U.S. Fish & Wildlife Service

Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington

Willamette Daisy

Left: Fender's Blue Butterfly
Below: Bradshaw's Lomatium

Above: Nelson's Checker-mallow
Left: Kincaid's Lupine

RECOVERY PLAN
FOR THE PRAIRIE SPECIES
OF WESTERN OREGON
AND SOUTHWESTERN WASHINGTON

Fender's blue butterfly (*Icaricia icarioides fenderi*)
***Erigeron decumbens* var. *decumbens* (Willamette daisy)**
***Lomatium bradshawii* (Bradshaw's lomatium)**
***Lupinus sulphureus* ssp. *kincaidii* (Kincaid's lupine)**
***Sidalcea nelsoniana* (Nelson's checker-mallow)**

REGION 1
U.S. FISH AND WILDLIFE SERVICE
PORTLAND, OREGON

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U.S. Fish and Wildlife Service

Date: 5/20/10

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Recovery plans delineate reasonable actions that are believed to be required to recover and/or protect listed species. We, the U.S. Fish and Wildlife Service, publish recovery plans, sometimes preparing them with the assistance of recovery teams, contractors, State agencies, and others. Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery plans do not necessarily represent the views nor the official positions or approval of any individuals or agencies involved in the plan formulation, other than our own. They represent our official position **only** after they have been signed by the Regional Director or Director as **approved**. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

***Literature citation should read as follows*:**

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An electronic version of this recovery plan will also be made available at http://www.fws.gov/pacific/ecoservices/endangered/recovery/plans.html and http://www.fws.gov/endangered/recovery/index.html.

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EXECUTIVE SUMMARY

CURRENT SPECIES STATUS

This recovery plan addresses one listed butterfly and four listed plants:

Fender's blue butterfly	*Icaricia icarioides fenderi*	Endangered
Willamette daisy	*Erigeron decumbens* var. *decumbens*	Endangered
Bradshaw's lomatium	*Lomatium bradshawii*	Endangered
Kincaid's lupine	*Lupinus sulphureus* ssp. *kincaidii*	Threatened
Nelson's checker-mallow	*Sidalcea nelsoniana*	Threatened

This recovery plan also provides conservation measures specific to the Willamette Valley for *Castilleja levisecta* (golden paintbrush), a threatened species for which a recovery plan was published in 2000. In addition, the recovery plan addresses one candidate species and six nonlisted species of conservation concern: Taylor's checkerspot butterfly (*Euphydryas editha taylori*), *Delphinium leucophaeum* (pale larkspur), *Delphinium oreganum* (Willamette Valley larkspur), *Delphinium pavonaceum* (peacock larkspur), *Horkelia congesta* ssp. *congesta* (shaggy horkelia), *Sericocarpus rigidus* (white-topped aster), and *Sisyrinchium hitchcockii* (Hitchcock's blue-eyed grass).

HABITAT REQUIREMENTS AND LIMITING FACTORS

The prairie species addressed in this recovery plan occur on upland prairies and grasslands, and in wet prairies that range from southwestern Washington south through the Willamette Valley and into the Umpqua Valley in Oregon. They are all threatened by the continued degradation, loss, and fragmentation of their native prairie ecosystems.

RECOVERY STRATEGY

The strategy to achieve the recovery of Fender's blue butterfly, *Erigeron decumbens* var. *decumbens, Lomatium bradshawii, Lupinus sulphureus* ssp. *kincaidii, and Sidalcea nelsoniana* is to restore and maintain multiple viable populations of the species by protecting, restoring, maintaining, and connecting the remaining fragments of prairie habitats or areas with potential for restoration to prairie habitats within their historical range. These areas should be restored to functional prairie ecosystems with management that restores and maintains a diversity of native species typical of these prairie communities. The primary threats to be addressed through this recovery strategy are habitat destruction, isolation and fragmentation, invasion by non-native plant species, and

succession. The recovery plan also recommends actions to help better understand and respond to potential threats posed by changing climate conditions in the region.

RECOVERY GOALS, OBJECTIVES, AND CRITERIA

Specific recovery goals for the five listed species are as follows:

Fender's blue butterfly – reclassify from endangered to threatened, and then delist.
***Erigeron decumbens* var. *decumbens* – reclassify from endangered to threatened, and then delist.**
***Lomatium bradshawii* – reclassify from endangered to threatened, and delist.**
***Lupinus sulphureus* ssp. *kincaidii* – delist.**
***Sidalcea nelsoniana* – delist.**

Other goals of this recovery plan are to ensure the long-term conservation of *Castilleja levisecta* in the Willamette Valley and to conserve the candidate species and other nonlisted species of conservation concern in prairie habitats within the range of this plan such that listing is not necessary.

The objective of the recovery program is to achieve viable populations of the listed species distributed across their historical ranges in a series of interconnected populations; this will be accomplished by establishing networks of restored prairie reserves across the geographic range of this recovery plan.

For Fender's blue butterfly, three recovery zones have been delineated that encompass the historical range of the species. To delist Fender's blue butterfly, we set an extinction risk threshold of 95 percent probability of persistence for 100 years. This standard may be achieved with a variety of combinations of networks and independent populations in each of the three recovery zones. Populations that do not drop below a minimum threshold must be maintained for at least 10 years at all functioning networks and independent populations to meet the delisting criteria. The habitat that supports the populations must be managed for high quality prairie habitat, and must be in secure, conservation-oriented ownership, with management and monitoring to control threats.

For the listed plants, we have delineated 10 recovery zones that cover the geographic range of the species. Recovery criteria for each of the listed plants specify the number and size of populations in each recovery zone, the distribution of subpopulations that make up the populations, evidence of a stable or increasing population trend for at least 15 years, and evidence of reproduction. The habitat that supports the populations must be managed for high quality prairie habitat, and must be in secure, conservation-oriented

ownership, with management and monitoring to control threats. In addition, genetic material must be banked in a facility approved by the Center for Plant Conservation.

ACTIONS NEEDED

Actions needed to recover Fender's blue butterfly:

1. Preserve, restore, and manage existing populations and habitat for Fender's blue butterfly.
2. Coordinate management with recovery efforts for *Lupinus sulphureus* ssp. *kincaidii*, the larval host plant for Fender's blue butterfly.
3. Implement a standardized population monitoring protocol.
4. Monitor prairie quality and diversity at all population sites.
5. Reintroduce populations and restore habitat, as necessary, to meet recovery goals.
6. Implement further research needed for the conservation of the species.
7. Develop a post-delisting monitoring plan prior to delisting.

Actions needed to recover *Erigeron decumbens* var. *decumbens*, *Lomatium bradshawii*, *Lupinus sulphureus* ssp. *kincaidii*, and *Sidalcea nelsoniana*:

1. Preserve, restore, and manage existing populations and habitat.
2. Develop and implement a standardized population monitoring protocol.
3. Monitor prairie quality and diversity at all population sites.
4. Collect and bank seeds.
5. Identify reintroduction sites, develop and implement outplanting protocol, reintroduce populations and restore habitat, as necessary, to meet recovery goals, and manage and monitor reintroduced populations.
6. Identify and implement further research needed for the conservation of the species.
7. Monitor effectiveness of management actions and apply adaptive management measures, as needed.
8. Develop post-delisting monitoring plans prior to delisting.

Actions to contribute to the recovery of *Castilleja levisecta*:

1. Evaluate protected sites established for other listed prairie species in this plan as potential reintroduction sites for *Castilleja levisecta*.
2. Reintroduce *Castilleja levisecta* to restored prairie reserve sites.
3. Manage and monitor reintroduced populations.
4. Monitor effectiveness of management actions and apply adaptive management measures, as needed.

Actions to benefit all listed and nonlisted species addressed in this recovery plan:

1. Coordinate recovery actions to benefit other listed species and nonlisted prairie species of conservation concern.
2. Promote protection of listed species and prairie restoration on private lands.
3. Cultivate partnerships with both public and private agencies and organizations to promote the conservation of prairie ecosystems and listed prairie species.

TOTAL ESTIMATED COST OF RECOVERY

The Implementation Schedule provides the estimated costs of implementing recovery actions for the first 5 years after the release of the recovery plan. Continual and ongoing costs, as well as the estimated total cost, are based on the projected timeframes to recovery and delisting of each species.

Annual cost estimates are as follows:

Year 1 = $2,285,000
Year 2 = $1,602,000
Year 3 = $1,252,000
Year 4 = $1,029,000
Year 5 = $660,000

The estimated cost to implement this plan for the first 5 years is $6,828,000. The total cost to implement this plan through the year 2035, the estimated recovery date of Fender's blue butterfly, is $16,590,000. It should be noted that because many of the recovery actions identified for particular species will also benefit other listed species, the total cost of recovery may be overestimated.

DATE OF RECOVERY

The estimated recovery dates for the species addressed in this recovery plan account for 10 to 15 years of monitoring to establish population stability as well as the time it may take to supplement or establish new populations. If recovery actions are prompt and effective, delisting for the Fender's blue butterfly could occur by 2035. Delisting for the plants (*Erigeron decumbens* var. *decumbens*, *Lomatium bradshawii*, *Lupinus sulphureus* ssp. *kincaidii*, and *Sidalcea nelsoniana*) could occur between 2020 and 2030.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

I. BACKGROUND

A. BRIEF OVERVIEW

The native prairies of western Oregon and southwestern Washington are among the most endangered ecosystems in the United States (Noss *et al.* 1995). Six native prairie species in the region – one butterfly and five plants – have been added to the Federal List of Endangered and Threatened Wildlife and Plants since 1988 (Table I-1) pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. 1531, *et seq*.). In this recovery plan, we develop recovery strategies and objectives for Fender's blue butterfly (*Icaricia icarioides fenderi*), *Erigeron decumbens* var. *decumbens* (Willamette daisy), *Lomatium bradshawii* (Bradshaw's lomatium), *Lupinus sulphureus* ssp. *kincaidii* (Kincaid's lupine), and *Sidalcea nelsoniana* (Nelson's checker-mallow). We also provide conservation measures to restore *Castilleja levisecta* (golden paintbrush) in the Willamette Valley. This plan replaces and supersedes previously approved recovery plans for *Lomatium bradshawii* (U.S. Fish and Wildlife Service 1993a) and *Sidalcea nelsoniana* (U.S. Fish and Wildlife Service 1998); it augments, but does not replace, the existing recovery plan for *Castilleja levisecta* (U.S. Fish and Wildlife Service 2000b). In addition to recovery goals for these six listed species, the plan recommends conservation measures for Taylor's checkerspot butterfly (*Euphydryas editha taylori*), which is a candidate for Federal listing, and six nonlisted plant species of conservation concern (Table I-1). All of the species addressed in this recovery plan are threatened by the continued degradation, loss, and fragmentation of their native prairie ecosystems.

The listed prairie species addressed in this recovery plan range from southwestern Washington south through the Willamette Valley and into the Umpqua Valley in Oregon (Figure I-1). The exception is *Castilleja levisecta*, which historically reached the southern extent of its range in the Willamette Valley, but is now extirpated there and only occurs to the north of the geographic boundaries of this plan (it is sparsely distributed in the Puget lowlands and on two islands of British Columbia, Canada). A recovery plan was recently published for *Castilleja levisecta* (U.S. Fish and Wildlife Service 2000b); this new Prairie Species Recovery Plan will provide recommendations for the reintroduction of the species into its historical range in the Willamette Valley, consistent with the species' published recovery plan. The ranges of Taylor's checkerspot butterfly and three of the nonlisted plant species addressed in this recovery plan (*Delphinium oreganum*, *Horkelia congesta* ssp. *congesta, and Sericocarpus rigidus*) are larger than the geographical scope of the

