* dalmatica (Dalmatian toadflax), *Onopordum acanthium* (Scotch thistle), and *Potentilla recta* (sulfur cinquefoil). These invasive nonnative plants and others as they are discovered should be controlled or eliminated utilizing integrated pest management practices (Bottrell 1979; Luken and Thieret 1997) within a 100 meters (328 foot) of *Silene spaldingii* populations at key conservation areas (see Recovery Action 2.3.1). Other invasive nonnative plants including bur chervil (*Anthriscus caucaluis*), Bromus *tectorum* (cheatgrass), *Centaurea solstitialis* (yellow starthistle), and *Hypericum perforatum* (St. Johnswort), *Poa pratensis* (Kentucky bluegrass), and *Ventenata dubia* (ventenata) are already relatively common within the Canyon Grasslands and so would be extremely expensive and difficult to control. Instead, these invasive nonnative plant species should be controlled using integrated pest management practices to within 25 meters (82 feet) of *S. spaldingii* populations. Where these more widespread invasive nonnative plants are not already present within *S. spaldingii* populations, such as *Centaurea solstitialis* at the Blue Mountain Foothills, control or eradication should occur within 100 meters (328 feet).

1.3. Conserve, identify, and expand *Silene spaldingii* populations and habitat within the Channeled Scablands (goal: eight key conservation

areas). The Channeled Scablands region of Washington, with 35 *Silene spaldingii* populations, has 7 potential key conservation areas identified here: Coal Creek –Lamona, Crab Creek, Fishtrap Lake – Miller Ranch, Rocky Ford, Swanson Lake, Telford, and Twin Lakes (Figure 8). Intact habitat comprises many of these areas, which if fully surveyed have the potential to yield many more *Silene spaldingii* populations. In addition, many recent land acquisitions have led to the discovery of substantial new populations of *S. spaldingii*. Therefore, the goal of eight populations of *S. spaldingii* with intact habitat surrounding the populations and a minimum of 500 reproducing individuals is attainable within the Channeled Scablands. Populations with fewer than 500 individuals, not identified as potential key conservation areas, should be conserved where possible, particularly on federally managed land.

1.3.1. Conserve, survey, and work to enhance the seven *Silene spaldingii* populations within the Channeled Scablands identified here as potential key conservation areas. Of these 7 potential key conservation areas, the Coal Creek – Lamona (500 individuals) and Telford (1100 individuals) populations currently have over 500 individuals. To meet the recovery goal for this region, at least 5 of the remaining potential key conservation areas must be further surveyed or enhanced to achieve the minimum of 500 individuals. At present, Crab Creek has at least 162 individuals, Fishtrap Lake – Miller Ranch has at least 490 individuals in two populations, Rocky Ford has over 300 individuals, Swanson Lake has over 487 individuals at one population and over 220 at another, and Twin Lakes has 603 individuals in four populations. Two of these potential key conservation areas, Fishtrap Lake – Miller Ranch and Swanson Lake, includes more than one population of *Silene spaldingii*. Both of these sites are within relatively intact habitat which if more thoroughly surveyed may lead to the discovery of more *S. spaldingii* individuals in interspaces. Crab Creek and Rocky Ford, with more extensive survey effort, could be part of the same population. The Coal Creek – Lamona, Crab Creek, Fishtrap Lake – Miller Ranch, Rocky Ford, and Telford key conservation areas are all managed by the Bureau of Land Management Spokane District. Twin Lakes are managed by both the Bureau of Land Management Spokane District as well as private landowners. Swanson Lake is managed by the Bureau of Land Management Spokane District and the Washington Department of Fish and Wildlife. Preferably, at least one key conservation area would be located in the northeastern portion of the Channeled Scablands, closer to Spokane and one further south to get better geographical spacing of key conservation areas.

1.3.2. Conduct further surveys to identify, or work to create, at least one new population and key conservation area within the Channeled Scablands with over 500 individuals. At least one additional population and key conservation area is needed within the Channeled Scablands. Populations towards the southern and northeastern reaches of the Channeled Scablands are small and isolated. To preserve genetic material across the Channeled Scablands, it would be better if new populations and key conservation areas were found or developed in these areas.

1.3.3. Conserve and protect smaller populations within the Channeled Scablands. Numerous smaller populations exist within the Channeled Scablands. These populations should also be protected from threats (see recovery actions listed under 2). Those populations that occur on private lands may benefit from education and outreach activities (see actions 2.3.1.4 and 2.7.3), conservation easements and voluntary cooperation (see action 2.7)

1.3.4. Control and manage invasive nonnative plant species specific to the Channeled Scablands. Within the Channeled Scablands, invasive nonnative plants of concern include: *Cirsium arvense* (Canada thistle), *Centaurea diffusa* (diffuse knapweed), *Chondrilla juncea* (rush skeletonweed), *Euphorbia esula* (leafy spurge), *Linaria* (toadflax), and *Centaurea solstitialis* (yellow starthistle). These invasive nonnative plants and others as they are discovered should be controlled or eliminated utilizing integrated pest management practices (Bottrell 1979; Luken and Thieret 1997) within 100 meters

(328 foot) of *S. spaldingii* populations at key conservation areas (see Recovery Action 2.3.1). Other invasive nonnative plants including *Poa pratensis* (Kentucky bluegrass), *Bromus tectorum* (cheatgrass), *Ventenata dubia* (ventenata), and *Hypericum perforatum* (St. Johnswort) are already relatively common within the Channeled Scablands and so would be extremely expensive to control. Instead, these invasive nonnative plant species should be controlled using integrated pest management practices to within 25 meters (82 feet).

1.4. Conserve, identify, and expand *Silene spaldingii* populations and habitat within the Intermontane Valleys (goal: four key conservation areas). The Intermontane Valleys of Montana, with 11 *Silene spaldingii* populations, have three potential key conservation areas identified: Crosson Valley, Dancing Prairie, and Lost Trail (Figure 9). Two of these sites, Crosson Valley and Dancing Prairie, already have populations with over 500 individuals. Further surveys and supplementation of already existing populations may be necessary within the Intermontane Valleys to achieve the recovery goal of four populations with a minimum of 500 individuals. Populations with fewer than 500 individuals, not identified within potential key conservation areas, should be conserved where possible, particularly on federally managed lands.

1.4.1. Conserve and work to enhance the three *Silene spaldingii* populations within the Intermontane Valleys identified here as potential key conservation areas. The Dancing Prairie key conservation area has over 10,000 individuals and is the largest known population of *Silene spaldingii*. Crosson Valley (near Sullivan Hill) was recently resurveyed and 651 individuals were counted. Lost Trail is separated into 2 populations, one with 203 individuals, and one with 177 individuals. The Crosson Valley key conservation area is on the Flathead Indian Reservation, home of the Confederated Salish and Kootenai Tribes. The Dancing Prairie key conservation area is composed of lands managed by The Nature Conservancy on its Dancing Prairie Preserve. Lost Trail is managed by the U.S. Fish and Wildlife Service and adjacent Montana State Trust Lands.

1.4.2. Conduct further surveys or work to supplement existing populations within the Intermontane Valleys to achieve at least one additional key conservation areas with over 500 individuals. The Dancing Prairie and Crosson Valley sites already meet the criteria of 500 individuals for key conservation areas. Two additional key conservation areas with at least 500 individuals are needed to meet the recovery goal for this region. These additional key conservation areas may be established through either further survey effort or enhancement of known sites. Although not identified in Figure 9, a series of small, isolated valleys exist within Montana where suitable habitat and populations of *Silene spaldingii* may exist. If 2 new populations with a minimum of 500 individuals cannot be discovered with increased survey effort, the supplementation of existing potential key conservation area populations should be considered (see Recovery Action 2.5.2). Sites with known populations in intact habitat that could potentially be enhanced to function as key conservation areas include Wild Horse Island and the Cromwell Creek/Hog Heaven Range sites. It has been suggested that a key conservation area be established somewhere near Kalispell because one extirpated site was near this area (P. Lesica, *in litt.* 2006, p. 4).

1.4.3. Conserve and protect smaller populations within the Intermontane Valleys. Several smaller populations exist within the Intermontane Valleys. These populations should also be protected from threats (see recovery actions listed under 2). Those populations that occur on private lands may benefit from education and outreach activities (see actions 2.3.1.4 and 2.7.3), conservation easements and voluntary cooperation (see action 2.7).

1.4.4. Control and manage invasive nonnative plant species specific to the Intermontane Valleys. Within the Intermontane Valleys, invasive nonnative plants of concern include: *Hieracium pratense* (meadow hawkweed), *Centaurea maculosa* (spotted knapweed), and *Potentilla recta* (sulfur cinquefoil). These invasive nonnative plants and others as they are discovered should be controlled or eliminated utilizing integrated pest management practices (Bottrell 1979; Luken and Thieret 1997) within 100 meters (328 foot) of *Silene spaldingii* populations at key conservation areas (see Recovery Action 2.3.1). Other invasive nonnative plants including *Poa pratensis* (Kentucky bluegrass), *Bromus tectorum* (cheatgrass), *Cirsium arvense* (Canada thistle), and *Hypericum perforatum* (St. Johnswort) are already relatively common within *S. spaldingii* Intermontane Valley sites and so would be extremely expensive to control. Instead, these invasive nonnative plant species should be controlled using integrated pest management to within 25 meters (82 feet) of *S. spaldingii* populations.

1.5. Conserve, identify, develop, and expand *Silene spaldingii* populations and habitat within the Palouse Grasslands (goal: three key conservation areas). The Palouse Grasslands of Idaho and Washington, with 17 *Silene spaldingii* populations, have 3 potential key conservation areas identified: the Kramer Palouse Natural Area, Paradise Ridge/Gormsen Butte, and the Pitt Cemetery (Figure 10). Two of these sites, the Kramer Palouse Natural Area and the Pitt Cemetery are small (under 16 hectares [40 acres]) and have fewer than 500 individuals. Paradise Ridge/Gormsen Butte currently has no *Silene spaldingii* individuals, but is a larger site (over 150 acres [60 hectares]) that is protected through interested landowners as well as conservation easements but currently has no *S. spaldingii*. The Idaho Department of Transportation is considering a plan to attempt introducing *S. spaldingii* plants to another private land site in Idaho. Of the five physiographic regions, the Palouse Grasslands have been most heavily impacted by agricultural development with few large intact parcels of lands remaining. To better survey for potential *S. spaldingii* populations, the Palouse Grasslands need to be first surveyed for intact stands of habitat, and subsequently these should be searched for *S. spaldingii*. To preserve genetic material from this physiographic region, supplementing or developing new *S. spaldingii* populations that can be adequately conserved will be necessary to attain the goal of three populations with a minimum of 500 reproducing individuals. Because it represents a larger area of contiguous Palouse Prairie habitat, Kamiak Butte in Washington has also been suggested as a potential key conservation areas, no *S. spaldingii* plants currently reside there. Populations with fewer than 500 individuals, not currently identified as potential key conservation areas, should be conserved where possible, particularly on federally managed lands.

1.5.1. Conserve and work to enhance the three *Silene spaldingii* populations within the Palouse Grasslands identified here as potential key conservation areas. The Kramer Palouse Natural Area has at least 200 *Silene spaldingii* individuals and is within two miles of another population with 11 individuals. The Pitt Cemetery has at least 62 *S. spaldingii* individuals. Paradise Ridge/Gormsen Butte currently has no *Silene spaldingii* but comprises over 150 acres 960 hectares) of intact Palouse Prairie; the landowners manage the land and are willing to have *S. spaldingii* introduced there. The Kramer Palouse Natural Area is managed by Washington State University, the Pitt Cemetery is privately owned and Paradise Ridge is privately owned. Other key conservations areas are needed where existing or new populations of *S. spaldingii* can be supplemented or established within the Palouse Grasslands (see Recovery Action 2.5.2).

1.5.2. Conduct a study identifying intact habitat within the Palouse Grasslands where *Silene spaldingii* may occur and follow with surveys for the plant. With over 95 percent of the Palouse Grasslands lost to agricultural development, very few intact grasslands remain in this area. A study that identifies parcels of land that are over 4 hectares (10 acres) in size with potential *Silene spaldingii* habitat is needed. Subsequently, these parcels should be surveyed for the plant.

1.5.3. Supplement existing populations and conduct a restoration and reintroduction program within the Palouse Grasslands to achieve the goal of three key conservation areas of *Silene spaldingii* with over 500 individuals. The recovery goal for this region may be met through a combination of enhancing the two extant populations identified as potential key conservation areas (Recovery Action 1.5.1) and restoration and reintroduction to establish additional key conservation areas. If intact habitat exists or if adjacent habitat can be restored, existing populations of *Silene spaldingii* within the Palouse Grasslands should be supplemented (see Recovery Action 2.5.2) to create self sustaining populations of *S. spaldingii* with a minimum of 500 individuals. In the event that existing populations cannot be expanded, a new site with intact habitat that can be conserved should be identified and planted with nearby genetic material from *S. spaldingii*. If intact habitat cannot be found, restoration should occur at a site that can be conserved and subsequently planted with nearby genetic material from *S. spaldingii*.

1.5.4. Conserve and protect smaller populations within the Palouse Grasslands. Numerous smaller populations exist within the Palouse Grasslands, most on private lands. These populations should also be protected from threats (see recovery actions listed under 2). Those populations that occur on private lands may benefit from education and outreach activities (see actions 2.3.1.4 and 2.7.3), conservation easements and voluntary cooperation (see action 2.7).

1.5.5. Control and manage invasive nonnative plant species specific to the Palouse Grasslands. Within the Palouse Grasslands, invasive nonnative plants of concern include: *Chondrilla juncea* (rush skeletonweed), *Potentilla recta* (sulfur cinquefoil), *Dipsacus sylvestris* (teasel), *Linaria* (toadflax), and *Centaurea solstitialis* (yellow starthistle). These invasive nonnative plants and others as they are discovered should be controlled or eliminated utilizing integrated pest management practices (Bottrell 1979; Luken and Thieret 1997) within 100 meters (328 foot) of *Silene spaldingii* populations at key conservation areas (see Recovery Action 2.3.1). Other invasive nonnative plants, including *Anthriscus caucalis* (bur chervil), *Bromus tectorum* (cheatgrass), *Cirsium arvense* (Canada thistle), *Hypericum perforatum* (St. Johnswort), and *Poa pratensis* (Kentucky bluegrass), are already relatively common within *S. spaldingii* Palouse Grassland sites and so would be extremely expensive and difficult to control. Instead, these invasive nonnative plant species should be controlled using integrated pest management practices to within 25 meters (82 feet) of *S. spaldingii* populations.

2. Conduct general recovery actions across the range of *Silene spaldingii*. Many recovery actions are applicable across *Silene spaldingii*'s range. These actions are condensed here instead of being repeated for each physiographic region above. These actions should protect important (occupied and potentially suitable) habitat and implement actions that may be necessary to eliminate or control threats. Habitat should be managed to maintain or enhance viable populations of *S. spaldingii*, to protect pollinators, and to allow for the maintenance of natural ecosystem functions and processes and contribute to the long-term preservation of this species.

2.1. Revise and implement general management plans to include *Silene spaldingii* where the species resides. Land management agencies including Federal, State, Tribal, and private entities that are responsible for the development and revision of land management plans should specifically address conservation of *Silene spaldingii* in their plans. Federal agencies include: the Bureau of Land Management (Spokane District in Washington, and the Coeur d'Alene and Cottonwood Field Offices in Idaho), the Department of Defense (Fairchild Air Force Base), the National Park Service (Chief Joseph Gravesite in Oregon), the U.S. Fish and Wildlife Service (Lost Trail National Wildlife Refuge in Montana and Turnbull National Wildlife Refuge in Washington), and the U.S. Forest Service (Wallowa-Whitman National Forest in Oregon, the Nez Perce and Clearwater National Forests in Idaho, and the Umatilla National Forest in Oregon and Washington). State managed lands include: the Craig Mountain Wildlife Management Area managed by the Idaho Department of Fish and Game; Montana State managed lands adjacent to the Lost Trail National Wildlife Refuge and on Wild Horse Island State Park; and in Washington on the Swanson Lakes Wildlife Area, at the Steptoe Butte State Historic Area, and at three sites managed by Washington State University, the Smoot Hill Reserve, the Kramer Palouse Natural Area, and the Washington State University Prairie Preserve. Tribal lands where the species resides includes lands owned by the Confederated Salish and Kootenai Tribes and the Nez Perce Tribe. *Silene spaldingii* is not currently included in any management plans for these areas. The Nature Conservancy manages three populations of *S. spaldingii* at their Garden Creek Ranch Preserve in Idaho, the Dancing Prairie Preserve in Montana, and the Zumwalt Prairie Preserve in Oregon. If management plans are developed for these sites, conservation of *S. spaldingii* should be incorporated. Actions specific to *S. spaldingii* identified within general land management plans should include recommendations made in *S. spaldingii* habitat management plans (see Recovery Action 2.2) and be consistent with the actions identified in this recovery plan.

2.2. Develop *Silene spaldingii* habitat management plans at all key conservation areas. All key conservation areas identified in 1.1, 1.2, 1.3, 1.4, and 1.5 above should have habitat management plans developed specifically to assist in conserving *S. spaldingii* at these sites. Management plans should include provisions to identify and control factors that may degrade habitat quality for *S. spaldingii*, such as nonnative plant invasions, changes in the fire regime, land conversions, adverse livestock grazing and trampling, herbicide or pesticide use, wildlife herbivory, off-road vehicle use, and insect damage and disease. When cross-agency coordination is needed for activities such as invasive nonnative plant control through integrated pest management programs, prescribed burns, or herbicide use, management plans should indicate who will take the lead and how that coordination will be accomplished. Plans should incorporate principles of adaptive management.

2.3. Habitat management plans and recovery actions should manage for impacts and threats to *Silene spaldingii* populations and habitat both at key conservation areas as well as at smaller populations. Threats include invasive nonnative plants; problems associated with small, geographically isolated populations; changes in the fire regime and fire effects; land conversion associated with urban and agricultural development; adverse livestock grazing and trampling; herbicide and insecticide spraying; adverse grazing (herbivory) and trampling by wildlife species; off-road vehicle use; insect damage and disease; impacts from prolonged drought and climate change; and an inadequacy of existing regulatory mechanisms. All of these threats should be addressed both through habitat management plans and recovery actions both at key conservation areas as well as at smaller populations.

2.3.1. Implement invasive nonnative plant control and integrated pest management programs at all *Silene spaldingii* sites, taking care not to impact *S. spaldingii*. Invasive nonnative plants may deleteriously affect *Silene spaldingii* through direct competition and habitat degradation. Therefore, ongoing invasive nonnative plant control and management is needed at all *S. spaldingii* sites. Unfortunately invasive nonnative plant control activities, such as herbicide applications, may also negatively affect *S. spaldingii* individuals. While invasive nonnative plant control is necessary, it should be done with care to minimize effects from control activities on *S. spaldingii*. Integrated pest management strategies that utilize the least aggressive tool necessary to enact control measures when economic and/or ecological values are affected should be incorporated into *S. spaldingii* habitat management plans (Bottrell 1979; Luken and Thieret 1997).

2.3.1.1. Incorporate integrated pest management programs into habitat management plans for *Silene spaldingii* at all key conservation areas and other areas as needed. Effective control and management of invasive nonnative plant species cannot be done without considering impacts to *Silene spaldingii* and, more importantly, its habitat. Without a healthy native plant community, habitat degradation is accelerated, thereby impacting the threatened species. Integrated pest management (Bottrell 1979; Luken and Thieret 1997) plans should seek to control nonnative plant invasions while maintaining or restoring the native plant community, not just *S. spaldingii*. Integrated pest management strategies utilize the least aggressive tool necessary to achieve management goals. Incorporating integrated pest management strategies into habitat management plans should facilitate the conservation of *S. spaldingii* as well as its habitat. Integrated pest management strategies are needed at all key conservation areas (see Recovery Actions 1.1, 1.2, 1.3, 1.4, and 1.5 above), and should be targeted to maintain cover of native species at 80 percent or greater within each area. Integrated pest management strategies should identify all control methods available such as prevention, manual control, biological control, and herbicide control. These integrated pest management strategies should include periodic weed surveys to detect new infestations or new invasive nonnative plant species, restore areas where weeds have been controlled to prevent reinvasion, and monitoring and evaluation to determine if control goals are being met.

2.3.1.2. Conduct invasive nonnative plant control and management measures at all key conservation areas and other populations as needed. Physiographic region specific guidelines for invasive nonnative plant control and management measures are listed above (see Recovery Actions 1.1.3, 1.2.3, 1.3.2, 1.4.3, and 1.5.4). Implementation of integrated pest management strategies should be conducted at all key conservation areas.

2.3.1.3. Ensure invasive nonnative plant control and management measures are coordinated with appropriate agencies. Invasive nonnative plant control and management efforts should be coordinated with the U.S. Fish and Wildlife Service, U.S. Bureau of Land Management, U.S. National Forests, private landowners, County, Tribal, and State agencies to ensure the protection of *S. spaldingii* individuals and habitat. This will minimize the opportunity for *S. spaldingii* plants to be inadvertently harmed by invasive nonnative plant control activities.

2.3.1.4. Conduct outreach activities for individuals or organizations that are involved in controlling and managing invasive nonnative plants. Many organizations that conduct invasive nonnative plant control measures on a regular basis may be accidentally spraying *Silene spaldingii* because of identification problems or because they do not realize the plant is an imperiled species (USFWS, pers. comm. 2004, p. 6). Outreach is needed to inform invasive nonnative plant management agencies such as Weed Management Areas, County Weed Boards, State and County highway maintenance programs, and programs for herbicide applicators to prevent inadvertent spraying of *S. spaldingii*. Counties with *S. spaldingii* sites include Idaho, Lewis, and Nez Perce Counties in Idaho; Flathead, Lake, Lincoln, and Sanders Counties in Montana; Wallowa County in Oregon; and Adams, Asotin, Lincoln, Spokane, and Whitman Counties in Washington.

2.3.1.5.Conduct surveys for *Silene spaldingii* before invasive nonnative plant control measures are implemented. Surveys should be conducted in all suitable habitats prior to spraying for invasive nonnative plants. If possible, surveys should not be conducted during drought years, since many *Silene spaldingii* plants may remain dormant and consequently will not be visible.

2.3.1.6.Develop and implement guidelines for herbicide applications around *Silene spaldingii* plants. Herbicides will deleteriously affect *Silene spaldingii*; therefore, careful application is needed to minimize effects to *S. spaldingii*. Chemicals and application methods will differ by site. A preliminary set of guidelines that can be altered to match specific sites is offered below to assist land managers and owners in determining how and where to apply various herbicides. Invasive nonnative plant control, when possible, should occur when *S. spaldingii* is dormant (October thru March), to minimize effects to the plant. When possible use herbicides that break down in the environment quickly, since chemicals that are longer lived in the environment such as picloram based chemicals are more likely to travel and affect non-target organisms (Cox 1998, p. 16 to 19).

2.3.1.6.1. Develop set distances where various herbicide application techniques may be used near *Silene spaldingii* plants. Before spraying at *Silene spaldingii* sites, all individuals should be located and flagged. All herbicide applications should occur when wind speeds are less than 8 kilometers (5 miles) an hour to minimize herbicide drift. Aerial spraying (from airplanes or helicopters) should not occur within 305 meters (1,000 feet) of known *S. spaldingii* plants; boom spraying should not occur within 15 meters (50 feet), and wiping or wicking should be the only herbicide application technique employed when within 15 meters (50 feet). Managers may want to utilize manual control techniques only when within 0.3 meter (1 foot) of individual *S. spaldingii* plants. These suggestions may be adjusted depending on the characteristics of the site where they are being employed.

2.3.1.6.2. Develop set distances for specific herbicides that may be employed near known *Silene spaldingii* sites. Persistent chemicals such as picloram should not be used within 15 meters (50 feet) of existing *Silene spaldingii* plants. Chemicals that do not affect members of the Caryophyllaceae family should be identified and utilized whenever possible. These suggestions may be adjusted depending on the characteristics of the site where they are being employed.

2.3.1.6.3. Develop guidelines for the timing of herbicide applications. Herbicide applications can occur at times when the target invasive nonnative plant is susceptible but when *Silene spaldingii* is not susceptible. For example, *S. spaldingii* actively grows from May to September while *Potentilla recta* (sulfur cinquefoil) is active from April to October. Herbicide applications to *P. recta* in April and October, when *S. spaldingii* is dormant, will help to minimize effects.

2.3.2. Conduct fire management activities within *Silene spaldingii* habitat. Assessing historical fire frequencies within *Silene spaldingii* habitat (grasslands) is difficult because of the lack of trees and tree rings (used to determine fire frequencies). The wide range of *S. spaldingii* also makes analyzing the effects of fire more difficult because of the variability in habitats and historical fire regimes. For example, unlike the Intermontane Valleys, Canyon and Palouse Grasslands may have been stable ecosystems, with species composition and distribution not determined by fire (Daubenmire 1970, p. 7; Tisdale 1986a, p. 35), although fire did still occur in these areas. Although there are some areas at higher elevations in the Canyon Grasslands that were maintained by fire. Because fire poses a threat to humans, fire suppression activities are sometimes necessary but should be done so as to minimize damage to *S. spaldingii* to the extent possible. Prescribed burning may enhance plant communities and prevent tree encroachment, but may also damage *S. spaldingii* plants or degrade its habitat by accelerating nonnative plant invasions or harm native plant communities by applying fire at times when plant communities did not historically burn. All fire management should be done carefully and with due consideration of these factors.

2.3.2.1. Incorporate fire management plans into habitat management plans for all *Silene spaldingii* populations identified as key conservation areas and other areas as needed. Fire management should not be done without considering impacts to *Silene spaldingii* and, perhaps more importantly, its habitat. Furthermore, fire management plans should be considered on a physiographic region basis. For example, fire management in Montana's Intermontane Valleys with a thick litter layer and tree encroachment should differ significantly from fire management within the Canyon Grasslands with a thin litter layer (Hill and Weddell 2003, pp. 17–18, 23-24; Hill and Gray 2004a, pp. 105-106) and little to no problems with tree encroachment (Daubenmire 1970, pp. 7-8; Tisdale 1986a, p. 35; Johnson and Simon 1997, pp. 55-56; Lesica 1999, p. 1001; Weddell 2001, p. 2). Fire management plans should clearly describe strategies to protect *S. spaldingii* populations and habitat in the event of a wildfire, during both fire-fighting activities and post-fire rehabilitation efforts. Fire management plans should be incorporated into habitat management plans. The potential for using prescribed or wild fire to enhance *S. spaldingii* habitat, if appropriate, could also be included in fire management plans. These fire management plans should carefully assess and mimic, as closely as possible, historical fire regimes.

2.3.2.2. Carefully conduct prescribed burns within *Silene spaldingii* habitat. Prescribed burns should be especially considered as a management tool for increasing *Silene spaldingii* in areas where *Festuca scabrella* (rough fescue) is a dominant species (Lesica 1997, p. 355). Some have suggested that in areas where *F. scabrella* is not present, the benefits of fire may be more questionable. Because of the risk of exacerbating invasive nonnative plant populations, prescribed burning should be carefully employed across *S. spaldingii*'s range. Prescribed burns should not occur across an entire *S. spaldingii* populations but should instead occur in smaller pieces. This should enable managers and land owners to adjust burning practices accordingly if problems arise.

2.3.2.2.1. Conduct surveys for *Silene spaldingii* before prescribed burns are implemented. All prescribed burn areas within *Silene spaldingii* habitat should be surveyed for the plant prior to burning. If *S. spaldingii* is located, management activities should be adjusted accordingly either by not burning in the area or enacting a monitoring program to gauge the plant's response.

2.3.2.2.2. Monitor the effects to *Silene spaldingii* and its habitat from all burns. If a fire or a prescribed burn does occur where *Silene spaldingii* resides, trend monitoring and possibly demographic monitoring (see actions 2.4.1 and 2.4.2) studies should be done for 4 years prior to burning, whenever possible. Ideally a control plot should be part of the monitoring scheme. Post-fire monitoring should be done consecutively for 4 years, every 5 years, for a monitoring period of at least 15 years after a fire. Monitoring should measure both the abundance of *S. spaldingii* as well as habitat characteristics including invasive nonnative plant populations. This monitoring is needed to understand fire's effects on *S. spaldingii* recruitment and its habitat.

2.3.2.2.3. Do not conduct prescribed burns where invasive nonnative plant infestations exist unless accompanied by an integrated pest management program and monitoring. Fire may exacerbate nonnative plant invasions (Christensen and Burrows 1986, p. 100; Hobbs and Huenneke 1992, pp. 324-325; Lesica and Martin 2003, pp. 516, 521). In areas where invasive nonnative plants are present, control of or a well formulated integrated pest management program for control of invasive nonnative plants should be accomplished prior to burning. For example, within the Channeled Scablands, prior to burning, *Bromus tectorum* (cheatgrass) cover should be less than 20 percent, and all *Centaurea solstitialis* (yellow starthistle), *Potentilla recta* (sulfur cinquefoil), *Chondrilla juncea* (rush skeletonweed), and *Centaurea maculosa* (spotted knapweed) populations should be controlled or eliminated. In addition, carefully planned monitoring with an unburned control should be implemented prior to burning (see action 2.3.2.2.2).