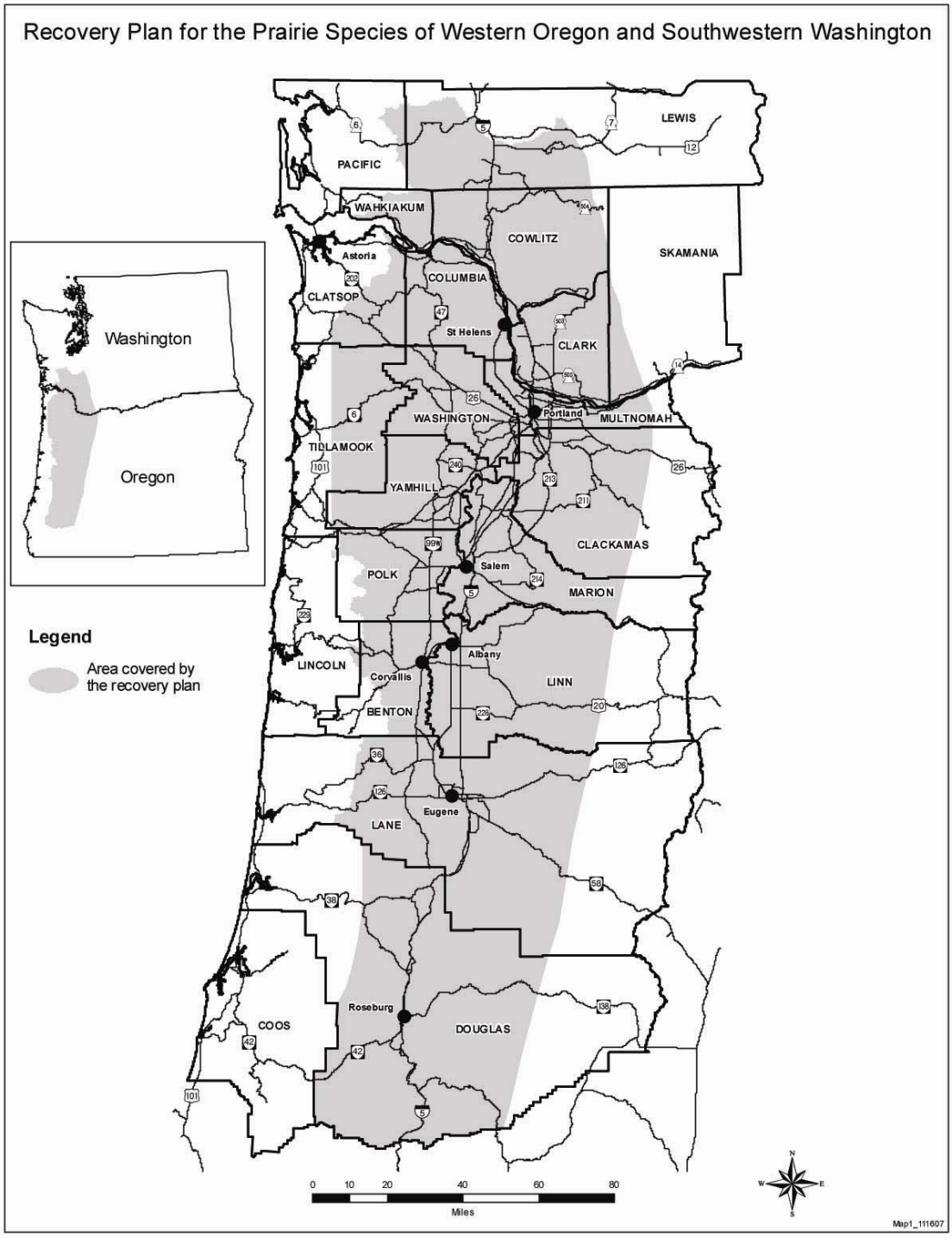

Figure I-1. Geographic scope of the Recovery Plan.

Table I-1. Species addressed in this plan.					
Listed Species					
Species	**Federal Status**	**Federal Listing Date and Reference**	**Recovery Priority Number[1]**	**State Status**	
				OR	**WA**
Fender's blue butterfly, *Icaricia icarioides fenderi*	Endangered	January 25, 2000; 65 FR 3875	3C	Endangered	--
Willamette daisy, *Erigeron decumbens* var. *decumbens*	Endangered	January 25, 2000; 65 FR 3875	3C	Endangered	--
Bradshaw's lomatium, *Lomatium bradshawii*	Endangered	September 30, 1988; 53 FR 38448	5	Endangered	Endangered
Kincaid's lupine, *Lupinus sulphureus* ssp. *kincaidii*	Threatened	January 25, 2000; 65 FR 3875	6C	Threatened	Endangered
Nelson's checker-mallow, *Sidalcea nelsoniana*	Threatened	February 12, 1993; 58 FR 8235 8243	2	Threatened	Endangered
Golden paintbrush, *Castilleja levisecta*	Threatened	June 11, 1997; 62 FR 31740	2	Endangered	Endangered
Nonlisted Species					
Taylor's (whulge) checkerspot butterfly, *Euphydryas editha taylori*	Candidate	October 30, 2001; 66 FR 54808	--	--	Endangered
Pale larkspur, *Delphinium leucophaeum*	None	--	--	Endangered	Endangered
Willamette Valley larkspur, *Delphinium oreganum*	None	--	--	Candidate	--
Peacock larkspur, *Delphinium pavonaceum*	None	--	--	Endangered	--
Shaggy horkelia, *Horkelia congesta* ssp. *congesta*	None	--	--	Candidate	--
White-topped aster, *Sericocarpus rigidus*	None	--	--	Threatened	Sensitive
Hitchcock's blue-eyed grass, *Sisyrinchium hitchcockii*	None	--	--	--	--

[1] Listed species are given a recovery priority number, which may range from a high of 1C to a low of 18, whereby priorities to recovery tasks are assigned. The criteria on which the recovery priority number is based are degree of threat, recovery potential, taxonomic distinctiveness, and presence of an actual or imminent conflict between the species and development activities.

recovery plan; we will provide management recommendations for these species only within the area covered by this recovery plan.

B. PRAIRIES OF WESTERN OREGON AND SOUTHWESTERN WASHINGTON

Prairies[2], as the term is used in this recovery plan, are open native grasslands with little tree cover or the grassland understories of **savanna** habitats. This recovery plan covers three disjunct prairie regions distributed across roughly 480 kilometers (300 miles) in a longitudinal band bounded to the east by the Cascades Range and to the west by the Coast Range in western Oregon and southwestern Washington. In this plan, we will refer to these prairie regions as Southwestern Washington (encompassing Cowlitz and Lewis Counties in Washington), the Willamette Valley (in Benton, Clackamas, Lane, Linn, Marion, Multnomah, Polk, Tillamook, Washington and Yamhill Counties in Oregon and extending north across the Columbia River into Clark County, Washington), and the Umpqua Valley (in Douglas County, Oregon).

1. Southwestern Washington

The prairies of southwestern Washington fall into the Puget Lowlands or Puget Trough physiographic province, with moderate topographic relief and elevations below 160 meters (525 feet)(Franklin and Dyrness 1988, Altman *et al.* 2001). Prairies in this region are found on very well drained, gravelly soils (Altman *et al.* 2001). Prairie habitats were among the first to be converted to agricultural uses with the immigration of Euro-American settlers; it has been estimated that greater than 90 percent of the prairies in the southern Puget Trough have been converted to other (*i.e.*, non-prairie) uses (Chappell *et al.* 2001, Caplow and Miller 2004). This recovery plan addresses two listed species, *Lupinus sulphureu*s ssp. *kincaidii* and *Sidalcea nelsoniana,* that occur in this region, as well as the nonlisted *Delphinium leucophaeum*.

2. Willamette Valley

The Willamette Valley physiographic province of western Oregon, which also reaches north across the Columbia River to include a portion of Clark County in Washington (Franklin and Dyrness 1988), is the largest prairie region addressed in this plan. The prairies of the Willamette Valley occur at low elevation (between 50 and 130 meters [165 and 425 feet]), generally on deep **alluvial** soils in the valley bottoms and low foothills

[2] Terms defined in the Glossary (Appendix A) are shown in **bold** when first used in the text.

(Franklin and Dyrness 1988). Before Euro-Americans settled the Willamette Valley, prairies were one of the dominant habitat types, accounting for perhaps 30 percent of the valley floor (Altman *et al.* 2001). Prairies were created and maintained by natural and human-caused disturbances; the native Kalapuya peoples burned the prairies frequently to maintain high quality hunting and gathering grounds (Boyd 1986). As settlers arrived, native habitats were converted to agricultural landscapes, annual burning ceased, and native upland prairies and wet prairies now cover much less than one percent of their former area (Habeck 1961, Johannessen *et al.* 1971, Towle 1982), making them among the rarest of North American ecosystems (Oregon Natural Heritage Program 1983, Noss *et al.* 1995). Five of the listed species (Fender's blue butterfly, *Erigeron decumbens* var. *decumbens*, *Lomatium bradshawii*, *Lupinus sulphureus* ssp. *kincaidii*, and *Sidalcea nelsoniana*) and all of the nonlisted species addressed by this plan (Taylor's checkerspot butterfly, *Delphinium leucophaeum, Delphinium oreganum, Delphinium pavonaceum, Horkelia congesta* ssp. *congesta, Sericocarpus rigidus*, and *Sisyrinchium hitchcockii*) occur in the Willamette Valley; the lone exception is *Castilleja levisecta*, which historically occurred in the valley, but has been extirpated there since the 1930s (Sheehan and Sprague 1984).

3. Umpqua Valley

South of the Willamette Valley, the prairies of the Umpqua River Valley in Douglas County differ somewhat from those described above. In Douglas County, prairies are the patchy grasslands which may be found in areas of dry oak savanna, shrublands, oak woodlands, or forest openings within the mixed conifer zone (Peck 1961; Franklin and Dyrness 1988; Menke and Kaye 2003; Sam Friedman, U.S. Fish and Wildlife Service, Roseburg, Oregon, pers. comm., 2004). These habitats have been described as belonging to the Klamath Mountains physiographic province (Franklin and Dyrness 1988) or the Westside Oak and Dry Douglas-fir Forest and Woodlands zone (Chappell and Kagan 2001). Elevations are generally below 460 meters (1,500 feet) and soils are typically shallow and rocky over bedrock, or sometimes deep and very well drained (Chappell and Kagan 2001). As with the other prairie regions addressed in this recovery plan, fire was the primary mode of disturbance which kept grassland habitats open and free from encroaching trees and shrubs; the settlement of the Umpqua Valley by Euro-Americans resulted in the conversion of grasslands to urban and agriculture uses, and severely restricted the frequency of fires (Chappell and Kagan 2001).

*Lupinus sulphureu*s ssp. *kincaidii i*s the only listed species covered by this plan that occurs in the grasslands of the Umpqua Valley. The nonlisted prairie species *Horkelia congesta* ssp. *congesta* and *Sisyrinchium hitchcockii* also occur in the region.

C. PRAIRIE ECOLOGY

Although once widespread in the region, today prairies "… are invariably small, moderately to heavily disturbed, and geographically disjunct" (Altman *et al.* 2001). Moist winters, dry summers and gentle topography are necessary to produce a prairie, but prairies will generally only persist when regular fire, flooding or other disturbance prevents **succession** to woody vegetation. Disturbances can be natural, such as wildfire, although most present day disturbances are **anthropogenic** (*e.g.*, prescribed fire or mowing). In the absence of regular disturbance, the prairies may be overtaken by shrubs and trees, which shade and crowd out the open grasslands and the species that depend on them, ultimately allowing succession to forest habitat.

Historically, the prairies of southwestern Washington and western Oregon are thought to have been actively maintained by the native peoples of the region, who lived here for at least 10,000 years before the arrival of Euro-American settlers (Boag 1992). Prairies were burned to increase growth of favored food plants and to improve conditions for hunting game (Boyd 1986). Frequent burning reduced the abundance of shrubs and trees, favoring open prairies or savannas with a rich variety of native plants and animals.

After Euro-American settlement of the region began in the 1830s, regular burning of prairies ceased, and most of the grasslands were gradually developed for agricultural or urban uses (Altman *et al.* 2001). Woody species and non-native weeds encroached on the remaining prairie habitats. The decline in prairies and their increased fragmentation has led to the decline of many native prairie plants and animals (Altman *et al.* 2001). Even so, remnants of these highly diverse, complex, and poorly understood ecosystems provide necessary habitat for many rare species.

The prairies of western Oregon and southwestern Washington are divided botanically into upland and wet types. We present here a brief description of the two types.

1. Upland Prairies

Upland prairies occur on well drained soils, especially in bottomlands, along valley margins, and in the lower foothills (Altman *et al.* 2001). Native upland prairies are low-growing plant communities dominated by **perennial** grasses and **forbs**. Most of the foliage of native prairie plants is within 40 centimeters (16 inches) of the soil, with flowering stalks of some grasses sometimes reaching 1.5 meters (5 feet).

Historically, fire was the major disturbance factor in this habitat type. Some fires may have occurred naturally following lightning strikes, but the fires set by the native peoples of the valleys were likely much more regular, and were largely responsible for maintaining the vast areas of prairie habitats that existed before Euro-American settlement, especially in the Willamette Valley.