2.3.3. Protect *Silene spaldingii* sites from development on public and private lands. All *Silene spaldingii* sites and populations, especially key conservation areas, should be protected from development. Requirements of the Endangered Species Act should prevent *S. spaldingii* sites from development on Federal lands and Tribal lands held in trust by the Federal government. Sites on State lands should be protected from development through habitat management plans and by needed State designations. Sales to conservation entities may also be considered. Populations of *S. spaldingii* on private land should be protected by education and encouragement, conservation easements, consideration of deed restrictions, or possibly direct acquisition from willing landowners. Working through appropriate State, Federal, local, or County agencies, voluntary cooperation should be encouraged to protect *S. spaldingii* habitat on private lands. In particular, the conservation and protection of the large population on private lands at the north end of Wallowa Lake, Oregon, should be encouraged because of its large population size (over 500 individuals) (ONHP 2006, Element Occurrence 10; Hill and Gray 2004a, pp. 11, 13).

2.3.4. Monitor and manage livestock grazing and associated management activities to avoid impacts to *Silene spaldingii* and its habitat. All Federal lands with suitable habitat for *Silene spaldingii* should be surveyed in allotments where grazing is authorized. Consultation under section 7 of the Endangered Species Act should be completed by 2010 for all Federal land allotments with suitable habitat for *S. spaldingii*. If livestock grazing and *Silene spaldingii* co-occur, careful management and monitoring is needed (see 2.3.4.1 and 2.3.4.2 below) that includes several site visits during the growing season to ensure detrimental effects are not occurring. It has been suggested that livestock grazing could be a benefit when a thick litter layer has accumulated and prescribed fire may not be used (P. Lesica, *in litt.* 2006, p.3). It has also been suggested that livestock utilize the dry areas where *Silene spaldingii* resides more in spring when moisture is available in these areas and that the plant may still be able to produce an inflorescence(s) if grazed. Later in the season livestock may preferentially eat the inflorescences of *Silene spaldingii* and the plant appears unable to produce another inflorescence.

2.3.4.1. Manage and mitigate livestock grazing and associated management activities to avoid and minimize impacts to *Silene spaldingii* and its habitat. Livestock grazing should not occur within *Silene spaldingii* populations, especially at key conservation areas, when seedling germination occurs in early spring (April and May), during plant emergence and growth (May and June), or when the plant is flowering and setting seed in late July through September. Careful monitoring that demonstrates livestock do not generally utilize areas where *S. spaldingii* resides (*i.e.* hard to reach because of rocky areas or distant from water sources) or demonstrates that population numbers are not being deleteriously affected (see 2.3.4.3 below) by livestock grazing, may preclude these prescriptions.

Effective grazing management may include the construction and maintenance of fencing, moving watering troughs and/or salting areas away from *Silene spaldingii* population, allowing for rest years, and revising allotment plans, grazing schedules, and stocking levels to maintain *S. spaldingii* habitat. Management of livestock should be tailored to each individual site based on topographic features and utilization scenarios.

Grazing that reduces vegetation by over 50 percent should not take place at any time because of the potential damage to pollinators, the chance for creating and exacerbating invasive nonnative plant problems, and the damages that *S. spaldingii* may incur. Livestock grazing should not occur in *S. spaldingii* pastures where serious invasive nonnative plant populations exist unless the invasive nonnative flowers have been removed. Responsible parties should evaluate cumulative effects of herbivory in areas where both native and domestic ungulates graze.

2.3.4.2. Monitor livestock grazing and associated management activities to measure and manage impacts to *Silene spaldingii* and its habitat. Monitoring that can determine whether livestock grazing is having an effect on *S. spaldingii* should occur at all sites within grazing allotments on a regular basis. If populations decline because of adverse livestock grazing or trampling, grazing practices should be amended. It is recommended that monitoring associated with livestock use include paired grazed versus ungrazed transects at each site where grazing occurs to adequately determine whether grazing is having an effect. In addition, the vegetation community should be assessed at each paired plot to determine the effects livestock may be having on the habitat. Careful selection of paired plots is needed to ensure that trampling or site differences are not influencing data.

Alternative monitoring methods being employed where *Silene spaldingii* resides include: placing "key areas for utilization measuring" near *Silene spaldingii* plants; conducting trend monitoring for *S. spaldingii* without a paired, ungrazed site; implementation monitoring; consistent site visits. These alternatives should be further discussed as part of the monitoring actions (see 2.4 below). Standardized monitoring for livestock use should be developed, in as much as possible, through the *Silene spaldingii* technical team.

2.3.5. Implement effective off-road vehicle use control measures. Off-road vehicle use should be effectively controlled in all areas containing *Silene spaldingii* habitat. This may involve the use of fencing or other barriers, and developing signs to restrict vehicle use to existing, designated roads. Educational signs, oral presentations, or other forms of public outreach may be necessary to inform the public about the conservation needs of this rare species and raise awareness of their responsibility to protect the plant on public lands.

2.3.6. Monitor and manage wildlife populations and associated management activities to avoid impacts to *Silene spaldingii* and its habitat. Analyze the potential effects of wildlife management activities on *Silene spaldingii* sites and habitat. Federal and State agencies should monitor and evaluate the effects of wildlife populations and associated activities on *S. spaldingii*. Responsible parties should also evaluate cumulative effects of herbivory in areas where both native and domestic ungulates graze.

2.3.7. Avoid herbicide use not related to controlling invasive nonnative plant infestations specific to protecting *Silene spaldingii* and all insecticide use within a 1.6 kilometer (1 mile) radius of all *S. spaldingii* populations. Because of the risk of herbicides harming *S. spaldingii* and insecticides harming the pollinators of *S. spaldingii*, a 1.6 kilometer (1 mile) buffer where no pesticide use may occur should be utilized whenever possible. In sites where populations are near or adjacent to agricultural fields this buffer may not be feasible. In these instances precautionary measures should be taken to minimize the effects to *Silene spaldingii* populations. These precautionary measures should include minimizing or eliminating drift, or the use of pesticides that will not harm *S. spaldingii* or its pollinators.

2.4. Monitor population trends and habitat conditions. Measuring recovery will require monitoring of both *Silene spaldingii* individuals and habitat throughout its range in Idaho, Montana, Oregon, and Washington. Monitoring will provide information on threats to *S. spaldingii* habitat, population and habitat trends, and will also provide feedback on the effectiveness of management and conservation activities. Furthermore, monitoring will provide a measurement of when the recovery criteria have been met and delisting of *S. spaldingii* may be considered. In as much as possible, a standardized monitoring procedure should be established rangewide.

2.4.1. Monitor *Silene spaldingii* populations at key conservation areas periodically to determine population trends. Responsible agencies at potential key conservation areas should ensure that long-term monitoring is conducted, beginning within the next 3 years, to determine population trends and evaluate habitat conditions at *Silene spaldingii* populations. The effects of adjacent land uses, such as recreation, prescribed burns, livestock grazing and trampling, and herbicide spraying on this species should be monitored annually. Monitoring programs should be designed to evaluate the effects of invasive nonnative plants, native ungulate grazing, insect predation levels, and other impacts, and be able to document declines at *S. spaldingii* sites. Use of global positioning equipment may be helpful. Because of the long-lived nature of the plant and its prolonged dormancy, one suggestion is that to adequately assess trends monitoring should occur consecutively for 4 or more years every 5 to 20 years (Lesica and Steele 1994, p. 211). In as much as possible, a standardized trend monitoring procedure, coordinated through the technical team, should be established rangewide. This will be challenging because different areas may require different protocols. Because of the difficulties prolonged dormancy presents for monitoring, either repeated measures analysis (Lesica and Steele 1994, p. 211; Lesica and Steele 1996, p. 880; Lesica and Steele 1997, p. 336) or mark-recapture methods (Alexander *et al.* 1997, pp. 1235-1236; Shefferson *et al.* 2001, pp. 153-154) should be utilized. This standardized trend monitoring procedure should at a minimum identify at what time of the year monitoring should occur, standardize the minimum acceptable power, a standardized sample universe, and standardize age classes. Results from demographic monitoring studies in Idaho have found that monitoring should be done early in the season soon after emergence when all aboveground plants are detectable since some individuals senesce or are eaten before flowering (J. Hill, *in litt.* 2007a). It is important that these results be analyzed and reported so they may be shared with other parties.

2.4.2. Conduct demographic monitoring across the range of *Silene spaldingii*. Demographic data (good estimates of demographic transition probabilities) allow researchers to predict short-term trends, analyze factors that limit population growth and establishment (Pavlik 1994, p. 322-350), and are necessary for conducting population viability analyses (see Recovery Action 2.5.1). Because of the long-lived nature of the plant and its prolonged dormancy, demographic monitoring should occur consecutively for a minimum of 10 consecutive years (P. Lesica, *in litt.* 2007a, pp. 2-3). Careful consideration should be given to both aboveground structures that senesce or are eaten by the time flowering structures, which should be measured later in the season, appear (J. Hill, *in litt.* 2007a). Not detecting a plant that is present aboveground can lead to biased results and erroneous conclusions (Kéry and Gregg 2003; Kéry *et al.* 2005). Also, in some cases, age classes cannot be inferred from the aboveground life form. Information gained from such studies can be used to guide management of *Silene spaldingii* habitat. Therefore demographic studies, dispersed across the range of the plant, are recommended. It is important that these results be analyzed and reported so they may be shared with other parties. In as much as possible, a standardized demographic monitoring procedure should be established rangewide. This will be challenging because different areas may require different protocols.

2.4.3. Monitor and evaluate the response of *Silene spaldingii* to fire and invasive nonnative plants. In the event that *Silene spaldingii* sites are burned by wildfire or prescribed burning, annual monitoring should be conducted to evaluate the response of *S. spaldingii* and its habitat to fire (see Recovery Action 2.3.2.2.2). If habitat rehabilitation or enhancement measures are needed (*e.g.*, to control and manage invasive nonnative plants or erosion), these measures should be developed in conjunction with the U.S. Fish and Wildlife Service, and should be described in site-specific fire management plans. The same should be done in association with the incursion of invasive nonnative plants. It is important that these results be analyzed and reported so they may be shared with other parties. In as much as possible, a standardized monitoring procedure should be established rangewide (see action 2.4.1 above). This will be challenging because different areas may require different protocols.

2.4.4. Obtain permission from private landowners to conduct population trend monitoring for *Silene spaldingii* on private lands. *Silene spaldingii* sites on private lands should be monitored to determine population trends and habitat conditions. Prior to conducting monitoring on private lands, permission will be requested and obtained from appropriate landowners. In as much as possible, a standardized trend monitoring procedure should be established rangewide. This will be challenging because different areas may require different protocols.

2.4.5. Determine if sites with no plants have been extirpated. Many sites had no *Silene spaldingii* individuals present when last surveyed. Further surveys and methodologies are needed to determine if the plants may have been dormant at the time they were last surveyed and have since reappeared, or if the species should be considered extirpated from these sites.

2.5. Conduct research essential to the conservation of *Silene spaldingii.* Additional research regarding *Silene spaldingii* needs to be conducted to validate the recovery objectives for this species or to allow for their revision, as appropriate. Information on life history, population characteristics, and habitat requirements should be obtained to allow for more accurate specification of management and population goals. Partnerships with other State, Federal, Tribal, or private agencies and individuals should be developed, where possible, to meet these objectives. We will work with appropriate entities to identify and support the funding to conduct essential research on *S. spaldingii*.

2.5.1. Determine population viabilities for *Silene spaldingii* populations. Conduct essential research, including further genetic (including genetic diversity and the loss of genetic variation over time) and demographic studies, to determine the long-term population viability of *Silene spaldingii* under various management scenarios. A population viability analysis is needed to guide management in answering how to manage sites, identifying which populations are likely to survive into the future, and which are too small and isolated to persist (Menges 1991b, p. 45). Estimates of population viability for this species will require data on factors such as mortality, dispersal, and recruitment. In addition, habitat availability and threats, including manmade or anthropogenic threats, natural catastrophes, and genetic and demographic stochasticity (Menges 1991b, p. 45) should also be evaluated. A population viability analysis may also assist in determining whether the current goal of a minimum of 500 reproducing individuals in a potential key conservation area and the number of key conservation areas within each physiographic region is valid to ensure long-term persistence, and allow for refinement of this number, if necessary.

2.5.2. Develop new populations or supplement existing populations of *Silene spaldingii* where appropriate. Recruitment of *Silene spaldingii* is rare and occurs slowly (P. Lesica, *in litt.* 2004, p. 6), making human intervention necessary to preserve smaller populations. Preliminary studies looking at seedling growth indicate that growing *S. spaldingii* in cultivation is a possibility (Lesica 1988a; 1993; Hill and Gray 2000; 2004a; A. Brusven, University of Idaho, *in litt.* 2004; A. Raven, *in litt.* 2004). Potential key conservation areas where populations will be supplemented or developed will need to have plans that address how these activities will occur. All new populations and supplementations will be conducted on protected areas only. When completed, the population viability analysis should assist in identifying what genetic material needs to be better conserved.

2.5.2.1. Utilize existing potential key conservation areas and identify new key conservation area sites with good habitat where new populations should be developed or where existing populations could be supplemented. The time and expense of supplementing existing populations and creating new populations should be undertaken only at areas that are protected and only at areas that have the potential to become key conservation areas. Supplementation, reintroduction, and introduction should occur only if it will help facilitate the recovery of the species and meeting the goals of this recovery plan.

2.5.2.2. Determine the best techniques and develop guidelines for creating new populations or supplementing existing populations of *Silene spaldingii*. More research is needed in developing the best techniques for successful establishment of *Silene spaldingii* individuals. Seeds seem to germinate easily and grow in greenhouse containers. However, techniques to successfully transplant individuals to the wild are still needed. Furthermore, growing seed as a crop (grow-out) to increase seed has not been tested. A grow-out experiment could help in providing seed for supplementing or creating new populations and minimize impacts to native populations. Guidelines and the suitability of re-introduction and introduction activities should be periodically evaluated based on new information.

2.5.2.3. Develop guidelines to ensure genetic conservation during supplementation, re-introduction, and introduction activities. Use principles of population genetics to guide transplanting and reintroduction activities. Additional research to describe the genetic variability of *S. spaldingii* populations across the species range may be needed before introduction and supplementation efforts can proceed. These efforts should be coordinated through the technical team (see action 2.12). Guidelines the suitability of re-introduction and introduction activities should be periodically evaluated based on new information.