The plant composition of upland prairies is dominated by bunchgrasses, including *Festuca idahoensis* ssp. *roemeri* (Roemer's bunchgrass), *Danthonia californica* (California oatgrass), *Elymus glaucus* (blue wildrye), *Achnatherum lemmonii* (Lemmon's needlegrass), and *Koeleria macrantha* (junegrass) (Chappell and Kagan 2001). The spaces between the bunchgrasses are typically covered by mosses, fruticose lichens, or native forbs (Altman *et al.* 2001). Showy, slow-growing perennial forbs include *Eriophyllum lanatum* (common woolly sunflower), *Potentilla gracilis* (slender cinquefoil), *Fragaria virginiana* (wild strawberry), *Sidalcea malviflora* ssp. *virgata* (rose checker-mallow), and *Symphotrichum* (=*Aster) hallii* (Hall's aster), and the bulbs *Calochortus tolmiei* (Tolmie's mariposa lily) and *Dichelostemma congestum* (ookow). Some fast-growing **annual** forbs, including various species of tarweed (*Madia* spp.) and *Clarkia*, are also prominent members of the native community.

Of the species addressed in this plan, the endangered Fender's blue butterfly, three listed plant species (*Erigeron decumbens* var. *decumbens, Lupinus sulphureu*s ssp. *kincaidii* and *Castilleja levisecta*), one candidate (Taylor's checkerspot butterfly) and five nonlisted species of conservation concern (*Delphinium leucophaeum, Delphinium pavonaceum, Horkelia congesta* ssp. *congesta, Sericocarpus rigidus,* and *Sisyrinchium hitchcockii*) all depend on upland prairies as habitat.

All extant upland prairies have been invaded by non-native plants. Native species seem to coexist with some non-native invaders, such as *Dactylis glomerata* (orchard-grass) and *Daucus carota* (wild carrot), which do not spread **vegetatively**. Of greater concern are the

more aggressive non-native pest plants, such as *Agrostis* spp. (including *A. capillaris* [colonial bentgrass] and *A. stolonifera* [creeping bentgrass]), *Arrhenatherum elatius* (tall oatgrass), *Festuca arundinacea* (tall fescue), *Brachypodium sylvaticum* (slender false brome), and *Rubus armeniacus* (Armenian blackberry), which form dense patches excluding native plant species. Non-native annual grasses, including *Bromus mollis* (soft cheat), *Cynosurus echinatus* (bristly dogstail grass), and *Taeniantherum caput-medusae* (medusa-head grass), are also common. The most common non-native shrub is *Cytisus scoparius* (Scotch broom), which is highly invasive. Some native species, including *Toxicodendron diversilobum* (poison oak) and *Pteridium aquilinum* (bracken fern), also invade prairies in the absence of regular disturbance.

2. Wet Prairies

In pre-settlement times, perhaps one-third of the prairies of the Southwestern Washington and Willamette Valley regions were wet prairies (Altman *et al.* 2001). Wet prairies are seasonally wet ecosystems dominated by **herbaceous** plants. These habitats generally occur on poorly drained lowland soils; wet prairies can also occur on well-drained soils in which drainage is impeded by shallow pans or bedrock where rain collects, saturating the soil and often resulting in standing water from November through April (Alverson 1990, Finley 1995). Although soils dry during the summer drought, wet prairie soils have hydric characteristics typical of wetlands and support **facultative** or obligate wetland plant species (Reed 1988).

Both fire and flooding have shaped wet prairies. As with upland prairies, wet prairies are capable of supporting forest vegetation (Franklin and Dyrness 1988), but historically remained open as a result of periodic fires set by native peoples (Boyd 1986, Boag 1992). Summer drought dries both the soil and the vegetation, leaving the prairie susceptible to burning. In the past, regular fires reduced the abundance of shrubs and trees, favored the growth of grasses such as *Deschampsia cespitosa* (tufted hairgrass), and promoted a rich variety of native forbs.

Wet prairies are dominated by low-growing herbaceous plants. These habitats have a complex horizontal structure, with several types of **microhabitat**s. Most well-developed wet prairies have a small-scale pattern of raised pedestals 3 to 20 centimeters (1 to 8 inches) above a lower level of soil. These raised areas, typically 15 to 400 square centimeters (2 to 60 square inches) in area, support the bulk of the vegetation. However, some plants, such as *Juncus* spp. (rushes), *Plagiobothrys* spp. (popcorn flower), or *Madia*

spp. (tarweed), are found in the low spaces between pedestals. These low spaces are flooded during much of the winter, whereas the pedestals often remain above water between winter storms.

Of the species addressed in this plan, three listed plant species (*Erigeron decumbens* var. *decumbens, Lomatium bradshawii,* and *Sidalcea nelsoniana*) and four nonlisted species of conservation concern (*Delphinium oreganum, Delphinium pavonaceum, Horkelia congesta* ssp. *congesta,* and *Sericocarpus rigidus*) are found in wet prairie habitats. Common species found in wet prairies include **cespitose graminoids**, such as *Deschampsia cespitosa* and *Carex unilateralis* (one-sided sedge); short-rhizomatous graminoids, including *Hordeum brachyantherum* (meadow barley); perennial forbs, such as *Eriophyllum lanatum, Camassia quamash* (common camas), *Eryngium petiolatum* (coyote-thistle), and *Perideridia erythrorhiza* (western yampah); and annual forbs, including *Plagiobothrys figuratus* (fragrant allocarya) and *Downingia elegans* (elegant downingia).

Most wet prairies in the region have been over-run by invasive non-native plants; among the most dominant are *Rosa eglanteria* (sweetbriar rose), *Agrostis* spp., *Anthoxanthum odoratum* (sweet vernal grass), *Cirsium vulgare* (bull thistle), *Cirsium arvense* (Canada thistle), *Alopecurus pratensis* (meadow foxtail), and *Phalaris arundinacea* (reed canary-grass). Other non-native species, such as *Phleum pratense* (timothy) and *Myosotis discolor* (changing forget-me-not), are less invasive, and seem to coexist with native prairie species.

D. SENSITIVE WILDLIFE SPECIES ASSOCIATED WITH PRAIRIES

As the prairies of western Oregon and southwestern Washington have been lost to agriculture and development or overgrown by shrubs and trees, the resulting fragmentation of the remnants has had a substantial effect on the native wildlife that depend on those habitats. Two consequences of this loss and fragmentation have been: (1) genetic isolation for small-bodied animals (amphibians, reptiles, small mammals, and invertebrates) with low **vagility** and limited dispersal abilities, and (2) the small size of most of the remaining prairie patches, which may now be too small to support **population**s of larger-bodied animals (birds, reptiles, and medium to large mammals) (Altman *et al.* 2001).

Little pre-settlement data exist for mammals of the prairies, with the exception of game mammals. Elk (*Cervus elaphus*), Columbian black-tailed deer (*Odocoileus hemionus columbiana*), and Columbian white-tailed deer (*Odocoileus virginianus leucurus*) were common in the 19th century in the Willamette Valley; elk have declined and the Columbian

white-tailed deer has been extirpated from the Willamette Valley, although a Federally endangered population remains along the Columbia River and it is relatively common in the Umpqua Valley (Altman *et al.* 2001, U.S. Fish and Wildlife Service 2003).

Several bird species have declined with the loss of the prairies. The western meadowlark (*Sturnella neglecta*), Oregon vesper sparrow (*Pooecetes gramineus affinis*) and streaked horned lark (*Eremophila alpestris strigata*) are all highly associated with native grasslands and are now uncommon to rare in the region (Altman *et al.* 2001). The streaked horned lark is a candidate for Federal listing (U.S. Fish and Wildlife Service 2001); however, its conservation is not specifically addressed in this recovery plan because its preferred habitat is relatively bare, **ruderal** grasslands that differ from the native prairies occupied by the other species addressed in this recovery plan.

There is little information on the historical occurrence of the **herpetofauna** of the western prairies. Several species of frogs (western toad [*Bufo boreas*]), snakes (western rattlesnake [*Crotalus viridis*], gophersnake [*Pituophis catenifer*], sharp-tail snake [*Contia tenuis*], racer [*Coluber constrictor*]), and the northwestern pond turtle (*Actinymys* [=*Clemmys*] *marmorata marmorata*), all of which had some association with open grasslands, have declined and are now considered uncommon or rare in the Willamette Valley and Puget Trough (Altman *et al.* 2001, Oregon State University 2005).

Data on native invertebrate diversity in western prairies is spotty. The Fender's blue butterfly, which is listed as endangered, and the Taylor's checkerspot, a Federal candidate for listing, have both undergone substantial declines as their prairie habitats have disappeared. The American acetropis grass bug (*Acetropis americana*), found only in the wet prairies of the Willamette Valley (Oregon State University 2005), has also declined and has been identified as a species of concern by the Oregon Fish and Wildlife Office (U.S. Fish and Wildlife Service 2008).

II. SPECIES ADDRESSED IN THE RECOVERY PLAN

A. LISTED SPECIES

1. Fender's blue butterfly (*Icaricia icarioides fenderi* Macy)

Listing Status and Critical Habitat

Fender's blue butterfly was listed as endangered, without critical habitat, on January 25, 2000 (U.S. Fish and Wildlife Service 2000a). Its taxonomy and physical description are summarized in Appendix F.

Critical habitat for the Fender's blue butterfly was designated on October 31, 2006 (U.S. Fish and Wildlife Service 2006a). Critical habitat units have been designated in Benton, Lane, Polk and Yamhill Counties, Oregon. The primary constituent elements of critical habitat for the Fender's blue butterfly (i.e., those physical and biological features essential to the conservation of the species) are: (1) early seral upland prairie, wet prairie, or oak savanna habitat with a mosaic of low-growing grasses and forbs, an absence of dense canopy vegetation, and undisturbed subsoils; (2) larval host-plants *Lupinus sulphureus* ssp. *kincaidii*, *L. arbustus* (longspur lupine), or *L. albicaulis* (sickle-keeled lupine); (3) adult nectar sources, such as: *Allium acuminatum* (tapertip onion), *Allium amplectens* (narrowleaf onion), *Calochortus tolmiei*, *Camassia quamash*, *Cryptantha intermedia* (clearwater cryptantha), *Eriophyllum lanatum*, *Geranium oreganum* (Oregon geranium), *Iris tenax* (Oregon iris), *Linum angustifolium* (pale flax), *Linum perenne* (blue flax), *Sidalcea campestris* (meadow checker-mallow), *Sidalcea malviflora* ssp. *virgata*, *Vicia cracca* (bird vetch), *V. sativa* (common vetch), and *V. hirsute* (tiny vetch); and (4) stepping-stone habitat, consisting of undeveloped open areas with the physical characteristics appropriate for supporting the short-stature prairie oak savanna plant community (well drained soils), within 1.2 miles (about 2 kilometers) of natal lupine patches. Critical habitat does not include human-made structures existing on the effective date of the rule and not containing one or more of the primary constituent elements, such as buildings, aqueducts, airports, and roads, and the land on which such structures are located.

Population Trends and Distribution

The historic distribution of Fender's blue butterfly is not precisely known due to the limited information collected on this species prior to its description in 1931. Although the **type specimen** for this butterfly was collected in 1929, few collections were made between the time of the subspecies' discovery and Macy's last observation of the Fender's blue on May 23, 1937, in Benton County, Oregon (Hammond and Wilson 1992). Uncertainty regarding the butterfly's host plant caused researchers to focus their survey efforts on common lupine species known to occur in the vicinity of Macy's collections. Fifty years passed before the butterfly was found again.

Fender's blue butterfly was rediscovered in 1989 at the McDonald Research Forest, Benton County, Oregon; it was found to be associated primarily with *Lupinus sulphureus* ssp. *kincaidii*, a rare lupine, and occasionally *L. arbustus* or *L. albicaulis* (Hammond and Wilson 1993). Recent surveys have determined that Fender's blue butterfly is endemic to the Willamette Valley and persists in about 17 populations on remnant prairies in Yamhill, Polk, Benton, and Lane Counties (Figure II-1)(Hammond and Wilson 1993, Schultz *et al.* 2003, U.S. Fish and Wildlife Service unpublished data). Fender's blue butterfly populations occur on upland prairies historically characterized by native bunch grasses (*Festuca* spp.) The association of Fender's blue butterfly with upland prairie is mostly a result of its dependence on *Lupinus sulphureus* ssp. *kincaidii*, although Fender's blue butterfly often uses wet prairies for nectaring and dispersal habitat. Sites occupied by Fender's blue butterfly are predominantly located on the western side of the Willamette Valley, within 33 kilometers (21 miles) of the Willamette River. A recent synthesis of existing data estimated the current rangewide number of butterflies to be about 3,000 to 5,000 individuals (Schultz *et al*. 2003). Fewer than 10 sites with populations of 100 adult butterflies or more are known (Table II-1). We acknowledge, however, that our data on Fender's blue butterfly populations are incomplete and show some inconsistencies. Three different survey methods have been used to count populations over the last 20 years, and their results are not directly comparable (Fitzpatrick 2009). The quality of survey data depends on the experience level of the surveyors, weather conditions, and the ability to schedule surveys at the peak of the species' short flight season (Fitzpatrick 2009). In addition, not all sites have been surveyed each year, and in most years population counts have been obtained on only a portion of known sites, which results in incomplete counts and biased population estimates. One of the goals of the recovery program for Fender's blue butterfly is to develop survey protocols that provide more reliable data and are less costly to implement.