2.5.2.4. Determine the best techniques to restore *Silene spaldingii* habitat. Before populations of *Silene spaldingii* are created or expanded, habitat restoration may be needed to mimic native habitat. This native habitat cannot be recreated without identifying and practicing the most effective restoration techniques.

2.5.3. Conduct research essential to controlling and managing invasive nonnative plants within *Silene spaldingii* habitat. More research is needed in determining the best invasive nonnative plant control and management methods within and adjacent to *Silene spaldingii* sites. Subjects for investigation should include the most effective herbicides for various invasive nonnative plants; best times for herbicide application; the effects of prescribed burning, mowing, and biological control agents; and various other techniques that will reduce competition from invasive nonnative plants and improve habitat for *S. spaldingii*.

Additional research is needed to determine the effects of nonnative plant invasions on *Silene spaldingii*. Questions investigated should include: which species of invasive nonnative plants have the most deleterious effect on *S. spaldingii*; at which life history stage of *S. spaldingii* is competition from invasive nonnative plants most severe; and whether invasive nonnative plants are expanding into *S. spaldingii* habitat where they previously were unable to reside.

Research is needed to investigate the best restoration techniques to use in degraded *Silene spaldingii* habitats. Invasive nonnative plants may be better detected if remote sensing techniques are identified that can detect invasive nonnative plant populations in locations that are difficult to access by foot or vehicle.

2.5.4. Conduct research essential to managing livestock, wildlife, and insect herbivory at *Silene spaldingii* populations. Herbivory of *Silene spaldingii* occurs at all sites where *S. spaldingii* resides. The plant has adapted to some herbivory over the course of evolutionary time, while other herbivory is new or may have increased as a result of human activities. Research is needed to determine at what levels of herbivory *S. spaldingii* plants can persist, and at what levels its habitat remains intact. Also research is needed to address whether under some conditions where prescribed fire may not be utilized and litter has accumulated, livestock grazing could be used as a tool to enhance *S. spaldingii* populations. Livestock grazing is the most obvious form of human-related herbivory.

Information is needed on how differences in duration, intensity, and seasonality of herbivory, particularly livestock grazing and trampling, impact *Silene spaldingii*, its habitat, and nonnative plant invasions. Aside from livestock grazing and trampling, herbivory effects from wildlife species that may be at higher than historical levels need investigation. Finally, insect and small mammal herbivory needs further investigation. For example, to what extent is the presence of invasive nonnative plants increasing or decreasing natural insect herbivory levels.

2.5.5. Conduct research to better determine the effects of fire on *Silene spaldingii* and identify when and where prescribed fire should occur, particularly outside of Montana. Information is needed on how fires conducted during various seasons, the presence of invasive nonnative plants, and various habitat types affect *Silene* *spaldingii*, its recruitment rates, its habitat, and nonnative plant invasions. For example, because litter build-up varies, do fires within the Canyon Grasslands and their effects on *S. spaldingii* differ from those at the Dancing Prairie Preserve in Montana, where research has already occurred? Which invasive nonnative plants benefit from fire and which are affected deleteriously? At what densities do invasive nonnative plants proliferate with fire and at what densities do they decline? Are these densities different across various habitat types? Is tree encroachment into grasslands a problem across the range of *S. spaldingii*? What are the effects to *S. spaldingii* and its habitats from prescribed fires that typically occur outside of the historical fire season? Since some research on fire effects has already taken place on *S. spaldingii* populations in Montana, such studies are particularly needed in other areas within the species' range.

An accurate method of measuring historical fire frequency within grassland habitats is needed. In addition, research on the effects of fire on *Symphoricarpos albus* (snowberry) and *Rosa* spp. (rose) is needed to determine if fire encourages these browse species, as has been suggested by wildlife managers.

2.5.6. Conduct further research regarding reproductive biology and essential pollinators for *Silene spaldingii*. Research is needed to better separate self-incompatibility mechanisms from inbreeding depression and to determine if *Silene spaldingii* is capable of creating seed without the addition of pollen (apomixis). No research has investigated if outbreeding depression may be problematic for *S. spaldingii*. Information on outbreeding depression would be useful in reintroduction experiments.

Because pollinators are required for full seed set of *Silene spaldingii* (Lesica 1988b, p. 5; 1993, p. 198; Lesica and Heidel 1996, p. 9), conservation measures should be designed to protect nearby pollinator populations. Research is needed to better design conservation measures that protect pollinators. Additional information on the requirements of pollinators, especially *Bombus* *fervidus*, is needed, including the locations of nests, queen overwintering sites, preferred habitats, and resource competition. Research investigating how far *Bombus fervidus* is capable of transporting pollen as well as the relative contributions of other pollinators is needed. The effects of threats including adverse livestock grazing and trampling, and fire on *S. spaldingii*'s ground dwelling pollinators should be studied.

2.5.7. Conduct research investigating seed dispersal mechanisms for *Silene spaldingii*. No studies have investigated seed dispersal mechanisms for *Silene spaldingii*. Research is needed to determine how *S. spaldingii* seeds are transported, what transports seeds, and how far seeds are generally transported. This information is needed to conserve dispersal mechanisms, and to develop a better understanding of gene dispersal and what constitutes a discrete population.

2.5.8. Conduct research on soil seed bank ecology including seed longevity, seed viability, and genetics. No studies have investigated how long *Silene spaldingii* seeds may remain viable in the ground. This information is important because if seeds are viable for only a year or two, the loss of one year's seed production to fire or herbivory will dramatically reduce the amount of seed available for recruitment.

2.5.9. Conduct further genetic research including genetic diversity and gene flow across *Silene spaldingii*'s range. Baldwin and Brunsfeld's (1995) genetic study was only preliminary; they made a number of recommendations for further genetic work. First, genetic material should be collected from a wider range of samples and analyze more loci during a moist year when sample sizes can be large enough to more definitely make conclusions about the dispersal of genes across the range of *Silene spaldingii* (Baldwin and Brunsfeld 1995, p. 7). And second, the higher homozygosity levels and lower pollinator visitation rates at the Dancing Prairie site need to be further investigated (Baldwin and Brunsfeld 1995, p. 7).

In addition, genetic research is needed that investigates the effects of small population size, fragmentation, and genetic isolation. Genetic analyses should help to identify high priority populations for conservation efforts, which populations should be used to found new populations, the suitability of preservation based on key conservation areas, and should be incorporated with the population viability analysis identified in Recovery Action 2.5.1 above. Finally, investigations of the genetic reservoir represented by the soil seed bank would further clarify the overall genetic diversity of the species and assist managers in assessing the importance of the seed bank to future conservation of the species.

2.6. Conduct surveys in potential habitat areas. Manage and protect any newly discovered *Silene spaldingii* populations. Intensive field work should be conducted to locate additional populations of this species, especially within the Canyon Grasslands. The habitat of any newly discovered populations should be protected and managed as necessary. Habitat models are often utilized to prioritize where surveys should occur for rare species. To date, habitat models for *S. spaldingii* have resulted in large areas of suitable habitat. These large areas are then difficult to prioritize. Better habitat models are need for further refining and prioritizing survey efforts. Because the Canyon Grasslands are extremely steep and quite remote, there are still significant portions of suitable habitat to be searched, particularly on the Oregon side of the Snake River directly across from Craig Mountain, along the lower Grande Ronde River in Oregon and Washington, the Imnaha River in Oregon, and the lower Clearwater and Salmon Rivers in Idaho (summarized in Hill and Gray 2004a, pp. 17-21). Over 40 percent of known *S. spaldingii* sites are on private land; in general, these private lands have had much less inventory effort. The possibility for large populations residing on private property can not be overlooked. Several recent Bureau of Land Management land acquisitions in Washington (B. Benner, *in litt.* 2003, p. 6), as well as The Nature Conservancy's acquisition in 2000 of the Zumwalt Prairie Preserve, have led to the discovery of large, previously unknown *S. spaldingii* populations.

2.6.1. Conduct surveys on Federal lands for *Silene spaldingii*. Intensive surveys for *Silene spaldingii* should be conducted prior to approving and implementing activities that may affect habitat (either occupied or potentially suitable) for this species in the Canyon Grasslands, Palouse Grasslands, Channeled Scablands, Blue Mountain Basins, and Intermontane Valleys. Discovering new and large populations of *S. spaldingii*, especially within intact habitat, will help meet delisting goals. Surveys are especially needed within the Canyon Grasslands where it is surmised populations may reside with minimal threats. Surveys should also be conducted in areas where ongoing activities such as livestock grazing or trampling may adversely affect known or potentially suitable habitat for *S. spaldingii* on Federal lands, and whenever possible on State, Tribal, and private lands as well.

2.6.2. Conduct surveys on State and Tribal lands, especially where activities may affect *Silene spaldingii* habitat. Surveys are needed on both Tribal and State lands. Staff and funding should be identified to accomplish these activities.

2.6.3. Obtain permission from private landowners to conduct surveys for *Silene spaldingii* on private lands. Prior to conducting surveys on private lands, permission will be requested and obtained from appropriate landowners.

2.6.4. Protect newly discovered *Silene spaldingii* populations. Newly discovered populations should be granted the same protection as already discovered sites, and recovery tasks included here should apply to these newly discovered sites.

2.7. Support conservation on privately owned lands. Over 50 percent of the known populations of *Silene spaldingii* are on lands not managed by Federal, Tribal, or State entities (Hill and Gray 2004a, pp. 7, 14). Because the Endangered Species Act does not require surveys of *S. spaldingii* on private land, it is expected that many *S. spaldingii* sites remain unidentified or unreported on private lands. One of the seven known populations with over 500 individuals is currently unprotected on private lands. Three populations with over 500 individuals are located either wholly or partially on lands managed by The Nature Conservancy, a private conservation organization. Participation with private landowners is needed for successful conservation of *S. spaldingii*. Participation from private landowners is not required by the Endangered Species Act; therefore, outreach activities are needed to encourage voluntary conservation on private lands.

2.7.1. Support conservation actions on lands owned by The Nature Conservancy. The Nature Conservancy has been vital in conservation of *Silene spaldingii*. The largest population of *S. spaldingii* is located on The Nature Conservancy's Dancing Prairie Preserve (Mincemoyer 2005, p. 10). The Zumwalt Prairie Preserve in Oregon and the Garden Creek Ranch in Idaho also have large populations of *S. spaldingii* (ONHP 2006, Element Occurrences 7, 22, 28-36; ICDC 2007, Element Occurrence 6). Many research and monitoring studies have been conducted and funded on these parcels of land. The action items listed here should apply to *S. spaldingii* sites on The Nature Conservancy lands. A volunteer registry of *S. spaldingii* populations on private lands, such as the one The Nature Conservancy maintains in Washington and Montana, should be implemented and updated in all States where *S. spaldingii* resides. Registry lands should be considered for permanent easements that protect *S. spaldingii*.

2.7.2. Support conservation activities on other private lands. Key conservation areas on private land, such as those along Wallowa Lake in Oregon, should be identified where conservation of *Silene spaldingii* is needed. Appropriate landowners should be contacted and potential conservation activities identified and implemented whenever possible. Recommendations for protection on private lands are included in Recovery Actions 2.1, 2.2, 2.3, 2.3.3, 2.4, 2.4.4, and 2.7.1. Programs available to fund conservation activities and/or acquisitions on private lands include the U.S. Fish and Wildlife Service's Partners for Fish and Wildlife Program, Private Stewardship Grants, Recovery Land Acquisition Grants, and Landowner Incentive Program; and the Natural Resource

Conservation Service's Environmental Quality Incentives Program, Wildlife Habitat Incentives Program, Conservation Reserve Program, and Grassland Reserve Program. In addition, State agencies may have programs that provide incentives for conservation.

2.7.3. Conduct outreach and awareness efforts with the public regarding *Silene spaldingii*'s plight and its conservation. Without outreach and awareness activities, the public will not know about *Silene spaldingii* or its conservation needs. Written outreach material is needed in the form of newspaper articles, pamphlets, and displays at public meetings. Oral presentations are needed to groups concerned with invasive nonnative plant control (see Recovery Action 2.3.1.3), native plant societies, Master Gardeners, Natural Resource Conservation Service personnel, County conservation committees, Soil and Water Conservation Districts, Cooperative Extension Agencies, and others to reach the public. In areas experiencing impacts from off highway vehicle (OHV) use, specific outreach programs should be aimed at local OHV groups, businesses, and events.

2.8. Pursue land and species designations that will help facilitate conservation of *Silene spaldingii*. Federal agencies should consider designating important *Silene spaldingii* habitat areas on public land as special management areas (*e.g*., as Areas of Critical Environmental Concern, Botanical Special Interest Areas, or Research Natural Areas). Protected habitat areas should include occupied habitat and potentially suitable, currently unoccupied habitat to allow for population expansion, especially near key conservation areas. Recommendations for special management designations should be incorporated into *S. spaldingii* habitat management plans. Because *S. spaldingii* is not protected on State managed lands, protection of the species occurs only through the good will of State managers (the exception is in Oregon, where the species is technically protected; however, no populations of *S. spaldingii* are known to occur on State lands in Oregon). State legislation is recommended to better protect the species on State managed lands. This legislation should also serve to protect the plant on lands owned by educational institutions that receive State funding. In Washington, mechanisms exist to acquire land from willing landowners and designate the land as Natural Area Preserves, which are then managed specifically for the species or ecosystem of interest at the site.

2.9. Establish propagule banks, including a long-term seed storage facility for *Silene spaldingii*. *Silene spaldingii* seeds have been collected from only six populations, all of which are relatively large. Seeds of *S. spaldingii* should be collected according to currently accepted protocol from all populations, and stored at a long-term seed storage facility such as the Berry Botanic Garden in Portland, Oregon. Seeds should be collected in coordination with seed storage facilities to capture as much of the species' genetic variability as possible. Seeds should be collected from representative populations throughout the range of the species starting with all small, isolated populations and those on private lands to conserve genetic diversity. The U.S. Fish and Wildlife Service will assist with securing permits for activities as appropriate.

2.10. Secure funding for implementation of recovery actions. Additional funding over the long-term will be needed to implement the recovery actions listed here. Each land manager or owner will be responsible for securing funding to protect *Silene spaldingii*. Collaborative efforts between agencies and individuals will be necessary to accomplish larger actions such as surveying the Canyon Grasslands.

2.11. Validate and revise recovery objectives. This recovery plan should be updated as recovery actions are accomplished, or revised as additional information becomes available. In particular, the results of any population viability analyses conducted for *Silene spaldingii* will be considered in future recovery plan revisions.