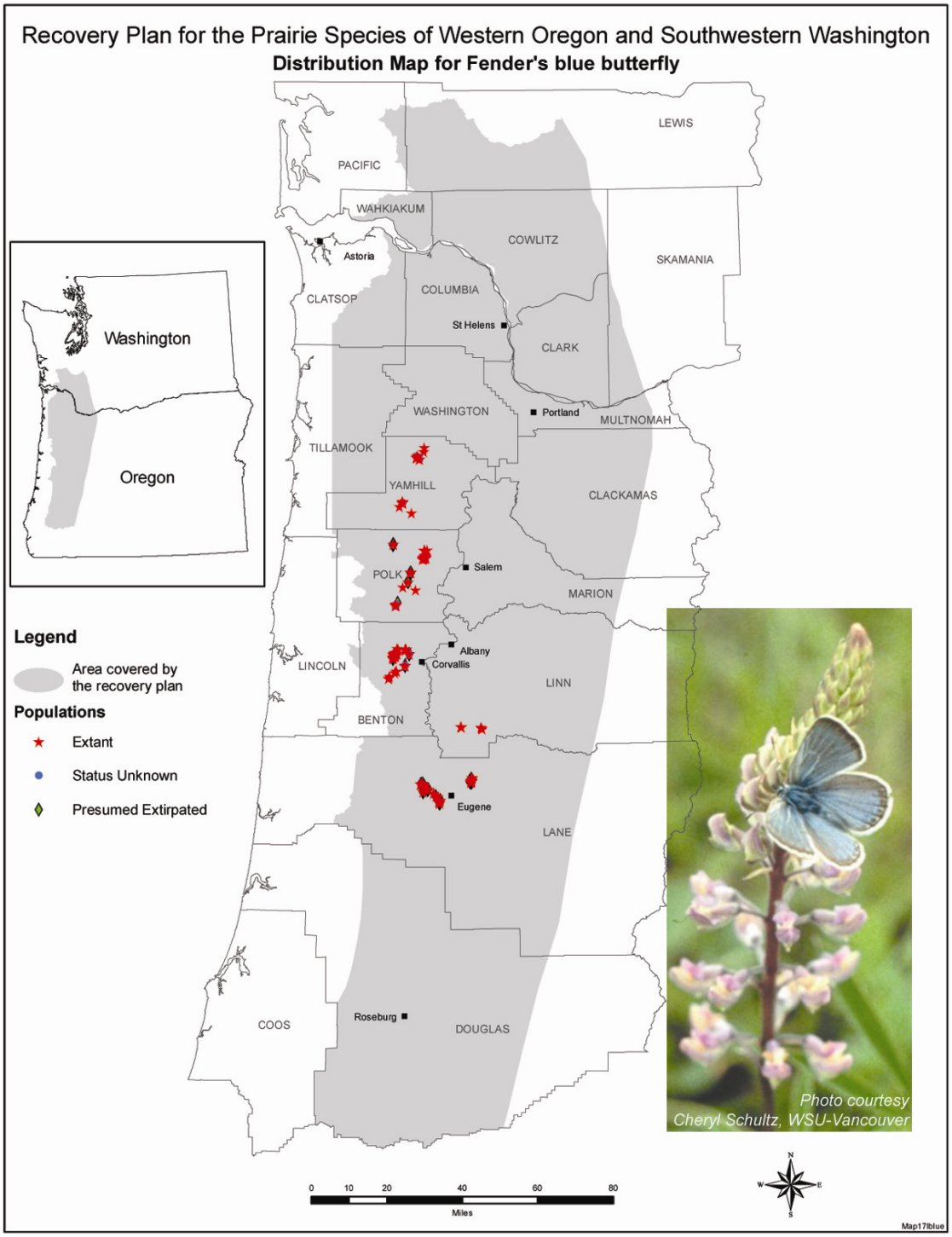

Figure II-1. Fender's blue butterfly distribution.

Table II-1. Fender's blue butterfly: estimated population sizes, 2000-2008.
Most estimates are derived from surveys of only a portion of the habitat, and are not based on complete counts of the populations. Different survey techniques are used at different sites, thus estimates are not directly comparable among sites.

Population	County	Year								
		2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Oak Ridge	Yamhill	168	192	293	240	259	96	100?	226[2]	226
Gopher Valley	Yamhill	12	7	22	21	10	12	20	80 - 100[2]	(b)
Mill Creek	Polk	25	22	48	50	43	20	?	12	(ns)
Dallas[1]	Polk	(ns)	(ns)	(ns)	(ns)	(ns)	(ns)	(ns)	6	6
Monmouth Road[1]	Polk	2	0	1	1	5	0		4	(ns)
McTimmonds Valley [1]	Polk	4	10	6	6	10	3	(ns)	2	5
Baskett	Polk	922	223	753	1236	1615[2]	768	1520	1385	(b)
Wren	Benton	(ns)	(ns)	(ns)	75	484[2]	180 - 200	>800[2]	1282	(b)
Lupine Meadows	Benton	(ns)	103	132	211	307	216	370	235	(b)
Butterfly Meadows	Benton	667	494	451	425	509	84	98	370	420
Greasy Creek[1]	Benton	(a)	(a)	(a)	(a)	1	2	20	20	(ns)
N. County	Benton	(a)	(a)	(a)	(a)	(a)	(a)	(a)	12 eggs	(ns)
Oak Basin	Linn	(a)	(a)	(a)	(a)	(a)	(a)	23	(ns)	45
Bond Butte	Linn	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(c)	(c)
Coburg	Lane	(ns)	(ns)	(ns)	154	236	23	221	355	121
Willow Creek	Lane	1439	577	2039	1336	1400	174	806	644	(b)
W. Eugene	Lane	179	119	195	795	1426	479	470	755	1188

[1] Estimates at these sites are the actual count of individuals detected, not populations estimates.
[2] Substantial additional habitat area discovered this year.
(ns) = Not surveyed.
(a) = Population not yet known.
(b) = Bad weather during flight season, no count conducted.
(c) = Adult Fender's blue butterflies observed but no count conducted.

Life History and Ecology

Adult Fender's blue butterflies live approximately 10 to 15 days and apparently rarely travel farther than 2 kilometers (1.2 miles) over their entire life span (Schultz 1998). Although only limited observations have been made of the early life stages of Fender's blue butterfly, the life cycle of the species likely is similar to other subspecies of *Icaricia icarioides* (Hammond and Wilson 1993). The life cycle of Fender's blue butterfly may be completed in one year. An adult Fender's blue butterfly may lay approximately 350 eggs over her 10 to 15-day lifespan, of which perhaps fewer than two will survive to adulthood (Schultz 1998, Schultz *et al*. 2003). Females lay their eggs on perennial lupines (*Lupinus sulphureus* ssp. *kincaidii*, *L. arbustus*, or occasionally *L. albicaulis*), which are the larval food plants, during May and June (Ballmer and Pratt 1988). Newly hatched **larvae** feed for a short time, reaching their second **instar** in the early summer, at which point they enter an extended **diapause**. When the lupine plant **senesces**, diapausing larvae remain in the leaf litter at or near the base of the host plant through the fall and winter. Larvae become active again in March or April of the following year, although some larvae may be able to extend diapause for more than one season depending upon the individual and environmental conditions. Once diapause is broken, the larvae feed and grow through three to four additional instars, enter their **pupal** stage, and, after about two weeks, emerge as adult butterflies in May and June (Schultz *et al.* 2003).

The larvae of many species of lycaenid butterflies, including *Icaricia icarioides*, possess specialized glands that secrete a sweet solution sought by some ant species which may actively tend and protect them from predators and parasites (Ballmer and Pratt 1988). Ants in the *Formica fusca* group have been observed tending Fender's blue butterfly larvae (Schultz *et al.* 2003); the strength or importance of this relationship has not been studied.

Fender's blue butterflies have limited dispersal ability. Adult butterflies may remain within 2 kilometers (1.2 miles) of their natal lupine patch (Schultz 1998), although anecdotal evidence exists of adult Fender's blues dispersing as far as 5 to 6 kilometers (3.1 to 3.7 miles) (Hammond and Wilson 1992, Schultz 1998); dispersal of this magnitude is not likely anymore because of habitat fragmentation. At large patches, such as the main area at Willow Creek in Lane County, 95 percent of adult Fender's blue butterflies are found within 10 meters (33 feet) of lupine patches (Schultz 1998).

Habitat Characteristics

Habitat requirements for Fender's blue butterfly include lupine host plants (*Lupinus sulphureus* ssp. *kincaidii* or *L. arbustus*, and occasionally *L. albicaulis*) for larval food and **oviposition** sites and native wildflowers for adult nectar food sources. Nectar sources used most frequently include *Allium amplectens*, *Calochortus tolmiei*, *Sidalcea malviflora* ssp. *virgata*, *Eriophyllum lanatum* and *Geranium oreganum* (Wilson *et al.* 1997, York 2002, Schultz *et al.* 2003). Non-native vetches (*Vicia sativa* and *V. hirsuta*) are also frequently used as nectar sources, although they are inferior to the native nectar sources (Schultz *et al.* 2003). Population size of Fender's blue butterfly has been found to correlate directly with the abundance of native nectar sources (Schultz *et al.* 2003). At least 5 hectares (12 acres) of high quality habitat are necessary to support a population of Fender's blue butterflies (Crone and Schultz 2003, Schultz and Hammond 2003); most prairies in the region are degraded and of low quality, and thus a much larger area is likely required to support a **viable** butterfly population.

Lupinus sulphureus ssp. *kincaidii* is the preferred larval host plant at most known Fender's blue butterfly populations. At two sites, Coburg Ridge and Baskett Butte, Fender's blue butterfly feeds primarily on *Lupinus arbustus*, even though *Lupinus sulphureus* ssp. *kincaidii* is present (Schultz *et al.* 2003). A third lupine, *Lupinus albicaulis*, is used by Fender's blue butterfly where it occurs in poorer quality habitats (Schultz *et al.* 2003). Fender's blue butterfly has not been found to use *Lupinus latifolius* (broadleaf lupine), a plant commonly used by other subspecies of *Icaricia icarioides*, even though it occurs in habitats occupied by the butterfly (Schultz *et al.* 2003).

Threats/Reasons for Listing

Habitat loss, encroachment into prairie habitats by shrubs and trees due to fire suppression, fragmentation, invasion by non-native plants and elimination of natural disturbance regimes all threaten the survival of Fender's blue butterfly. Few populations occur on protected lands; most occur on private lands which are not managed to maintain native prairie habitats. These populations are at high risk of loss to development or continuing habitat degradation (U.S. Fish and Wildlife Service 2000a). Prairie habitats have been invaded by tall non-native grasses that may be limiting the ability of the Fender's blue butterfly to find its host plant (Severns 2008). There is concern about the effects of pesticide application for agriculture, gypsy moth control, or mosquito control (Oregon Department of Human Service 2003, Oregon Department of Agriculture 2006). Recent population viability analyses have determined that the Fender's blue butterfly is at high risk

of extinction throughout most of its range (Schultz and Hammond 2003). Even the largest populations have a poor chance of survival over the next 100 years (Schultz *et al.* 2003).

Additional discussion and a complete description of threats and listing factors as they apply to Fender's blue butterfly can be found in section III (Threats Assessment) of this recovery plan.

Conservation Measures

Biologists from Federal and state agencies and private conservation organizations are engaged in active research and monitoring programs to improve the status of Fender's blue butterfly. Recent research has focused on population viability analyses (Schultz and Hammond 2003; Cheryl Schultz, Washington State University, Vancouver, pers. comm., 2009), **metapopulation** dynamics and the effects of habitat fragmentation (Schultz 1998), population response to habitat restoration (Wilson and Clark 1997, Kaye and Cramer 2003, Schultz *et al.* 2003), evaluating captive rearing techniques and outcomes (Schultz *et al.* 2009), and comparing population monitoring protocols (Fitzpatrick 2009).

Recent studies have shown that Fender's blue butterfly populations respond positively to habitat restoration. Mowing, burning and mechanical removal of weeds have all resulted in increasing Fender's blue butterfly populations. At two sites in the West Eugene Wetlands (The Nature Conservancy's Willow Creek Natural Area and the Bureau of Land Management's Fir Butte site), adult and larval Fender's blue butterflies have both increased in number following mowing to lower the stature of herbaceous non-native vegetation, although the response to habitat restoration is often complicated by other confounding factors, such as weather fluctuations (Schultz and Dlugosch 1999, Fitzpatrick 2005, Kaye and Benfield 2005a). Wilson and Clark (1997) conducted a study on the effects of fire and mowing on Fender's blue butterfly and its native upland prairie at Baskett Slough National Wildlife Refuge in the Willamette Valley. Although fire killed all larvae in burned patches, female Fender's blue butterflies from the nearby unburned source patch were able to colonize the entire burned area the following year, including lupine patches that were 107 meters (350 feet) from the unburned source plants. Fender's blue butterfly eggs were 10 to 14 times more abundant in plots that were mowed or burned compared to undisturbed, control plots. Woody plants were reduced 45 percent with burning and 66 percent with mowing. A study that modeled the effect of prescribed burning found that the best long-term population growth could be achieved by burning one-third of the habitat of a Fender's blue butterfly population each year (Schultz and Crone 1998).

Fender's blue butterfly population trends have been correlated with lupine vigor; abundant leaf growth appears to produce larger butterfly populations. At the U.S. Army Corps of Engineers' Fern Ridge Reservoir, the Fender's blue butterfly population has increased dramatically since fall mowing of lupine patches has been implemented. The abundance of Fender's blue butterfly eggs was found to be correlated with the abundance of Kincaid's lupine leaves at a number of study sites (Kaye and Cramer 2003); egg abundance increased substantially at sites which had been treated to control non-native weeds (Schultz *et al.* 2003).

A recent study, jointly conducted by Washington State University and the Oregon Zoo, evaluated techniques for captive rearing and release of Fender's blue butterflies, using the closely related Puget blue butterfly (*Icaricia icarioides blackmorei*) as a surrogate (Schultz *et al*. 2009). The study assessed different rearing techniques and evaluated the quality of the offspring produced. Survival in the captive facilities was low, and captive individuals had smaller wings and body length and had lower body mass at pupation than did individuals in their founding wild population. The authors suggested that captive rearing may not be the most effective means for augmenting wild populations, and that an alternative conservation strategy for reintroduction could aim to substantially increase existing populations via restoration efforts, and then translocate late stage larvae from existing populations to reintroduction sites (Schultz *et al*. 2009).

Fender's blue butterfly populations have been monitored using three different count protocols. A recent comparison of these protocols showed that they produce inconsistent results, and a new standardized protocol for use throughout the range of the species is needed (Fitzpatrick 2009).

Fender's blue butterfly populations occur on public lands or lands that are managed by a conservation organization at the U.S. Fish and Wildlife Service's Baskett Slough National Wildlife Refuge, the Army Corps of Engineers' Fern Ridge Reservoir, the Bureau of Land Management's West Eugene Wetlands, The Nature Conservancy's Willow Creek Preserve and Coburg Ridge easement, and on a small portion of Oregon State University's Butterfly Meadows in the McDonald State Forest (see Appendix C). All of these parcels have some level of management for native prairie habitat values. A habitat conservation plan that addresses conservation of the Fender's blue butterfly within Benton County is currently in preparation (Benton County 2009).

2. *Erigeron decumbens* Nutt. var. *decumbens* (Willamette daisy)

Listing Status and Critical Habitat

Erigeron decumbens var. *decumbens* is a perennial herb that was listed as endangered, without critical habitat, on January 25, 2000 (U.S. Fish and Wildlife Service 2000a). Its taxonomy and physical description are summarized in Appendix F.

Critical habitat was designated on October 31, 2006 (U.S. Fish and Wildlife Service 2006a). Critical habitat units for *Erigeron decumbens* var. *decumbens* have been designated in Benton, Lane, Linn, Marion and Polk Counties, Oregon. The primary constituent element of critical habitat is early seral upland prairie, wet prairie, or oak savanna habitat with a mosaic of low-growing grasses, forbs, and spaces to establish seedlings or new vegetative growth; an absence of dense canopy vegetation; and undisturbed subsoils. Critical habitat does not include human-made structures existing on the effective date of the rule and not containing one or more of the primary constituent elements, such as buildings, aqueducts, airports, and roads, and the land on which such structures are located.

Population Trends and Distribution

Erigeron decumbens var. *decumbens* is endemic to the Willamette Valley of western Oregon. Herbarium specimens show a historical distribution of *E. decumbens* var. *decumbens* throughout the Willamette Valley; frequent collections were made in the period between 1881 and 1934, yet no collections or observations were recorded from 1934 to 1980, and the plant was presumed to be extinct (Clark *et al.* 1993, Gisler 2004). The species was rediscovered in 1980 in Lane County, Oregon, and has since been identified at more than 30 sites (Figure II-2, and see Appendix B, Tables B-1 and B-2). *Erigeron decumbens* var. *decumbens* has been collected in Benton, Clackamas, Lane, Linn, Marion, Polk, Yamhill, and Washington Counties, Oregon, but today the species occurs in Benton, Lane, Linn, Marion, and Polk Counties, Oregon; at those sites, there are about 94 hectares (233 acres) of occupied habitat (Appendix B, Table B-1).

Population size may fluctuate substantially from year to year. Monitoring at the Oxbow West site, near Eugene, found 2,299 *Erigeron decumbens* var. *decumbens* plants in 1999, 2,912 plants in 2000, and only 1,079 plants in 2001 (Kaye 2002). The population at Baskett Butte declined to 48 percent of the original measured population between 1993 and 1999 (Clark 2000). Detecting trends in *E. decumbens* var. *decumbens* populations is

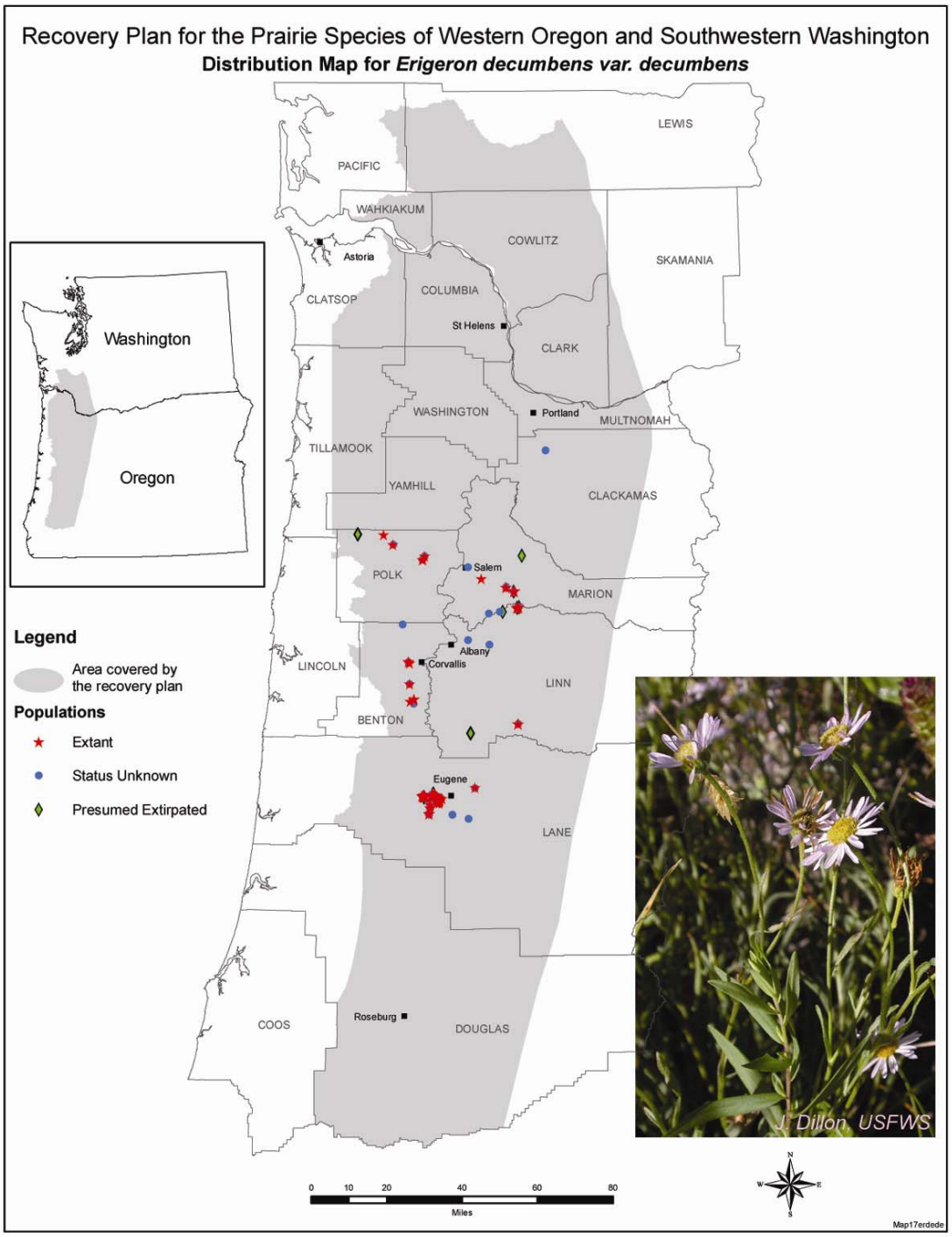

Figure II-2. *Erigeron decumbens* var. *decumbens* distribution.

complicated by the biology and **phenology** of the species. For instance, Kagan and Yamamoto (1987) found it difficult to determine survival and mortality between years because of sporadic flowering from year to year. They suggested that some plants may not flower in some years, as indicated by the sudden appearance of large plants where they were not previously recorded, and the disappearance and later re-emergence of large plants within monitoring plots. In addition, Clark *et al.* (1993) stated that non-reproductive individuals can be very difficult to find and monitor due to their inconspicuous nature, and that the definition of individuals can be complicated when flowering clumps overlap.

Life History and Ecology

Erigeron decumbens var. *decumbens* is an herbaceous perennial that occurs as single plants or clumps of genetically identical **ramets** (Clark *et al.* 1993). It blooms in June and early July and produces seeds in late summer (Cronquist 1955). Seedlings emerge in late winter or early spring, and plants require two to four years in the wild to reach flowering size. Large plants appear to spread vegetatively, but this spread is localized around the established plant (Clark *et al.* 1995). Field investigators have developed a distance-based rule for consistently differentiating closely-spaced plants. If it is unclear that two adjacent clumps are united underground, they are assumed to be distinct individuals if they are separated by 7 centimeters (3 inches) or more. Clumps closer than 7 centimeters (3 inches) are assumed to be part of the same plant (Kaye and Benfield 2005b).

The fruits of *Erigeron decumbens* var. *decumbens* are single-seeded **achenes**, like those of other *Erigeron* species, and have a number of small **capillary** bristles (the **pappus**) attached to the top, which allow them to be distributed by the wind. Population size can substantially affect reproductive success in this species. Populations of *E. decumbens* var. *decumbens* with fewer than 20 individuals appear to suffer a high rate of reproductive failure due to **inbreeding depression** and reduced probability of being pollinated by a compatible mate (Wise and Kaye 2006).

A variety of insects have been observed to visit the flowers of *Erigeron decumbens* var. *decumbens*; potential pollinators include solitary bees (*Ceratina* sp., *Megachile* sp., *Nomada* sp., *Halictus ligatus*, and *Ashmeadiella* sp.), beetles (*Meligethes nigrescens* and *Acanthoscelides pauperculus*), flies (*Toxomerus marginata, T. occidentalis* and *Tachina* sp.), and butterflies (*Phyciodes campestris*) (Kagan and Yamamoto 1987, Clark *et al.* 1993, Jackson 1996, Gisler 2004).

Habitat Characteristics

Erigeron decumbens var. *decumbens* typically occurs where woody cover is nearly absent and where herbaceous vegetation is low in stature (Clark *et al.* 1993). It occurs in both wet prairie grasslands and drier upland prairie sites. The wet prairie grassland community is typically dominated by *Deschampsia cespitosa*, *Danthonia californica* and a number of Willamette Valley endemic forbs. It is a flat, open, seasonally wet prairie with bare soil between the pedestals created by the bunching *Deschampsia cespitosa* (Kagan and Yamamoto 1987). On drier upland prairie sites, associated species commonly include *Symphotrichum hallii*, *Festuca idahoensis* ssp. *roemeri* and *Toxicodendron diversilobum* (Meinke 1982, Clark *et al*. 1993). *Erigeron decumbens* var. *decumbens* prefers heavier soils, and has been found on the following soil associations: Bashaw, Briedwell, Chehulpum, Dayton, Dixonville, Dupee, Hazelair, Marcola, Natroy, Nekia, Pengra, Philomath, Salkum, Saturn, Stayton, and Witzel.