2.12. Convene annual meetings of the *Silene spaldingii* technical team. Annual meetings or conference calls of the *S. spaldingii* technical team should be conducted. The technical team should be composed of interested individuals and organizations. These annual meetings should inform other members of ongoing *S. spaldingii* conservation actions, and serve as a forum to discuss, coordinate, evaluate, and prioritize recovery actions.

3. **Develop a post-delisting monitoring plan.** A plan for monitoring the species for a minimum of 5 years after delisting must be in place and ready for implementation at the time of delisting. Such a plan will ensure the ongoing recovery of the species and provide a means of assessing the effectiveness of management actions.

IV. Implementation Schedule

The Implementation Schedule that follows outlines the recommended recovery actions and estimated time and costs of the recovery program for *Silene spaldingii*, as set forth in this recovery plan. It is a guide for meeting the recovery goals outlined in this plan. The schedule indicates action priorities, action numbers, action descriptions, duration of actions, the parties responsible for actions, and estimated costs. Parties with the authority, responsibility, or expressed interest to implement a specific recovery action are identified in the Implementation Schedule. When more than one party has been identified, the proposed lead party is indicated by an asterisk (*). The listing of a party in the Implementation Schedule does not require the identified party to implement the action(s) or to secure funding for implementing the action(s).

Definition of Action Priorities:

Priority 1 - An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

Priority 2 - An action that must be taken to prevent a significant decline in species population or habitat quality, or some other significant negative impact short of extinction.

Priority 3 - All other actions necessary to meet the recovery objectives.

Definition of Action Durations:

Continual - An action that will be implemented on a routine basis once begun.

Ongoing - An action that is currently being implemented and will continue until the action is no longer necessary.

Estimated Costs:

Continual and ongoing costs, as well as the estimated total cost, are based on a projected 34-year timeframe to recovery and delisting of the species. Because *Silene spaldingii* is a long-lived perennial species and annual counts vary significantly in response to climatic events, a minimum of 20 years of monitoring is needed to determine long-term population trends. The estimated projected recovery date of 2040 reflects the need for this long-term monitoring as well as the time it may take to supplement or establish new populations.

Key to Responsible Parties:

BBG	Berry Botanic Garden
BLM	Bureau of Land Management
CSKT	Confederated Salish and Kootenai Tribes
CBLM	Cottonwood Field Office, Bureau of Land Management, Idaho
CMWMA	Craig Mountain Wildlife Management Area, Idaho Department of Fish and Game
DPP	Dancing Prairie Preserve, The Nature Conservancy
DOD	Department of Defense
DOT	Department of Transportation
EDU	Higher education facilities
FAFB	Fairchild Air Force Base
FS	U.S. Forest Service
GCR	Garden Creek Ranch, The Nature Conservancy
HP	Heritage Programs and Conservation Data Centers
IDL	Idaho Department of Lands
LTNWR	Lost Trail National Wildlife Refuge
MSTL	Montana State Trust Lands
NRCS	Natural Resource Conservation Service
NPT	Nez Perce Tribe
OCJG	Old Chief Joseph Gravesite, Nez Perce National Historic Park
PVT	Private landowners
SWCD	Soil and Water Conservation District
SBLM	Spokane District Bureau of Land Management, Washington
ST	State land management agencies
SLWA	Swanson Lakes Wildlife Area, Washington Department of Fish and Wildlife
T	Native American Tribes
TNC	The Nature Conservancy
TNWR	Turnbull National Wildlife Refuge
UNF	Umatilla National Forest
USFWS	U.S. Fish and Wildlife Service
VBLM	Vale District Bureau of Land Management, Oregon
WWNF	Wallowa-Whitman National Forest
WNHP	Washington Natural Heritage Program
WMA	Weed Management Areas
WHISP	Wild Horse Island State Park, Montana Fish, Wildlife, and Parks
ZPP	Zumwalt Prairie Preserve, The Nature Conservancy

Implementation Schedule for the *Silene spaldingii* Recovery Plan

Priority Number	Action Number	Action Description	Action Duration (years)	Responsible Parties	Cost Estimates ($1,000)						Comments
					Total Cost[†]	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	
1	1.1.1	Conserve and work to enhance the four *Silene spaldingii* populations within the Blue Mountain Basins identified here as potential key conservation areas.	Ongoing	EDU, NRCS, OCJG, PVT, SWCD, USFWS*, WWNF, ZPP							This action and associated costs will be completed through Action 2.2 below.
1	1.1.4	Control and manage invasive nonnative plant species specific to the Blue Mountain Basins.	Ongoing	OCJG, PVT, USFWS, VBLM, WMA, WWNF*, ZPP	102	3	3	3	3	3	See sub-actions for 2.3.1.
1	1.2.1	Conserve, identify, and work to enhance the five *Silene spaldingii* populations within the Canyon Grasslands identified here as potential key conservation areas.	Ongoing	CBLM, CMWMA, EDU, GKR, NPT, UNF, USFWS*, WWNF							This action and associated costs will be completed through Action 2.2 below.
1	1.2.4	Control and manage invasive nonnative plant species specific to the Canyon Grasslands.	Ongoing	CBLM, CMWMA, GKR, NPT, PVT, ST, UNF, USFWS, WMA*, WWNF	102	3	3	3	3	3	See sub-actions for 2.3.1.
1	1.3.1	Conserve, survey, and work to enhance seven *Silene spaldingii* populations within the Channeled Scablands identified here as potential key conservation areas.	Ongoing	NRCS, PVT, SBLM*, SLWA, SWCD, USFWS							This action and associated costs will be completed through Action 2.2 below.

Implementation Schedule for the *Silene spaldingii* Recovery Plan											
Priority Number	Action Number	Action Description	Action Duration (years)	Responsible Parties	Cost Estimates ($1,000)						Comments
					Total Cost†	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	
1	1.3.4	Control and manage invasive nonnative plant species specific to the Channeled Scablands.	Ongoing	FAFB, PVT, SBLM*, SLWA, TNWR, USFWS, WMA	102	3	3	3	3	3	See sub-actions for 2.3.1.
1	1.4.1	Conserve and work to enhance three *Silene spaldingii* populations within the Intermontane Valleys identified here as potential key conservation areas.	Ongoing	CSKT, DPP, EDU, LTNWR, PVT, ST, USFWS*, WHISP							This action and associated costs will be completed through Action 2.2 below.
1	1.4.2	Conduct further surveys or work to supplement existing populations within the Intermontane Valleys to achieve at least one additional potential key conservation areas with over 500 individuals.	Ongoing	CSKT, EDU, FS, LTNWR, MSTL, NRCS, PVT, ST, SWCD, USFWS*							This action and associated costs completed through Actions 2.3.1.5, 2.3.2.2.1, 2.5.2 (and sub-actions), 2.6 (and sub-actions), 2.7 (and sub-actions).
1	1.4.4	Control and manage invasive nonnative plant species specific to the Intermontane Valleys.	Ongoing	CSKT, DPP, FS, LTNWR, MSTL, PVT, ST, USFWS*, WHISP, WMA	102	3	3	3	3	3	See sub-actions for 2.3.1.

Implementation Schedule for the *Silene spaldingii* Recovery Plan

Priority Number	Action Number	Action Description	Action Duration (years)	Responsible Parties	Cost Estimates ($1,000) Total Cost[†]	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	Comments
1	1.5.1	Conserve and work to enhance the three *Silene spaldingii* populations within the Palouse Grasslands identified here as potential key conservation areas.	Ongoing	EDU, NRCS, PVT, SWCD, USFWS*, WSU, NPT							This action and associated costs will be completed through Action 2.2 below.
1	1.5.3	Supplement existing populations and conduct a restoration and reintroduction program within the Palouse Grasslands to achieve the goal of three key conservation areas of *Silene spaldingii* with over 500 individuals.	Ongoing	CBLM, EDU, NRCS, PVT, SBLM, ST, SWCD, USFWS*, WSU							See subactions of Action 2.5.2 below.
1	1.5.5	Control and manage invasive nonnative plant species specific to the Palouse Grasslands.	Ongoing	CBLM, PVT, SBLM, ST, USFWS*, WMA, WSU	34	1	1	1	1	1	See sub-actions of 2.3.1.
1	2.10	Secure funding for implementation or recovery tasks.	Continual	All							Costs included in other actions listed.

Implementation Schedule for the *Silene spaldingii* Recovery Plan

Priority Number	Action Number	Action Description	Action Duration (years)	Responsible Parties	Cost Estimates ($1,000)						Comments
					Total Cost†	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	
1	2.2	Develop *Silene spaldingii* specific habitat management plans at all key conservation areas.	6	CBLM, CMWMA, CSKT, DDP, GKR, LTNWR, OCJG, PVT, SBLM, SLWA, UNF, USFWS*, WHISP, WSU, WWNF, ZPP, NPT	480	40	40	40	40	40	$15K at each of the 27 key conservation areas plus an additional five potential key conservation areas.
1	2.3.1.2	Conduct invasive nonnative plant control and management measures at all key conservation areas and other populations as needed.	Continual	All							See Actions 1.1.4, 1.2.4, 1.3.4, 1.4.4, and 1.5.5.
1	2.3.3	Protect *Silene spaldingii* sites from development on public and private lands.	Continual	All	204	6	6	6	6	6	$6K each year at rangewide locations.
1	2.5.2.2	Determine the best techniques for creating new populations or supplementing existing populations of *Silene spaldingii*.	10	BLM, DOD, EDU, FS, ST, T, TNC, USFWS*	40	4	4	4	4	4	
1	2.5.2.3	Develop guidelines to ensure genetic conservation during supplementation, re-introduction, and introduction activities.	5	BLM, DOD, EDU, FS, ST, T, TNC, USFWS*	50	10	10	10	10	10	Will need to include a genetic analysis of the species range-wide.

Implementation Schedule for the *Silene spaldingii* Recovery Plan

Priority Number	Action Number	Action Description	Action Duration (years)	Responsible Parties	Cost Estimates ($1,000)						Comments
					Total Cost†	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	
1	2.5.2.4	Determine the best techniques to restore *Silene spaldingii* habitat.	Continual	BLM, DOD, EDU, FS, ST, T, TNC, USFWS*	170	5	5	5	5	5	Some of these techniques could be borrowed from research on other species.
1	2.5.9	Conduct further genetic research including genetic diversity and gene flow across *Silene spaldingii*'s range.	5	BLM, DOD, EDU, FS, ST, T, TNC, USFWS*	100	20	20	20	20	20	Should be concurrent with Action 2.5.1.
1	2.6.4	Protect newly discovered *Silene spaldingii* populations.	Continual	All							Costs included in other actions listed.
1	2.9	Establish propagule banks, including a long-term seed storage facility for *Silene spaldingii*.	Ongoing	All, BBG*	34	1	1	1	1	1	
2	1.1.2	Conduct further surveys to identify, or work to create, at least one new population and key conservation area within the Blue Mountain Basins with over 500 individuals.	Ongoing	EDU, NRCS, OCJG, PVT, SWCD, USFWS*, VBLM, WWNF, ZPP							This action and associated costs completed through Actions 2.3.1.5, 2.3.2.2.1, 2.5.2 (and sub-actions), 2.6 (and sub-actions), 2.7 (and sub-actions).
2	1.2.2	Conduct further surveys to identify at least two new populations and potential key conservation areas within the Canyon Grasslands with over 500 individuals.	Ongoing	CBLM, CMWMA, EDU, GKR, IDL, NPT, PVT, SBLM, ST, UNF, USFWS*, VBLM, WWNF							This action and associated costs completed through Actions 2.3.1.5, 2.3.2.2.1, 2.5.2 (and sub-actions), 2.6 (and sub-actions), 2.7 (and sub-actions).

Implementation Schedule for the *Silene spaldingii* Recovery Plan

Priority Number	Action Number	Action Description	Action Duration (years)	Responsible Parties	Cost Estimates ($1,000)						Comments
					Total Cost[†]	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	
2	1.3.2	Conduct further surveys to identify, or work to create, at least one new population and key conservation area within the Channeled Scablands with over 500 individuals.	Ongoing	FAFB, PVT, SBLM*, SLWA, TNWR, USFWS, WMA							This action and associated costs completed through Actions 2.3.1.5, 2.3.2.2.1, 2.5.2 (and sub-actions), 2.6 (and sub-actions), 2.7 (and sub-actions).
2	1.4.2	Conduct further surveys or work to supplement existing populations within the Intermontane Valleys to achieve two additional potential key conservation areas with over 500 individuals.	Ongoing	CSKT, EDU, FS, LTNWR, MSTL, NRCS, PVT, ST, SWCD, USFWS*							This action and associated costs completed through Actions 2.3.1.5, 2.3.2.2.1, 2.5.2 (and sub-actions), 2.6 (and sub-actions), 2.7 (and sub-actions).
2	2.3.1.5	Conduct surveys for *Silene spaldingii* before invasive nonnative plant control measures are implemented.	Ongoing	All	612	18	18	18	18	18	$3K for six different surveys (1000 acres [405 hectares]) each year across all land managers.
2	2.3.1.6.1	Develop set distances where various herbicide application techniques may be used near *Silene spaldingii* plants.	Once every 5 years	BLM, FS, ST, USFWS*, WMA	7	1					$1K once every 5 years (seven times total) to revisit and adaptively manage distances based upon current information.
2	2.3.1.6.2	Develop set distances for specific herbicides that may be employed near known *Silene spaldingii* sites.	Once every 5 years	BLM, FS, ST, USFWS*, WMA	7		1				$1K once every 5 years (seven times total) to revisit and adaptively manage distances based upon current information.

Priority Number	Action Number	Action Description	Action Duration (years)	Responsible Parties	Cost Estimates ($1,000)						Comments
					Total Cost[†]	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	
2	2.3.1.6.3	Develop guidelines for the timing of herbicide applications.	Ongoing; once every 5 years	BLM, EDU, FS, ST, USFWS*, WMA	7			1			$1K once every 5 years (seven times total) to revisit and adaptively manage distances based upon current information.
2	2.3.2.1	Incorporate fire management plans into habitat management plans for all *Silene spaldingii* populations identified as key conservation areas and other areas as needed.	6	Same as Action 2.2							Cost included in Action 2.2.
2	2.3.2.2.1	Conduct surveys for *Silene spaldingii* before prescribed burns are implemented.	Ongoing	All	612	18	18	18	18	18	$3K for six different surveys (1000 acres [405 hectares]) each year across all land managers.
2	2.3.2.2.3	Do not conduct prescribed burns where invasive nonnative plant infestations exist unless accompanied by an integrated pest management program and monitoring.	Ongoing	All							Cost included in Action 2.3.2.2.1.
2	2.3.4	Monitor and manage livestock grazing and associated management activities to avoid impacts to *Silene spaldingii* and its habitat.	Ongoing	All	442	13	13	13	13	13	$0.5K for each of 27 different land managers and owners.
2	2.3.5	Implement effective off-road vehicle use control measures.	Continual	All	170	5	5	5	5	5	$0.5K for each of 10 different land managers and owners.

Implementation Schedule for the *Silene spaldingii* Recovery Plan

Priority Number	Action Number	Action Description	Action Duration (years)	Responsible Parties	Cost Estimates ($1,000) Total Cost[†]	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	Comments
3	1.1.3	Conserve and protect smaller populations within the Blue Mountain Basins.	Ongoing	EDU, NRCS, OCJG, PVT, SWCD, USFWS*, VBLM, WWNF, ZPP							Costs included in other actions listed
3	1.2.3	Conserve and protect smaller populations within the Canyon Grasslands.	Ongoing	CBLM, CMWMA, EDU, GKR, IDL, NPT, PVT, SBLM, ST, UNF, USFWS*, VBLM, WWNF							Costs included in other actions listed
3	1.3.3	Conserve and protect smaller populations within the Channeled Scablands.	Ongoing	FAFB, PVT, SBLM*, SLWA, TNWR, USFWS, WMA							Costs included in other actions listed
3	1.4.3	Conserve and protect smaller populations within the Intermontane Valleys.	Ongoing	CSKT, EDU, FS, LTNWR, MSTL, NRCS, PVT, ST, SWCD, USFWS							Costs included in other actions listed
3	1.5.4	Conserve and protect smaller populations within the Palouse grasslands.	Ongoing	CBLM, PVT, SBLM, ST, USFWS*, WMA, WSU							Costs included in other actions listed

Implementation Schedule for the *Silene spaldingii* Recovery Plan

Priority Number	Action Number	Action Description	Action Duration (years)	Responsible Parties	Cost Estimates ($1,000)						Comments
					Total Cost†	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	
3	1.5.2	Conduct a study identifying intact habitat within the Palouse Grasslands where *Silene spaldingii* may occur and follow with surveys for the plant.	5	CBLM, EDU, PVT, SBLM, ST, USFWS*, WSU, NPT	20	4	4	4	4	4	
3	2.1	Revise and implement general management plans to include *Silene spaldingii* where the species resides.	As plans are revised	BLM, EDU, FAFB, FS, OCJG, ST, T, TNC, USFWS*	100	10	10	10	10	10	$5K for each general management plan at 20 different State, Federal, Tribal, and TNC managed areas.
3	2.3.1.1	Incorporate integrated pest management programs into habitat management plans for *Silene spaldingii* at all key conservation areas and other areas as needed.	6	Same as Action 2.2							Cost included in Action 2.2.
3	2.3.1.3	Ensure invasive nonnative plant control and management measures are coordinated with appropriate agencies.	Ongoing	All							Cost included in Actions 1.1.3, 1.2.3, 1.3.2, 1.4.3, and 1.5.4.
3	2.3.1.4	Conduct outreach activities for individuals or organizations that are involved in controlling and managing invasive nonnative plants.	Ongoing	All, USFWS*	34	1	1	1	1	1	Total cost based upon the 35 years until the first possible recovery date.
3	2.3.2.2.2	Monitor the effects to *Silene spaldingii* and its habitat from all burns.	Ongoing	All	340	10	10	10	10	10	$2K at five different burn sites each year across all land managers.

Implementation Schedule for the *Silene spaldingii* Recovery Plan

Priority Number	Action Number	Action Description	Action Duration (years)	Responsible Parties	Cost Estimates ($1,000)						Comments
					Total Cost†	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	
3	2.3.6	Monitor and manage wildlife populations and associated management activities to avoid impacts to *Silene spaldingii* and its habitat.	Continual	BLM, FS, ST*, T	68	2	2	2	2	2	$0.5K annually for each of the four states where *Silene spaldingii* resides.
3	2.3.7	Avoid herbicide use not related to controlling invasive nonnative plant infestations specific to protecting *Silene spaldingii* and all insecticide use within a 1.6 kilometer (1 mile) radius of all *S. spaldingii* populations.	Ongoing	All							Avoidance measure that should not have a cost.
3	2.4.1	Monitor *Silene spaldingii* populations at key conservation areas periodically to determine population trends.	Continual	Same as Action 2.2	1,632	48	48	48	48	48	$3K at each of the 27 key conservation areas plus an additional five potential key conservation areas five of every 10 years.
3	2.4.2	Conduct demographic monitoring across the range of *Silene spaldingii*.	At least 10 years	Same as Action 2.2	450	30	30	30	30	30	$6K in each of the five physiographic regions in five of every 10 years.
3	2.4.3	Monitor and evaluate the response of *Silene spaldingii* to fire and invasive nonnative plants.	Ongoing	All							Included in the costs listed in Action 2.4.1.

Implementation Schedule for the *Silene spaldingii* Recovery Plan

Priority Number	Action Number	Action Description	Action Duration (years)	Responsible Parties	Cost Estimates ($1,000)						Comments
					Total Cost†	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	
3	2.4.4	Obtain permission from private landowners to conduct population trend monitoring for *Silene spaldingii* on private lands.	Continual	BLM, EDU, FS, HP, NRCS, PVT, USFWS*							Included in the costs listed in Action 2.4.1.
3	2.4.5	Determine if sites with no plants have been extirpated.	3	BLM, EDU, FS, HP, NRCS, PVT, USFWS*	6		2	2	2		Eight sites in Washington that should be visited for 3 consecutive years at $0.25K a site.
3	2.5.1	Determine population viabilities for *Silene spaldingii* populations.	15	BLM, EDU, FS, ST, TNC, USFWS*	20						Some of the costs included in Action 2.4.2 (demography) and Action 2.5.9 (genetics).
3	2.5.2.1	Utilize existing key conservation areas and identify new key conservation areas with good habitat where new populations should be developed or where existing populations could be supplemented.	Continual	All	510	15	15	15	15	15	
3	2.5.3	Conduct research essential to controlling and managing invasive nonnative plants within *Silene spaldingii* habitat.	Continual	BLM, DOD, EDU, FS, ST, T, TNC, USFWS*	170	5	5	5	5	5	Some of these techniques could be borrowed from research on other species.

Implementation Schedule for the *Silene spaldingii* Recovery Plan

Priority Number	Action Number	Action Description	Action Duration (years)	Responsible Parties	Cost Estimates ($1,000)						Comments
					Total Cost†	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	
3	2.5.4	Conduct research essential to managing livestock, wildlife, and insect herbivory at *Silene spaldingii* populations.	20	BLM, DOD, EDU, FS, ST, T, TNC, USFWS*	200	10	10	10	10	10	
3	2.5.5	Conduct research to better determine the effects of fire on *Silene spaldingii* and identify when and where prescribed fire should occur, particularly outside of Montana.	20	BLM, DOD, EDU, FS, ST, T, TNC, USFWS*	200	10	10	10	10	10	
3	2.5.6	Conduct further research regarding reproductive biology and essential pollinators for *Silene spaldingii*.	3	BLM, DOD, EDU, FS, ST, T, TNC, USFWS*	18		6	6	6		
3	2.5.7	Conduct research investigating seed dispersal mechanisms for *Silene spaldingii*.	5	BLM, DOD, EDU, FS, ST, T, TNC, USFWS*	10				2	2	
3	2.5.8	Conduct research on soil seed bank ecology including seed longevity, seed viability, and genetics.	Depends on longevity	BLM, DOD, EDU, FS, ST, T, TNC, USFWS*	To be determined	1	1	1	1	1	Total cost will depend on the length of the study.
3	2.6.1	Conduct surveys on Federal lands for *Silene spaldingii*.	Ongoing	BLM*, DOD, FS, USFWS	612	18	18	18	18	18	Costs here are for non-project related surveys, see also Actions 2.3.1.5 and 2.3.2.2.1.

Implementation Schedule for the *Silene spaldingii* Recovery Plan

Priority Number	Action Number	Action Description	Action Duration (years)	Responsible Parties	Cost Estimates ($1,000)						Comments
					Total Cost†	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	
3	2.6.2	Conduct surveys on State and Tribal lands, especially where activities may affect *Silene spaldingii* habitat.	Ongoing	HP, ST, T, USFWS	204	6	6	6	6	6	Costs here are for non-project related surveys, see also Actions 2.3.1.5 and 2.3.2.2.1.
3	2.6.3	Obtain permission from private landowners to conduct surveys for *Silene spaldingii* on private lands.	Ongoing	HP, NRCS, PVT*, USFWS	204	6	6	6	6	6	
3	2.7.1	Support conservation actions on lands owned by The Nature Conservancy.	Ongoing	TNC*, USFWS							Costs included in other actions listed.
3	2.7.2	Support conservation activities on other private lands.	Continual	All							Costs included in other actions listed.
3	2.7.3	Conduct outreach and awareness efforts with the public regarding *Silene spaldingii*'s plight and its conservation.	Continual	All	272	8	8	8	8	8	$2K annually in each of the four states where *Silene spaldingii* resides.
3	2.8	Pursue land and species designations that will help facilitate conservation of *Silene spaldingii*.	Continual	All	34	1	1	1	1	1	
3	2.11	Validate and revise recovery objectives.	Continual	All, USFWS*	175					25	$25K every 5 years (seven times total)
3	2.12	Convene annual meetings of the *Silene spaldingii* technical team.									

Implementation Schedule for the *Silene spaldingii* Recovery Plan											
Priority Number	Action Number	Action Description	Action Duration (years)	Responsible Parties	Cost Estimates ($1,000)						Comments
					Total Cost†	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	
3	3.0	Develop a post-delisting monitoring plan.	1 year	All, USFWS*	10						To be developed within 2 years of anticipated delisting.
Total estimated cost for recovery					**8,666**	**330**	**338**	**338**	**339**	**331**	

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Appendix A. Endangered and Threatened Species Recovery Priority Number Guidelines*

Degree of Threat	**Recovery Potential**	**Taxonomy**	**Conflict?†**	**Priority**
High	High	Monotypic Genus	Yes	1C
			No	1
		Species	Yes	2C
			No	2
		Subspecies	Yes	3C
			No	3
	Low	Monotypic Genus	Yes	4C
			No	4
		Species	Yes	5C
			No	5
		Subspecies	Yes	6C
			No	6
Moderate	High	Monotypic Genus	Yes	7C
			No	7
		Species	Yes	8C
			No	8
		Subspecies	Yes	9C
			No	9
	Low	Monotypic Genus	Yes	10C
			No	10
		Species	Yes	11C
			No	11
		Subspecies	Yes	12C
			No	12
Low	High	Monotypic Genus	Yes	13C
			No	13
		Species	Yes	14C
			No	14
		Subspecies	Yes	15C
			No	15
	Low	Monotypic Genus	Yes	16C
			No	16
		Species	Yes	17C
			No	17
		Subspecies	Yes	18C
			No	18

* adapted from Listing and Recovery Priority Guidelines, Federal Register 48:4309-43105
†priority is given to those species that are, or may be, in conflict with construction or other development projects or other forms of economic activity, designated by a “C” in the priority ranking system.

Appendix B. Scientific and common names used in the text.

Plants

Scientific name	Common name
Acroptilon repens (L.) DC.	Russian knapweed
Agropyron cristatum (L.) Gaertn.	crested wheatgrass
Agropyron desertorum (Fisch. ex Link) J.A. Schultes	crested wheatgrass
Amsinckia grandiflora (Kleeb. Ex Gray) Kleeb. Ex Greene	large-flowered fiddleneck
Arabis fecunda Rollins	Mt. Sapphire rockcress
Artemisia tridentata Nutt.	big sagebrush
Artemisia tripartita Rydb.	three-tip sagebrush
Anthriscus caucalis Bieb.	bur chervil
Aster jessicae Piper = *Symphyotrichium jessicae* (Piper) Nesom	Jessica's aster
Astragalus riparius Barneby	Piper's milk-vetch
Bromus inermis Leyss.	smooth brome
Bromus japonicus Thunb. ex Murr = *B. arvensis* L.	Japanese brome
Bromus tectorum L.	cheatgrass
Calochortus macrocarpus Dougl. var. *maculosus* A. Nels and J.F. Macbr.	green-band or Nez Perce mariposa lily
Calochortus nitidus Dougl.	broad-fruit mariposa
Cardaria draba (L.) Desv.	whitetop
Centaurea diffusa Lam.	diffuse knapweed
Centaurea maculosa = *C. stoebe* L. ssp. *micranthos* (Gugler) Hayek	spotted knapweed
Centaurea solstitialis L.	yellow starthistle
Chondrilla juncea L.	rush skeletonweed
Cirsium arvense (L.) Scop.	Canada thistle
Cirsium brevifolium Nutt.	Palouse thistle
Cirsium vinaceum Woot. & Standl.	Sacramento Mountains thistle
Crupina vulgaris Cass.	common crupina
Dianthus deltoides L.	maiden pink
Dipsacus sylvestris Huds. = *Dipsacus*	teasel

Scientific name	Common name
fullonum L.	
Euphorbia esula L.	leafy spurge
Festuca idahoensis Elmer	Idaho fescue
Festuca scabrella Torr. ex Hook = *F. campestris* Rydb.	rough fescue
Hesperostipa comata (Trin. & Rupr) Barkworth = *Stipa comata* Trin. & Rupr.	needle-and-thread grass
Hieracium pratense Taush = *H. caespitosum* Dumort.	meadow hawkweed
Hypericum perforatum L.	St. Johnswort
Koeleria cristata Pers. = *K. macrantha* (Ledeb.) J.A. Schultes	prairie junegrass
Lepidium latifolium L.	perennial pepperweed
Linaria dalmatica (L.) P. Mill	Dalmatian toadflax
Linaria spp.	toadflax
Lupinus sericeus Pursh.	silky lupine
Mirabilis macfarlanei Constance & Rollins	Macfarlane's four-o'clock
Onopordum acanthium L.	Scotch thistle
Pinus ponderosa P. & C. Lawson	ponderosa pine
Poa pratensis L.	Kentucky bluegrass
Polemonium pectinatum Greene	Washington polemonium
Potentilla recta L.	sulfur cinquefoil
Primula elatior (L.) Hill	oxlip
Pseudoroegneria spicata (Pursh) A. Löve = *Agropyron spicatum* Pursh	bluebunch wheatgrass
Pyrrocoma liatriformis Greene = *Happlopappus liatriformis* (Greene) St. John	Palouse goldenweed
Rosa spp.	rose
Rubus nigerrimus (Greene) Rydb.	Northwest raspberry
Scabiosa columbaria L.	dove pincushions, pincushion flower
Silene cserei Baumg.	Balkan catchfly
Silene douglasii Hook.	Douglas' catchfly
Silene hawaiiensis Sherff	Hawai`i catchfly

Scientific name	Common name
Silene latifolia Poir ssp. *alba* (P. Mill) Greuter & Burdet	bladder campion
Silene oregana S. Wats.	Oregon catchfly
Silene regia Sims	royal catchfly
Silene scaposa B.L. Robins var. *scaposa*	Scapose silene
Silene scouleri Hook.	Scouler's catchfly
Silene spaldingii S. Wats.	Spalding's catchfly, Spalding's silene, Spalding's campion
Symphoricarpos albus (L.) Blake	snowberry
Trifolium plumosum Dougl. ex. Hook. var. *amplifolium* (J.S. Martin) J. Gillett	plumed clover
Ventenata dubia (Leers) Coss.	ventenata

Animals

Scientific Name	Common Name or Type of Animal
Bombus fervidus (Fabricius)	bumblebee
Bombus terrestris (L.)	bumblebee
Lasioglossum spp.	solitary bee
Halictus tripartitus Cockerell	solitary bee
Dienoplus rugulosus R. Bohart	solitary bee
Apis spp.	honey bee
Tympanuchus phasianellus columbianus Ord	Columbian sharp-tailed grouse

Appendix C. Summary of Threats and Recommended Recovery Actions for *Silene spaldingii*

This table identifies the recovery actions recommended to address the threats to *Silene spaldingii*, as well as those recovery criteria that will provide a measure of the elimination or sufficient reduction of those threats to consider delisting of this threatened species.