Threats/Reasons for Listing

Like many native species endemic to Willamette Valley prairies, *Erigeron decumbens* var. *decumbens* is threatened by habitat loss due to urban and agricultural development, successional encroachment into its habitat by trees and shrubs, competition with non-native weeds, and small population sizes (Kagan and Yamamoto 1987, Clark *et al.* 1993, Gisler 2004). The U.S. Fish and Wildlife Service (2000a) estimated that habitat loss is occurring at 80 percent of the remaining 84 remnants of native prairies occupied by *Erigeron decumbens* var. *decumbens* and *Lupinus sulphureu*s ssp. *kincaidii*. At the time of its listing, we estimated that 24 of the 28 extant *Erigeron decumbens* var. *decumbens* populations occurred on private lands "expected to be lost in the near future unless conservation actions are implemented" (U.S. Fish and Wildlife Service 2000a: 3882).

Populations occurring on private lands are the most vulnerable to threats of development, because state and Federal plant protection laws have little effect on private lands, although publicly owned populations are not immune from other important limitations or threats to the species. For instance, Clark *et al.* (1993) identified four populations protected from development on public lands (Willow Creek, Basket Slough National Wildlife Refuge, Bald Hill Park, and Fisher Butte Research Natural Area), but stated that even these appear to be threatened by the proliferation of non-native weeds and successional encroachment of brush and trees. Likewise, vulnerability arising from small population sizes and inbreeding depression may be a concern for the species, regardless of land ownership, especially among 17 of the 28 remaining sites that are smaller than 3.5 hectares (8 acres) (U.S. Fish and Wildlife Service 2000a). Given that the majority of populations are on private lands,

working with private landowners is critical if we are to promote the eventual conservation and recovery of *Erigeron decumbens* var. *decumbens*.

Additional discussion and a complete description of threats and listing factors as they apply to *Erigeron decumbens* var. *decumbens* can be found in section III (Threats Assessment) of this recovery plan.

Conservation Measures

Some research has been conducted on the ecology and population biology of *Erigeron decumbens* var. *decumbens*, effective methods for habitat enhancement, and propagation and reintroduction techniques (Clark *et al.* 1995, 1997; Wilson and Clark 1997; Kaye and Kuykendall 2001b; Leininger 2001; Kaye *et al.* 2003a). The results of these studies have been used to direct the management of *Erigeron decumbens* var. *decumbens* populations at sites that are managed for native prairie values.

The efficacy of mowing and burning as tools to restore habitat for *Erigeron decumbens* var. *decumbens* is under investigation. Preliminary findings indicate that *Erigeron decumbens* var. *decumbens* responds negatively to both mowing and burning, although it is possible that positive effects will be detected in future (Thorpe and Kaye 2007).

Several studies have investigated the feasibility of growing *Erigeron decumbens* var. *decumbens* in controlled environments for augmentation of wild populations. Cold stratification or seed-coat **scarification** is necessary for successful **germination** (Clark *et al.* 1995, Kaye and Kuykendall 2001b). Stem and **rhizome** cuttings have also been used successfully to establish plants in the greenhouse (Clark *et al.* 1995, Wilson *et al.* 2001). Attempts to establish *Erigeron decumbens* var. *decumbens* at new sites has shown that transplanting cultivated plants is much more effective than sowing seeds directly (Kaye *et al.* 2003b). It is likely that conservation of *Erigeron decumbens* var. *decumbens* may require augmenting small populations with propagated individuals (Clark *et al.* 1995). Seeds of this species have been banked at the Berry Botanic Garden in Portland, Oregon (Berry Botanic Garden 2005).

Habitat for *Erigeron decumbens* var. *decumbens* occurs on public lands or lands that are managed by a conservation organization at the U.S. Fish and Wildlife Service's Baskett Slough National Wildlife Refuge, the U.S. Army Corps of Engineers' Fern Ridge Reservoir, the Bureau of Land Management's West Eugene Wetlands, and The Nature Conservancy's Willow Creek Preserve (see Appendix C). All of these parcels have some

level of management for native prairie habitat values. A habitat conservation plan that addresses conservation of *Erigeron decumbens* var. *decumbens* within Benton County is currently in preparation (Benton County 2009).

3. *Lomatium bradshawii* [Rose ex Mathias] Mathias & Constance (Bradshaw's lomatium)

Listing Status and Critical Habitat

Lomatium bradshawii (Bradshaw's lomatium, also known as Bradshaw's desert-parsley) is a perennial herb that was listed as endangered, without critical habitat, on September 30, 1988 (U.S. Fish and Wildlife Service 1988). Its taxonomy and physical description are summarized in Appendix F.

Population Trends and Distribution

Lomatium bradshawii was historically overlooked and poorly documented, and there were no known collections between 1941 and 1969, leading to the assumption that the taxon might be extinct. By 1980, following a study of the species, six populations of the species had been located, including one large population (Kagan 1980). Since 1980, over 40 new sites have been discovered, including 3 large populations.

For many years *Lomatium bradshawii* was considered an Oregon endemic, its range limited to the area between Salem and Creswell, Oregon (Kagan 1980). However, in 1994, two populations of the species were discovered in Clark County, Washington. The Washington populations, though few in number, are large in population size, with one site estimated to have over 800,000 individuals (U.S. Fish and Wildlife Service unpublished data). Because of their proximity, these two populations are considered to be a single occurrence under NatureServe guidelines. In addition to the Washington populations, there are currently more than 60 sites with *Lomatium bradshawii*, concentrated in three population centers located in Benton, Lane, Linn, and Marion Counties, Oregon (Gisler 2004, Oregon Natural Heritage Information Center 2007) (Figure II-3, and see Appendix B, Tables B-1 and B-2). Most of these populations are small, ranging from about 10 to 1,000 individuals, although the two largest sites each have over 100,000 plants (Oregon Natural Heritage Information Center 2007). The total area of occupied habitat is about 300 hectares (742 acres) (Appendix B, Table B-2).

Some populations that were large when discovered have since declined in size substantially. A large population at Buford Park near Eugene, Oregon, dropped from about

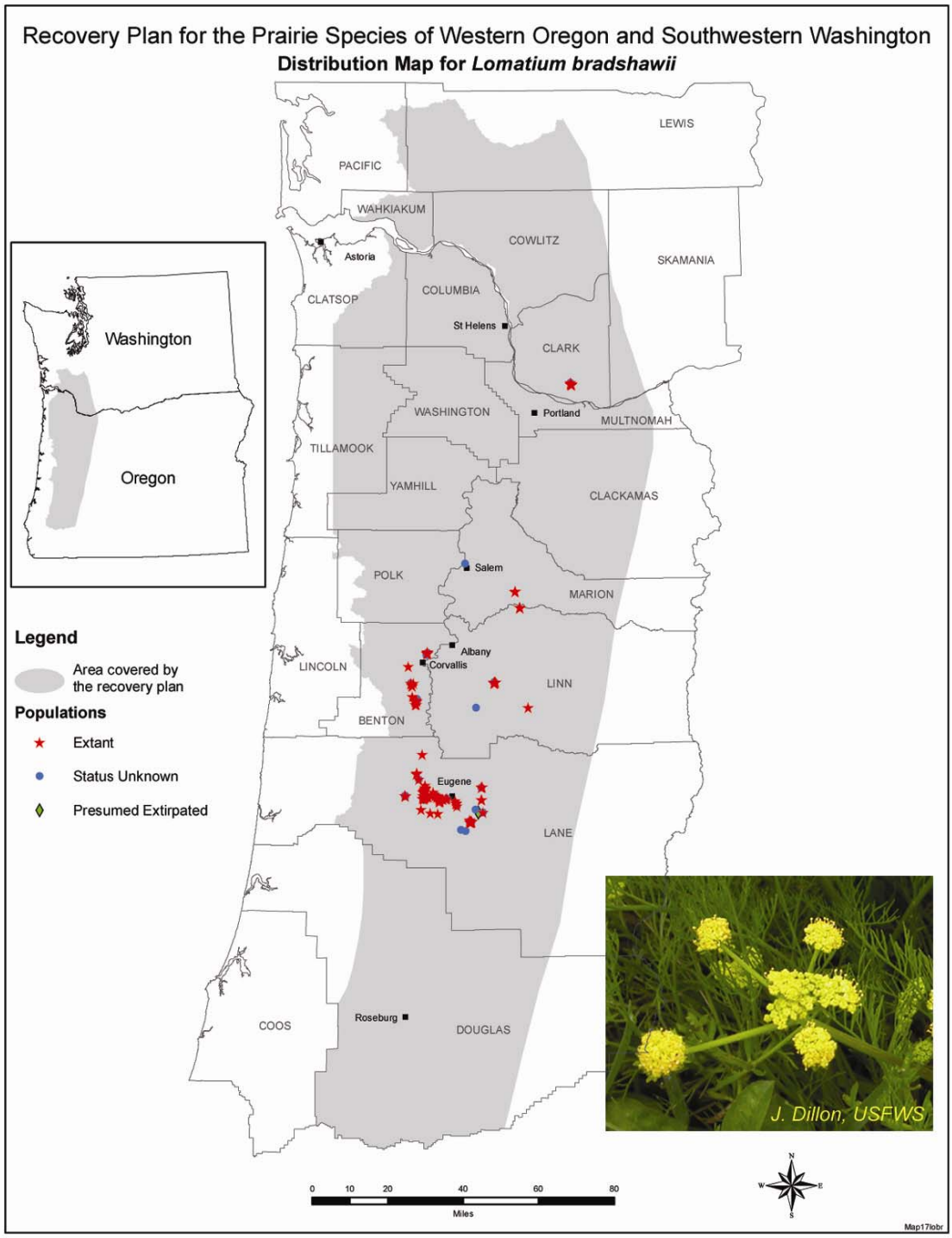

Figure II-3. *Lomatium bradshawii* distribution.

23,000 plants in 1993 to just over 3,000 plants in 1994 (Greenlee and Kaye 1995), recovered to 20,000 plants in 2000, and declined to about 200 plants in 2007 (Kate Norman, U.S. Fish and Wildlife Service, Portland, Oregon, 2010a). Herbivory by a booming vole population was suspected to be the cause of the decline.

Life History and Ecology

Lomatium bradshawii blooms in the spring, usually in April and early May. The flowers have a spatial and temporal separation of sexual phases, presumably to promote **outcrossing**, resulting in **protandry** on a whole plant basis, and **protogyny** within the flowers. A typical population is composed of many more vegetative plants than reproductive plants. The plant is pollinated by insects. Over 30 species of solitary bees, flies, wasps and beetles have been observed visiting the flowers (Kaye and Kirkland 1994, Jackson 1996). The very general nature of the insect pollinators probably buffers *Lomatium bradshawii* from the population swings of any one pollinator (Kaye 1992).

Lomatium bradshawii does not spread vegetatively and depends exclusively on seeds for reproduction (Kaye 1992). The large fruits have corky thickened wings, and usually fall to the ground fairly close to the parent. Fruits appear to float somewhat, and may be distributed by water. The fine-scale population patterns at a given site appear to follow seasonal microchannels in the tufted hairgrass prairies, but whether this is due to dispersal, habitat preference, or both, is not clear (Kaye 1992, Kaye and Kirkland 1994).

In a genetic study that included six populations of *Lomatium bradshawii*, the species displayed little population differentiation but the level of diversity was high across the species (Gitzendanner 2000). Isolated populations in Washington appear to have lower levels of diversity, but they do not appear to be genetically differentiated from the other populations of the species, consistent with historical gene flow among all populations, and a recent bottleneck in the Washington populations.

The species generally responds positively to disturbance. Low intensity fire appears to stimulate population growth of *Lomatium bradshawii.* The density and abundance of reproductive plants increased following fires (Pendergrass *et al.* 1999), although monitoring showed the effects to be temporary, dissipating after one to three years. Frequent burns may be required to sustain population growth, as determined from population models (Caswell and Kaye 2001, Kaye *et al.* 2001). Annual fall mowing has significantly increased the number of individual *Lomatium bradshawii* plants persisting in

the City of Eugene's Amazon Park, from 10,134 individuals in 1995 to 31,252 individuals in 2005 (Trevor Taylor, City of Eugene, *in litt*. 2008).

Habitat Characteristics

Lomatium bradshawii is restricted to wet prairie habitats. These sites have heavy, sticky clay soils or a dense clay layer below the surface that results in seasonal hydric soils. Most of the known *Lomatium bradshawii* populations occur on seasonally saturated or flooded prairies, which are found near creeks and small rivers in the southern Willamette Valley (Kagan 1980). The soils at these sites are dense, heavy clays with a slowly permeable clay layer located between 15 and 30 centimeters (6 and 12 inches) below the surface. This slowly permeable clay layer, which results in a perched water table in winter and spring, allows soils to be saturated to the surface or slightly inundated during the wet season. The soils include Dayton silt loams, Natroy silty clay loams or Bashaw clays; other soils on which the species has been found include Amity, Awbrig , Coburg, Conser, Courtney, Cove, Hazelair, Linslaw, Oxley, Panther, Pengra, Salem, Willamette, and Witzel.

Less frequently, *Lomatium bradshawii* populations are found on shallow, basalt areas in Marion and Linn County near the Santiam River. The soil type is characterized as Stayton Silt Loam; it is described as well drained, in alluvium underlain by basalt (Kaye and Kirkland 1994). The shallow depth to bedrock, 50 centimeters (20 inches) or less, results in sites which are poorly suited to agriculture. This soil type occurs at scattered locations in sites with deeper soils belonging to the Nekia-Jory association, which were originally vegetated by grassland and oak savanna (Alverson 1990). *Lomatium bradshawii* at these sites occurs in areas with very shallow soil, usually in vernal wetlands or along stream channels.

Lomatium bradshawii is often associated with *Deschampsia cespitosa*, and frequently occurs on and around the small mounds created by senescent *Deschampsia cespitosa* plants. In wetter areas, *Lomatium bradshawii* occurs on the edges of *Deschampsia cespitosa* or sedge bunches in patches of bare or open soil. In drier areas, it is found in low areas, such as small depressions, trails or seasonal channels, with open, exposed soils. The grassland habitat of *Lomatium bradshawii* frequently includes these species: *Carex* spp., *Danthonia californica*, *Eryngium petiolatum*, *Galium cymosum* (bedstraw), *Grindelia integrifolia* (Willamette Valley gumweed), *Hordeum brachyantherum*, *Juncus* spp., *Luzula comosa* (Pacific woodrush), *Microseris laciniata* (cut-leaved microseris), and *Perideridia* sp. (yampah) (Kagan 1980). In most sites, introduced pasture grasses (*Anthoxanthum odoratum*, *Holcus lanatus*, *Poa pratensis* [Kentucky bluegrass], *Agrostis capillaris*

[colonial bentgrass], *Dactylis glomerata* and *Festuca arundinacea*) are present. Invasive bentgrasses, including *Agrostis stolonifera*, have been found at many protected sites with *Lomatium bradshawii* populations, including The Nature Conservancy's Willow Creek Preserve and William L. Finley National Wildlife Refuge (Kate Norman, pers. comm. 2009).

Threats/Reasons for Listing

Expanding urban development, pesticides, encroachment of woody and invasive species, herbivory and grazing are threats to remaining *Lomatium bradshawii* populations (U.S. Fish and Wildlife Service 1988). The majority of Oregon's *Lomatium bradshawii* populations are located within a 16-kilometer (10-mile) radius of Eugene. The continued expansion of this city is a potential threat to the future of these sites. Even when the sites themselves are protected, the resultant changes in hydrology caused by surrounding development can alter the species' habitat (Meinke 1982, Gisler 2004). The majority of sites from which herbarium specimens have been collected are within areas of Salem or Eugene which have been developed for housing and agriculture. The populations in Washington occur on private lands and are not protected (Gisler 2004).

Populations occurring on roadsides are at risk from maintenance activities, and from adverse effects of management on adjacent lands. Pesticide use on agricultural fields and herbicide application adjacent to roads may harm *Lomatium bradshawii* populations across its range. There is concern that pesticides kill the pollinators necessary for plant reproduction; *Lomatium bradshawii* does not form a seed bank, therefore, any loss of pollinators (and subsequent lack of successful reproduction) could have an immediate effect on population numbers (Kaye and Kirkland 1994). Herbicides may drift, and even when *Lomatium bradshawii* is not the target, applications near a population may damage or kill the plants outright. For example, an herbicide application on private land adjacent to the William L. Finley National Wildlife Refuge drifted onto the refuge and damaged or killed *Lomatium bradshawii* plants in 2006 (Jock Beall, U.S. Fish and Wildlife Service, Corvallis, Oregon, pers. comm., 2008).

Additional discussion and a complete description of threats and listing factors as they apply to *Lomatium bradshawii* can be found in section III (Threats Assessment) of this recovery plan.

Conservation Measures

Extensive research has been conducted on the ecology and population biology of *Lomatium bradshawii*, effective methods for habitat enhancement, and propagation and reintroduction techniques (Kagan 1980, Kaye 1992, Kaye and Kirkland 1994, Kaye and Meinke 1996, Caswell and Kaye 2001, Kaye and Kuykendall 2001b, Kaye *et al.* 2003b). The results of these studies have been used to direct the management of the species at sites managed for wet prairies.

Propagation studies have found that long-term (8 weeks) cold stratification was necessary to fully break dormancy in this species (Kaye *et al.* 2003b). *Lomatium bradshawii* plants can be grown from seed in a greenhouse environment (Kaye *et al.* 2003b). Plants may be successfully established at existing populations or new locations through out-planting of greenhouse-grown plants. Fertilizing transplants may have a negative effect on survival in some cases. Direct seeding has a relatively high success rate (17 to 38 percent), and is improved by removal of competing vegetation (Kaye and Kuykendall 2001b, Kaye *et al.* 2003b). Seeds of this species have been banked at the Berry Botanic Garden in Portland, Oregon (Berry Botanic Garden 2005) and the University of Washington Botanic Garden.

Studies of the effects of cattle grazing on *Lomatium bradshawii* populations show mixed results. Grazing in the springtime, when the plants are growing and reproducing, can harm the plants by biomass removal, trampling and soil disturbance; however, late-season livestock grazing, after fruit maturation, has been observed to lead to an increase in emergence of new plants, and the density of plants with multiple umbels, although it did not alter survival rates or population structure (Drew 2000). Observed increases in seedlings may be due to small disturbances in the soil, a reduction of shading by nearby plants, and reduced herbivory by small mammals.

Populations of *Lomatium bradshawii* occur on public lands or lands that are managed by a conservation organization at the U.S. Fish and Wildlife Service's William L. Finley and Oak Creek units of the Willamette Valley National Wildlife Refuge Complex, the U.S. Army Corps of Engineers at Fern Ridge Reservoir, the Bureau of Land Management at the West Eugene Wetlands, The Nature Conservancy at Willow Creek Natural Area and Kingston Prairie Preserve, and Lane County at Howard Buford Recreation Area (see Appendix C). All of these parcels have some level of management for native prairie habitat values. A habitat conservation plan that addresses conservation of *Lomatium bradshawii* within Benton County is currently in preparation (Benton County 2009).

4. *Lupinus sulphureus* Dougl. ex Hook. ssp. *kincaidii* [C.P. Sm] L. Phillips (Kincaid's lupine)

Listing Status and Critical Habitat

Lupinus sulphureus ssp. *kincaidii* is a perennial herb that was listed as threatened, without critical habitat, on January 25, 2000 (U.S. Fish and Wildlife Service 2000a). A recovery outline for the species was published in 2006 (U.S. Fish and Wildlife Service 2006b). Its taxonomy and physical description are summarized in Appendix F.

Critical habitat was designated on October 6, 2006 (U.S. Fish and Wildlife Service 2006a). Critical habitat units for *Lupinus sulphureus* ssp. *kincaidii* have been designated in Benton, Lane, Polk and Yamhill Counties, Oregon, and Lewis County, Washington. The primary constituent elements of critical habitat are: (1) early seral upland prairie or oak savanna habitat with a mosaic of low-growing grasses and forbs and spaces to establish seedlings or new vegetative growth, an absence of dense canopy vegetation, and undisturbed subsoils; and (2) the presence of insect outcrossing pollinators, such as *Bombus mixtus* and *B. californicus* (bumblebees), with unrestricted movement between existing lupine patches. Critical habitat does not include human-made structures existing on the effective date of the rule and not containing one or more of the primary constituent elements, such as buildings, aqueducts, airports, and roads, and the land on which such structures are located.

Population Trends and Distribution

*Lupinus sulphureu*s ssp. *kincaidii* is found in dry upland prairies from Lewis County, Washington in the north, south to the foothills of Douglas County, Oregon; however, most of the known and historical populations are found in the Willamette Valley (Figure II-4, Appendix B, Tables B-1 and B-2). Historically, the species was documented from Vancouver Island, British Columbia, Canada (Dunn and Gillet 1966), but has not been located in that region since the 1920s (Kaye 2000). *Lupinus sulphureu*s ssp. *kincaidii* is currently known at about 164 sites, comprising about 246 hectares (608 acres) (Appendix B, Table B-2). Until the summer of 2004, Kincaid's lupine was known from just two extant populations in Washington, in the Boistfort Valley in Lewis County, more than 160 kilometers (100 miles) from the nearest population in the

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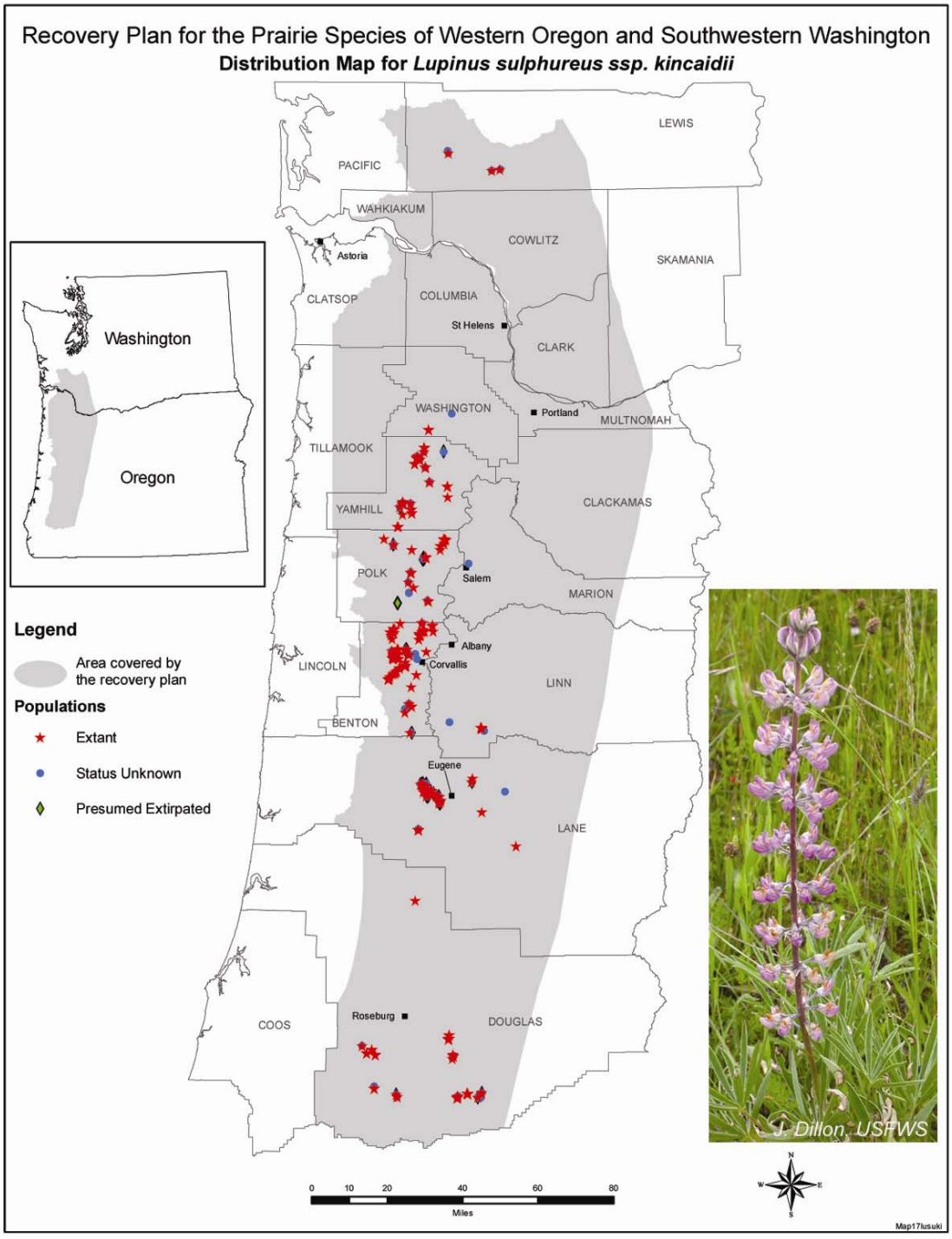

Figure II-4. *Lupinus sulphureus* ssp. *kincaidii* distribution.