Listing Factor*	Threat	Recovery Criteria	Recovery Action Numbers
A	Invasive Nonnative Plants	2, 3, 4, 5	1. conserve and expand populations in each physiographic region; 1.1.3. control in Blue Mountain Basins; 1.2.3. control in Canyon Grasslands; 1.3.2. control in the Channeled Scablands; 1.4.3. control in the Intermontane Valleys; 1.5.4. control in the Palouse Grasslands; 2.1 general management plans; 2.3 habitat management plans; 2.3.1 invasive nonnative plant control; 2.4 monitor; 2.5.3 control research; 2.7 private land conservation; 2.10 funding
A, E	Problems Associated with Small, Geographically Isolated Populations	1, 2, 3, 4, 7	1. conserve and expand populations in each physiographic region; 2.1 general management plans; 2.3 habitat management plans; 2.4 monitor; 2.5.1 population viabilities; 2.5.2 develop larger populations; 2.5.6 reproductive biology research; 2.5.7 seed dispersal research; 2.5.8 seed viability research; 2.5.9 genetic research 2.7 private land conservation; 2.9 propagule banks, 2.10 funding

Listing Factor*	Threat	Recovery Criteria	Recovery Action Numbers
A	Changes in the Fire Regime and Fire Effects	2, 3, 4, 6	1. conserve and expand populations in each physiographic region; 2.1 general management plans; 2.3 habitat management plans; 2.3.2 fire management; 2.5.5 fire research
A	Land Conversion Associated with Urban and Agricultural Development	1, 2, 3, 4	1. conserve and expand populations in each physiographic region; 2.1 general management plans; 2.3 habitat management plans; 2.3.3 protect from development; 2.4 monitor; 2.6 surveys; 2.7 private land conservation; 2.10 funding
A, C	Adverse Livestock Grazing and Trampling	2, 3, 4	1. conserve and expand populations in each physiographic region; 2.1 general management plans; 2.3 habitat management plans; 2.3.4 manage livestock grazing; 2.4 monitor; 2.5.4 research; 2.7 private land conservation; 2.10 funding
E	Herbicide and Insecticide Spraying	2, 3, 4	1. conserve and expand populations in each physiographic region; 2.1 general management plans; 2.3 habitat management plans; 2.3.1.6 herbicide application guidelines; 2.4 monitor; 2.5.3 control research; 2.7 private land conservation; 2.10 funding
C	Adverse Grazing (Herbivory) and Trampling by Wildlife Species	2, 3, 4	1. conserve and expand populations in each physiographic region; 2.1 general management plans; 2.3 habitat management plans; 2.3.6 monitor and manage wildlife; 2.4 monitor; 2.5.4 research; 2.7 private land conservation; 2.10 funding

Listing Factor*	Threat	Recovery Criteria	Recovery Action Numbers
A, E	Off-Road Vehicle Use	2, 3, 4	1. conserve and expand populations in each physiographic region; 2.1 general management plans; 2.3 habitat management plans; 2.3.5 implement off-road vehicle control; 2.4 monitor; 2.7 private land conservation; 2.10 funding
C	Insect Damage and Disease	2, 3, 4	1. conserve and expand populations in each physiographic region; 2.1 general management plans; 2.3 habitat management plans; 2.4 monitor; 2.5.4 research; 2.10 funding
E	Impacts from Prolonged Drought and Global Warming	2, 3, 4	1. conserve and expand populations in each physiographic region; 2.1 general management plans; 2.3 habitat management plans; 2.4 monitor; 2.10 funding
D	Inadequacy of Existing Regulatory Mechanisms	2, 3, 4	1 conserve and expand populations in each physiographic region; 2.1 general management plans; 2.3 habitat management plans; 2.4 monitor; 2.7 private land conservation; 2.8 pursue land and species designations, 2.10 funding

*Listing Factors:

A. The Present or Threatened Destruction, Modification, of Curtailment of *Silene spaldingii*'s Habitat or Range
B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes
C. Disease or Predation
D. The Inadequacy of Existing Regulatory Mechanisms
E. Other Natural or Manmade Factors Affecting *Silene spaldingii*'s Continued Existence.

Appendix D. Summary of Public, Agency, and Peer Review Comments on the Draft Recovery Plan for *Silene spaldingii* (Spalding's Catchfly)

On October 10, 2001, we, the U.S. Fish and Wildlife Service, listed *Silene spaldingii* (Spalding's catchfly) as a threatened species, under the Endangered Species Act of 1973, as amended. On December 17, 2001, a recovery outline was prepared. We then contracted the Idaho Conservation Data Center to compile a Conservation Strategy for Spalding's catchfly (*Silene spaldingii* Wats.) (Conservation Strategy). In writing the Conservation Strategy, over 35 individuals were consulted from the private sector, educational facilities, government agencies, and land managing conservation organizations. A group was assembled in Lewiston, Idaho on October 28, 2003, to discuss the draft Conservation Strategy, recovery priorities, and the next steps in the recovery planning process. The Conservation Strategy was complete on February 23, 2004 (Hill and Gray 2004a). This Conservation Strategy was utilized extensively in writing the Draft Recovery Plan for *Silene spaldingii* (Spalding's catchfly).

In addition, eight meetings were held to allow stakeholders to learn about and contribute to the recovery planning effort in early 2004, two meetings at each of four locations (Kalispell, Montana, on February 26th; Enterprise, Oregon, on March 1st; Ritzville, Washington, on March 2nd; and Lewiston, Idaho, on March 3rd). We also identified over 12 individuals to participate in a technical team. Members of this technical team reviewed and provided input on early versions of the draft recovery plan and participated in a related conference call on June 1, 2004.

The Draft Recovery Plan for *Silene spaldingii* (Spalding's catchfly) was made available to the public through a 60-day comment period from March 16, 2006, to May 15, 2006. More than 600 letters were sent out to individuals notifying them of the availability of the draft recovery plan. Over 50 copies of the draft recovery plan were sent out and electronic copies were available on our web site for review during the comment period. Additionally, letters were sent to Federal, State, Tribal, and local government offices within the range of the species as well as industry groups, conservation groups, scientists and interested parties. Members of the technical team provided comments during the 60-day comment period, reviewed a draft of the final recovery plan, and participated in a conference call on April 30, 2007. A list of individuals we solicited technical comments from is included in Appendix E.

Ten responses were received during the public comment period from the public and various agencies including: Idaho Conservation League; Idaho Department of Lands; Montana Fish, Wildlife and Parks; U.S. Bureau of Land Management Montana State Office, U.S. Department of Agriculture Pullman Plant Material Center; State of Idaho's Department of Agriculture, Idaho Office of Species Conservation, Friends of the Clearwater, and the general public.

We also received five peer review comments from: Peter Lesica; Scott Mincemoyer, Montana Natural Heritage Program; Maria Manta, The Nature Conservancy of Montana; Angela Sondenaa representing the Nez Perce Tribal Executive Committee; and Barbara Benner representing the U.S. Bureau of Land Management Spokane District Office.

Number of letters received by affiliation:

Federal agencies	2 letters
State and local governments	4 letters
Environmental interest	2 letter
General public	2 letters
Peer review	5 letters

We also requested a review of the draft final recovery plan from 10 scientists and agency persons familiar with *Silene spaldingii* and that had participated in the *S. spaldingii* technical team. This final technical review was to ensure that revisions to the draft recovery plan based on public, agency, and peer review were scientifically sound. These individuals included: LeAnn Abell, U.S. Bureau of Land Management, Idaho; Barbara Benner, U.S. Bureau of Land Management, Washington; John Gamon, Washington Natural Heritage Program; Karen Gray, Idaho Conservation Data Center; Mike Hays, Nez Perce National Forest; Dr. Janice Hill, Idaho Conservation Data Center; Peter Lesica, private consultant; Mark Lowry, U.S. Bureau of Land Management, Idaho; Maria Mantas, The Nature Conservancy of Montana; and Jim White, Idaho Department of Fish and Game.

Summary of significant issues and comments:

We received 10 public/agency and 5 peer review responses during the public comment period for the draft recovery plan. Some comments provided updated information about *Silene spaldingii* and its habitat. This information was incorporated into the appropriate sections of the final recovery plan. The substantive issues and comments, and our responses, are summarized in this appendix.

Issue 1: Several commenters questioned the definition of key conservation areas and their applicability in the recovery plan. Several commenters questioned the number of populations and the number of populations within physiographic regions in the recovery plan. Several commenters questioned the criteria in the recovery plan of 500 plants per population. One commenter suggested that key conservation areas be composed of at least 40 acres of habitat and surrounded by at least 300 acres of habitat that can be restored and eventually support *Silene spaldingii*. One commenter suggested that key conservation areas be spread across each physiographic region. One commenter questioned how populations of 500 would be an acceptable number for populations that already have over 500 plants.

Response: This recovery plan emphasizes conservation efforts for larger populations of *Silene spaldingii* while attempting to preserve the genetic diversity within each of the five physiographic regions where the plant resides. This is in line with the conservation strategy suggested by Nunney and Campbell (1993, pp. 235-238), which focuses on the preservation of several populations, each supporting a density of at least the minimum viable population size, across heterogeneous habitats. We agree that a population viability analysis would assist us in better identifying a minimum number of individuals of *Silene spaldingii*. However, in the absence of a population viability analysis, and based on recommendations from species experts, we utilize the standard minimum of 250 to 500 reproductive individuals (summarized in Schonewald-Cox *et al.* 1983, p. 392) and suggest that this number be revisited by species experts when a population viability analysis is completed. Sites with more than 500 plants will be maintained at or above current population numbers. Recovery Criterion 3 specifically states that populations will have stable or increasing trends.

We have made adjustments to the number of key conservation areas and their distribution across physiographic regions to incorporate commenters' suggestions. We set a minimum of three key conservation areas per physiographic region, and higher numbers of key conservation areas where it is believed that suitable habitat either exists or potentially can exist, to reach the total number of 27 key conservation areas across the historical range of *Silene spaldingii*. This number is intended to preserve the available genetic variability within the species and provide for its long-term persistence. We have added additional text in the recovery plan that states, when possible, key conservation areas should be surrounded by 300 acres of habitat that is intact or can be restored to eventually support *S. spaldingii*. We also added language that key conservation areas should be spread across each physiographic region.

Issue 2: Several commenters suggested that the plan must rely on a population viability analysis and that the plan should be adaptive to incorporate results from such an analysis. One commenter questioned who would lead recovery efforts, and make assessments that recovery criteria are being met. Several commenters questioned who would be responsible for various actions and how cooperation should occur.

Response: We agree that a population viability analysis would be useful for better managing *Silene spaldingii* and as a useful tool for assessing the validity of preserving the species based on populations composed of at least 500 reproducing individuals. However, minimum viable population size estimates are often erroneous as they relate to extinction risk (Brook *et al.* 2006, p. 375). We are required under section 4(f)(1)(B)(ii) of the Endangered Species Act of 1973 as amended, to have objective, measurable criteria. We have written Recovery Criterion 1 to meet this statute and included a population viability analysis as a recovery action. We have identified agencies responsible, including the primary agency responsible, for each action in the recovery plan in the Implementation Schedule. The Service is the primary agency responsible for assessing if recovery criteria are being met as well as for revising recovery criteria. We have added recovery action **2.12** (Convene annual meetings of the *Silene spaldingii* technical team) to the recovery plan and identified this team to guide all recovery efforts. The action states: Annual meetings or conference calls of the *Silene spaldingii* technical team should be conducted. The technical team should be composed of interested individuals and organizations. These annual meetings should inform other members of ongoing *S. spaldingii* conservation actions, and serve as a forum to discuss, coordinate, and prioritize recovery actions. We anticipate the technical team, when the population viability analysis is completed, will evaluate if the criterion of at least 500 reproducing *Silene spaldingii* individuals should be adjusted in the future.

Issue 3: One commenter suggested that the recovery plan should discuss the possibility of de-listing populations by physiographic region.

Response: Until recently, plants were not listed or de-listed except as a whole taxonomic entity (species or subspecies). That is, distinct population segments only applied to species of vertebrate fish or wildlife. However, recent draft guidance (D. Bernhardt, *in litt.* 2007), relating to the meaning of the phrase "in danger of extinction throughout all or a significant portion of its range" in the Endangered Species Act, may make it possible to list and de-list portions of species range based on various boundaries, which could include physiographic region.

Issue 4: One commenter suggested that smaller occurrences be given more weight in the recovery plan.

Response: As mentioned before, this recovery plan emphasizes conservation efforts for larger populations of *Silene spaldingii* while attempting to preserve the genetic diversity within each of the five physiographic regions where the plant resides. This is in line with the conservation strategy suggested by Nunney and Campbell (1993, pp. 235-238), which focuses on the preservation of several populations, each supporting a density of at least the minimum viable population size, across heterogeneous habitats. Furthermore, it is difficult to craft recovery criteria for small populations and these small populations, given their limited size, may not add much benefit to the overall recovery of the species.

With that in mind, we have addressed conservation of smaller populations. For example, Recovery Criterion 7 states: "Seed banking occurs *ex situ* for all smaller *Silene spaldingii* populations (not key conservation areas or potential key conservation areas) to preserve the breadth of genetic material across the species' range". We have added recovery actions 1.1.3, 1.2.3, 1.3.3, 1.4.3, and 1.5.4 to conserve and protect smaller populations within each physiographic region. We also modified action 2.3 to include both potential key conservation areas as well as smaller populations.

Issue 5: One commenter questioned how recovery actions in the recovery plan were prioritized.

Response: The Service's policy on how recovery actions are prioritized within recovery plans dictates priorities numbers. The Service's definition of recovery action priorities are as follows: Priority 1 – An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future; Priority 2 – An action that must be taken to prevent a significant decline in species population or habitat quality, or some other significant negative impact short of extinction; Priority 3 – All other actions necessary to meet the recovery objectives. Within each of these priority rankings, actions are not further prioritized. For example, while a population viability analysis is very important for better recovery planning, it is not an action that must be taken to prevent extinction of the species. We have added recovery action **2.12** (Convene annual meetings of the *Silene spaldingii* technical team) to assist managers and landowners in further prioritizing recovery actions. We also revised the priority number of several recovery actions based on commenters suggestions.

Issue 6: Several commenters suggested that the recovery plan did not adequately address the role of private lands in recovery. One commenter suggested that populations on public lands were not given enough special consideration. Several commenters suggested additional mechanisms for collaboration and protecting populations on private lands. One commenter suggested one recovery goal should be to engage with non-Federal partners to implement strategies, and that cooperation and mechanisms necessary for partnerships are vague or not discussed.

Response: Of the already identified 22 potential key conservation areas, 6 are solely on federally managed lands, 4 are on lands with both Federal management and private ownership, 1 has Federal, private, and The Nature Conservancy management or ownership, 4 have lands under both Federal and State management, 1 is on lands solely managed by States, 1 is on land managed solely by The Nature Conservancy, 1 is on land managed both by The Nature

Conservancy and under private ownership, 2 are solely on Tribal lands, and 2 are solely on privately owned lands (see Table D-1 below).

Table D-1. Ownership of potential key conservation areas.

Potential Key Conservation Area	Ownership
Clear Lake Ridge	The Nature Conservancy (TNC)/ Wallowa-Whitman National Forest (WWNF)/private
Crow Creek	WWNF/private
Wallowa Lake	Private/Old Chief Joseph Gravesite (managed by the National Park Service)
Zumwalt Prairie	The Nature Conservancy (TNC)
Blue Mountain Foothills	Umatilla National Forest
Center Ridge	Nez Perce National Forest
Craig Mountain	Idaho Department of Fish and Game/ Cottonwood District Bureau of Land Management (CBLM)
Garden Greek	TNC/CBLM
Joseph Creek	Nez Perce Tribe
Coal Creek – Lamona	Spokane District Bureau of Land Management (SBLM)
Crab Creek	SBLM
Fishtrap Lake – Miller Ranch	SBLM/private
Rocky Ford	SBLM
Swanson Lake	SBLM/Washington Department of Fish and Wildlife
Telford	SBLM
Twin Lakes	SBLM/private
Crosson Valley	Confederated Salish and Kootenai Tribes
Dancing Prairie	The Nature Conservancy
Lost Trail	Lost Trail National Wildlife Refuge/Montana State Trust Lands
Kramer Palouse Natural Area	Washington State University
Paradise Ridge/Gormsen Butte	Private
Pitt Cemetery	Private

Clearly the participation of Federal, State, Tribal, The Nature Conservancy, and private entities is needed for the recovery of *Silene spaldingii*. Conservation of *S. spaldingii* on private lands is dependent on willing landowners, and cooperation with Federal and State agencies for funding. We have further identified mechanisms for cooperation and funding on private lands with the recovery actions and implementation schedule in recovery action **2.7** (Support conservation on privately owned lands). We have also added action **2.12** (Convene annual meetings of the *S. spaldingii* technical team) to guide recovery actions that are needed for conservation on private lands. Conservation on private lands that may serve as potential key conservation areas is included in the recovery criteria.

Issue 7: Several commenters suggested that the recovery plan did not identify all known or potential population sites. Several commenters suggested that the recovery plan did not identify additional areas to be surveyed nor did it prioritize areas to survey based on physiographic areas. On commenter suggested that surveys on Federal land be a high priority since protecting sites on Federal land is less expensive than restoring known or establishing new *Silene spaldingii* sites.

Response: We have used the best available scientific information in the final recovery plan. The population information is current as of May 2007.

Habitat models have been used to predict where *Silene spaldingii* occurs in several instances. However, these models have all resulted in large tracts of suitable habitat that are too big to easily survey, making further prioritization of these areas difficult. Better techniques are need to further refine and prioritize surveys. The following areas are listed in the text: Because the Canyon Grasslands are extremely steep and quite remote, there are still significant portions of suitable habitat to be searched, particularly on the Oregon side of the Snake River directly across from Craig Mountain, along the lower Grande Ronde River in Oregon and Washington, the Imnaha River in Oregon, and the lower Clearwater and Salmon Rivers in Idaho (please see Hill and Gray 2004a, pp. 17-21 for a summary of areas to be surveyed). Over 40 percent of known *S. spaldingii* sites are on private land; in general, these private lands have had much less inventory effort. The possibility for large populations residing on private property can not be overlooked. Several recent Bureau of Land Management land acquisitions in Washington (B. Benner, *in litt.* 2003, p. 3), as well as The Nature

Conservancy's acquisition in 2000 of the Zumwalt Prairie Preserve, have led to the discovery of large, previously unknown *S. spaldingii* populations. Federal lands, because of environmental regulations, are already inventoried more frequently than State or private lands.

Issue 8: One commenter suggested that standardized monitoring methodologies are needed across the range of the species. Another commenter suggested that demographic monitoring needs to occur in early June as well as later in the season to capture early season rosettes and later season reproductive structure information.

Response: We have included language under all **2.4** (Monitor population trends and habitat conditions) recovery action items relating to a standardized monitoring procedure as follows: "In as much as possible, a standardized trend monitoring procedure should be established rangewide. This will be challenging because different areas may require different protocols." We have added recovery action **2.12** (Convene annual meetings of the *Silene spaldingii* technical team). Already efforts are underway to develop standardized monitoring methodologies through the technical team. We have added language to recovery action **2.4.2** (Conduct demographic monitoring across the range of *Silene spaldingii*) to address the need to conduct demographic monitoring twice a year, and for a minimum of 10 years.

Issue 9: One commenter suggested suitable techniques for supplementing or creating new *Silene spaldingii* populations. Several commenters supported plans to create new populations, especially in the Palouse Prairie. Several commenters suggested that guidelines be developed to ensure genetic conservation during supplementation, re-introduction, and introduction activities.

Response: We have added recovery action **2.5.2.2** (Develop guidelines to ensure genetic conservation during supplementation, re-introduction, and introduction activities) to the Recovery Plan. Re-introduction to create new populations are suggested for several physiographic regions.

Issue 10: Several commenters questioned the recovery criteria in the recovery plan associated with controlling/eradicating invasive nonnative plant species. Several commenters stated that the 0.4 kilometer (0.25 mile) radius for invasive nonnative plant control was not feasible or economical. One commenter suggested that keeping invasive nonnative plant species below 20 percent would not be as effective as eliminating them within a smaller perimeter. One commenter questioned if there was any evidence that exotic annual grasses have negatively affected the species. Several commenters discussed integrated pest management strategies; one commenter stated that integrated pest management strategies rely on reducing the frequency and density of invasive nonnative plant species rather than eradicating them. Several commenters suggested that herbicides should be used to control the spread of non-native species while one commenter suggested that herbicides should not be used in, or adjacent to known habitat. One commenter suggested that herbicides with short residual effects be used near *Silene spaldingii*.

Response: Based on recommendations, we adjusted the 0.4 kilometer (0.25 mile) radius for control of invasive nonnative plant to 100 meters (328 feet), and for those invasive nonnative plant species that are already more common from 80 percent cover to control within a 50 meter (164 foot) radius (see actions 1.1.4, 1.2.4, 1.3.4, 1.4.4, 1.5.5). We have no specific evidence that exotic annual grasses have negatively affected the species, but assume the possibility.

We have added more information for integrated pest management techniques and clarified that these techniques strive to use the least aggressive tool necessary and added two pertinent review citations. Integrated pest management strategies utilize the least aggressive tool necessary to achieve management goals and utilize all control methods available such as prevention, manual control, biological control, and herbicide control. In some instances, the use of herbicides may be necessary to effectively control an invasive nonnative plant infestation. For example, a particular invasive nonnative plant may have deep underground roots that are impossible to remove by hand pulling. Having an integrated pest management plan in place will help identify when and where herbicides may be necessary, and what herbicides would control the invasive nonnative plant while causing the least harm to *Silene spaldingii*, its pollinators, and its habitat. We have used the word "control" rather than "eradicate," recognizing that eradication may be extremely difficult. We have added recovery action **2.3.7** (Avoid herbicide use not related to controlling invasive nonnative plant infestations specific to protecting *S. spaldingii* and all insecticide use within a 1.6 kilometer (1 mile) radius of all *S. spaldingii* populations) to protect pollinators.

Issue 11: One commenter stated that the recovery plan did not allow the use of nonnative grasses for restoring sites that are near or contain *Silene spaldingii*.

Response: There is considerable discussion on how best to restore degraded sites within the arid west (Lesica and Allendorf 1999, Jones 2003, Roundy 2005). We recognize that native species may be more difficult to obtain and costly, and that successful invasive nonnative plant control and restoration with native species can be more difficult on arid sites or sites adjacent to invasive nonnative sites (Roundy 2005, p. 48). The use of nonnative restoration species and competition with rare species is not well understood. However, there are examples of nonnative restoration species affecting other rare plant species. For these reasons, we continue to suggest that nonnative restoration species should not be used near *Silene spaldingii* sites, unless previous greenhouse studies have shown that the nonnative restoration species will not compete with *S. spaldingii*.

Issue 12: Several commenter suggested that prescribed fire should be used to control vegetation and promote *Silene spaldingii* recruitment while one commenter suggested that prescribed fire should not be used in or adjacent to known habitat. Several commenters suggested that prescribed fire should be a tool that can be utilized when invasive nonnative species are present so long as integrated pest management practices are in place.

Response: We continue to include prescribed burning as a potential tool to be used cautiously, but have added language making it possible to do so in the presence of invasive nonnative plant infestations with appropriate invasive nonnative plant control measures, monitoring, and a management strategy being in place prior to the prescribed burn. We also added language recommending that only portions of *Silene spaldingii* populations be burned at any one time.

Issue 13: Several commenters stated that we do not understand the effects of livestock grazing and trampling on *Silene spaldingii*. Several commenters noted the recovery plan identified that managed livestock grazing could be beneficial to, or compatible with *S. spaldingii*. One commenter stated that managed livestock grazing should be considered an option when prescribed fire is not feasible to control litter accumulation and promote *S. spaldingii* recruitment. Other commenters stated that any level of livestock grazing and trampling is detrimental to the species, or provides a neutral effect depending how areas are managed. Several commenters stated that livestock grazing and trampling leads to habitat degradation. Several commenters stated that some recovery actions in the recovery plan related to livestock grazing appear to be unrealistic, for example, the time period when livestock use should not occur. One commenter stated we had not utilized livestock grazing references appropriately. One commenter stated that eliminating livestock grazing and trampling from *S. spaldingii* populations could limit the opportunity for future land acquisitions that would benefit *S. spaldingii.*

Response: Livestock grazing and trampling is probably the most contentious management issue within the range of *Silene spaldingii* with critics and supporters (see Curtin 2002, p. 240). Sufficient research has not been completed to determine what effects livestock grazing is having on *S. spaldingii*. We modified our suggestions in recovery action **2.3.4** to state that livestock grazing may occur with careful monitoring. It is recommended that monitoring associated with livestock use include paired grazed versus ungrazed transects at each site where grazing occurs to adequately determine whether grazing is having an effect. In addition, the vegetation community should be assessed at each paired plot to determine the effects livestock may be having on the habitat.

We have modified our "Adverse Livestock Grazing and Trampling" section in the document to incorporate commenters suggestions.

Issue 14: One commenter suggested that cumulative impacts of herbivory from native and non-native ungulates, rodents, and insects should be assessed.

Response: We have added to both recovery actions **2.3.4** (Monitor and manage livestock grazing and associated management activities to avoid impacts to *Silene spaldingii* and its habitat) and **2.3.6.** (Monitor and manage wildlife populations and associated management activities to avoid impacts to *S. spaldingii* and its habitat) that cumulative effects of herbivory should be assessed in areas where both native and domestic ungulates graze.

Issue 15: Several commenters suggested that invasive nonnative plant species spread along roads.

Response: We have included a discussion of roads and how invasive nonnative species move along them under the threat “Land Conversion Associated with Urban and Agricultural Development.”

Appendix E. List of agencies and individuals we requested to provide comments for the *Silene spaldingii* Recovery Plan.

LeAnn (Eno) Abell and Mark Lowry, U.S. Bureau of Land Management, Idaho
Joseph Arnett, Florence Caplow, and John Gamon, Washington Natural Heritage Program
Barbara Benner and Diane Stutzman, U.S. Bureau of Land Management, Washington
Joanne Bigcrane and Tamara Enz, The Confederated Salish and Kootenai Tribes of the Flathead Reservation, Montana
Carrie Cordova, Columbia Basin Fish and Wildlife Office, Spokane, Washington
Karen Gray, and Janice Hill, Idaho Conservation Data Center
Mike Hays, Nez Perce National Forest, Idaho
Trish Heekin, Latah County Soil and Water Conservation District, Idaho
Jerry Hustafa and Gene Yates, Wallowa-Whitman National Forest, Oregon
Peter Lesica, Consultant, Montana
Maria Mantas, The Nature Conservancy of Montana
Blair McClarin and Angela Sondenaa, Nez Perce Tribe, Idaho
Gary Miller, La Grande Fish and Wildlife Office, Oregon
Scott Mincemoyer and Sue Crispin, Montana Natural Heritage Program
Robert Taylor, The Nature Conservancy of Oregon
U.S. Fish and Wildlife Service Ecological Services Offices (Boise, Idaho; Helena and Kalispell, Montana; La Grande, Oregon; Spokane and Lacey, Washington)
Jim White and Jerome Hansen, Idaho Department of Fish and Game
Jean Wood, Umatilla National Forest, Oregon and Washington

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