Willamette Valley. In 2004, two small populations were found at Drew's Prairie and Cowlitz Prairie to the east of the Boistfort Valley in Lewis County; only one plant was observed at Drew's Prairie, and more than 40 plants were found at Cowlitz Prairie (Caplow and Miller 2004; Ted Thomas, U.S. Fish and Wildlife Service, Lacey, Washington, pers. comm., 2006; Joe Arnett, Washington Department of Natural Resources, *in litt.* 2008). Before Euro-American settlement of the region, *Lupinus sulphureu*s ssp. *kincaidii* was likely well distributed throughout the prairies of western Oregon and southwestern Washington; today, habitat fragmentation has resulted in existing populations that are widely separated by expanses of unsuitable habitat.

Monitoring the size of *Lupinus sulphureu*s ssp. *kincaidii* populations is challenging because its pattern of vegetative growth renders it difficult to distinguish individuals (Wilson *et al.* 2003). Instead of counting plants, most monitoring for this species relies on counting the number of leaves per unit area, partly because there is a strong correlation between Fender's blue butterfly egg numbers and lupine leaf density (Schultz 1998, Kaye and Thorpe 2006). Leaf counts are time consuming, however, and recent evaluations have shown that lupine cover estimates are highly correlated with leaf counts, much faster to perform, and useful for detecting population trends (Kaye and Benfield 2005a).

Life History and Ecology

Flowering begins in April and extends through June. As the summer dry season arrives, *Lupinus sulphureu*s ssp. *kincaidii* becomes dormant, and is completely senescent by mid-August (Wilson *et al.* 2003). Pollination is largely accomplished by small native bumblebees (*Bombus mixtus* and *B. californicus*), solitary bees (*Osmia lignaria*, *Anthophora furcata*, *Habropoda* sp., *Andrena* spp., *Dialictus* sp.), and occasionally European honey bees (*Apis mellifera*) (Wilson *et al.* 2003). Insect pollination appears to be critical for successful seed production (Wilson *et al.* 2003).

*Lupinus sulphureu*s ssp. *kincaidii* reproduces by seed and vegetative spread. It is able to spread extensively through underground growth. Individual **clones** can be several centuries old (Wilson *et al.* 2003), and become quite large with age, producing many flowering stems. Excavations and morphological patterns suggest that plants 10 meters (33 feet) or more apart can be interconnected by below-ground stems, and that clones can exceed 10 meters (33 feet) across (Wilson *et al.* 2003). As part of a genetic evaluation, collections taken from small populations of *Lupinus sulphureu*s ssp. *kincaidii* at the Baskett Slough National Wildlife Refuge were found to be genetically identical, indicating that the population consists of one or a few large clones (Liston *et al.* 1995). Reproduction by seed

is common in large populations where inbreeding depression is minimized and ample numbers of seeds are produced. In small populations, seed production is reduced and this appears to be due, at least in part, to inbreeding depression (Severns 2003).

*Lupinus sulphureu*s ssp. *kincaidii* is vulnerable to seed, fruit and flower predation by insects, which may limit the production of seeds. Seed predation by bruchid beetles and weevils and larvae of other insects has been documented, and may result in substantially reduced production of viable seed (Kaye and Kuykendall 1993, Kuykendall and Kaye 1993). Floral and fruit herbivory by larvae of the silvery blue butterfly (*Glaucopsyche lygdamus columbia*) has also been reported (Kuykendall and Kaye 1993). The vegetative structures of *Lupinus sulphureu*s ssp. *kincaidii* support a variety of insect herbivores, including root borers, sap suckers and defoliators (Wilson *et al.* 2003).

*Lupinus sulphureu*s ssp. *kincaidii* is the primary larval host plant of the endangered Fender's blue butterfly (Wilson *et al.* 2003). Female Fender's blue butterflies lay their eggs on the underside of *Lupinus sulphureu*s ssp. *kincaidii* leaves in May and June; the larvae hatch several weeks later and feed on the plant for a short time before entering an extended diapause, which lasts until the following spring (Schultz *et al.* 2003). *Lupinus sulphureu*s ssp. *kincaidii*, like other members of the genus *Lupinus,* is unpalatable to vertebrate grazers. *Lupinus sulphureu*s ssp. *kincaidii* forms root nodules with *Rhizobium* spp. bacteria that fix nitrogen, and also has **vesicular-arbuscular mycorrhizae**, which may enhance the plant's growth (Wilson *et al.* 2003).

Habitat Characteristics

In the Willamette Valley and southwestern Washington, *Lupinus sulphureu*s ssp. *kincaidii* is found on upland prairie remnants where the species occurs in small populations at widely scattered sites. A number of populations are found in road rights-of-way, between the road shoulder and adjacent fence line, where they have survived because of a lack of agricultural disturbance. Some of the populations in Washington occur in pastures and appear to benefit from light grazing by livestock, which reduces the cover of competing shrubs and grasses (Joe Arnett, Washington Department of Natural Resources, *in litt* 2008). Common native species typically associated with *Lupinus sulphureu*s ssp. *kincaidii* include: *Festuca idahoensis* ssp. *roemeri*, *Danthonia californica*, *Calochortus tolmiei*, *Eriophyllum lanatum*, and *Fragaria virginiana.* The species appears to prefer heavier, generally well-drained soils and has been found on 48 soil types, typically Ultic Haploxerolls, Ultic Argixerolls, and Xeric Palehumults (Wilson *et al.* 2003).

In Douglas County, Oregon, *Lupinus sulphureu*s ssp. *kincaidii* appears to tolerate more shaded conditions, where it occurs at sites with canopy cover of 50 to 80 percent (Barnes 2004). In contrast to the open prairie habitats of the more northerly populations, the Douglas County sites are dominated by tree and shrub species, including *Pseudotsuga menziesii* (Douglas-fir), *Quercus kelloggii* (California black oak), *Arbutus menziesii* (Pacific madrone), *Pinus ponderosa* (ponderosa pine), *Calocedrus decurrens* (incense cedar), *Arctostaphylos columbiana* (hairy manzanita) and *Toxicodendron diversilobum*.

In contrast to historical ecosystem composition, invasive non-native species are a significant component of *Lupinus sulphureu*s ssp. *kincaidii* habitat today. Common invasives include: *Arrhenatherum elatius*, *Brachypodium sylvaticum*, *Dactylis glomerata*, *Festuca arundinacea*, *Rubus armeniacus* and *Cytisus scoparius* (Wilson *et al.* 2003). In the absence of fire, some native species, such as *Toxicodendron diversilobum* and *Pteridium aquilinum*, invade prairies and compete with *Lupinus sulphureu*s ssp. *kincaidii.*

Threats/Reasons for Listing

The three major threats to *Lupinus sulphureu*s ssp. *kincaidii* populations are habitat loss, competition from non-native plants and elimination of historical disturbance regimes (Wilson *et al.* 2003). Habitat loss from a wide variety of causes (*e.g.*, urbanization, agriculture, silvicultural practices, and roadside maintenance) has been the single largest factor in the decline of *Lupinus sulphureu*s ssp. *kincaidii* (U.S. Fish and Wildlife Service 2000a). Land development and alteration in the prairies of western Oregon and southwestern Washington have been so extensive that the remaining populations are essentially relegated to small, isolated patches of habitat. Habitat loss is likely to continue as private lands are developed; at least 49 of 54 sites occupied by *Lupinus sulphureu*s ssp. *kincaidii* in 2000 at the time of listing were on private lands and are at risk of being lost unless conservation actions are implemented (U.S. Fish and Wildlife Service 2000a).

Habitat fragmentation and isolation of small populations may be causing inbreeding depression in *Lupinus sulphureu*s ssp. *kincaidii*. The subspecies was likely wide-spread historically, frequently outcrossing throughout much of its range, until habitat destruction and fragmentation severely isolated the remaining populations (Liston *et al.* 1995). There is some evidence of inbreeding depression, which may result in lower seed set (Severns 2003). **Hybridization** between *Lupinus sulphureu*s ssp. *kincaidii* and *Lupinus arbustus* has been detected at Baskett Slough National Wildlife Refuge (Liston *et al.* 1995).

Before settlement by Euro-Americans, the regular occurrence of fire maintained the open prairie habitats essential to *Lupinus sulphureu*s ssp. *kincaidii*. The loss of a regular disturbance regime, primarily fire, has resulted in the decline of prairie habitats through succession to native trees and shrubs, and has allowed the establishment of numerous non-native grasses and forbs. Some aggressive non-native plants form dense monocultures, which compete for space, water and nutrients with the native prairie species, and ultimately inhibit the growth and reproduction of *Lupinus sulphureu*s ssp. *kincaidii* by shading out the plants (Wilson *et al.* 2003). When *Lupinus sulphureu*s ssp. *kincaidii* was listed, we estimated that 83 percent of upland prairie sites within its range were succeeding to forest (U.S. Fish and Wildlife Service 2000a).

Additional discussion and a complete description of threats and listing factors as they apply to *Lupinus sulphureu*s ssp. *kincaidii* can be found in section III (Threats Assessment) of this recovery plan.

Conservation Measures

Active research efforts have focused on restoring the essential components of *Lupinus sulphureu*s ssp. *kincaidii* habitat by mimicking the historical disturbance regime with the application of prescribed fire, mowing and manual removal of weeds. Research and habitat management programs for *Lupinus sulphureu*s ssp. *kincaidii* have been implemented at several sites, including Baskett Slough National Wildlife Refuge, Bureau of Land Management's Fir Butte site and The Nature Conservancy's Willow Creek Preserve (Wilson *et al.* 2003, Kaye and Benfield 2005a). Prescribed fire and mowing before or after the growing season have been effective in reducing the cover of invasive non-native plants; following treatments, *Lupinus sulphureu*s ssp. *kincaidii* has responded with increased leaf and flower production (Wilson *et al.* 2003). Research has also been conducted on seed **germination**, propagation and reintroduction of *Lupinus sulphureu*s ssp. *kincaidii* (Kaye and Kuykendall 2001a, 2001b, Kaye and Cramer 2003, Kaye *et al.* 2003b). Seeds of this species have been banked at the Berry Botanic Garden in Portland, Oregon (Berry Botanic Garden 2005).

The Bureau of Land Management, Umpqua National Forest and U.S. Fish and Wildlife Service completed a programmatic conservation agreement for *Lupinus sulphureus* ssp. *kincaidii* in Douglas County, Oregon, in April 2006 (Roseburg Bureau of Land Management *et al*. 2006). The objectives of the agreement are: (1) to maintain stable populations of the species in Douglas County by protecting and restoring habitats, (2) to reduce threats to the species on Bureau of Land Management and Forest Service lands, (3)

to promote larger functioning metapopulations, with increased population size and genetic diversity, and (4) to meet the recovery criteria in the Recovery Outline for the species (U.S. Fish and Wildlife Service 2006b).

Populations of *Lupinus sulphureus* ssp. *kincaidii* occur on public lands or lands that are managed by a conservation organization at the U.S. Fish and Wildlife Service's William L. Finley National Wildlife Refuge and Baskett Slough National Wildlife Refuge, the Army Corps of Engineers' Fern Ridge Reservoir, Bureau of Land Management units in Lane and Douglas Counties, the Umpqua National Forest, The Nature Conservancy's Willow Creek Preserve, and at a small portion of Oregon State University's Butterfly Meadows in the McDonald State Forest (see Appendix C). All of these parcels have some level of management for native prairie habitat values. A habitat conservation plan that addresses conservation of *Lupinus sulphureus* ssp. *kincaidii* within Benton County is currently in preparation (Benton County 2009).

5. *Sidalcea nelsoniana* Piper (Nelson's checker-mallow)

Listing Status and Critical Habitat

Sidalcea nelsoniana is a perennial herb that was listed as threatened, without critical habitat, on February 12, 1993 (U.S. Fish and Wildlife Service 1993b). Its taxonomy and physical description are summarized in Appendix F.

Population Trends and Distribution

In the past, *Sidalcea nelsoniana* has been collected in Benton, Clackamas, Linn, Marion, Polk, Tillamook, Yamhill, and Washington Counties, Oregon, and Cowlitz and Lewis Counties, Washington. *Sidalcea nelsoniana* is currently known from about 90 sites, comprising about 517 hectares (1,277 acres) of total cover, distributed from southern Benton County, Oregon, northward through the central and western Willamette Valley, to Cowlitz and Lewis Counties, Washington (CH2MHill 1997, U.S. Fish and Wildlife Service 1998) (Figure II-5; Appendix B, Tables B-1 and B-2). This species also occurs in several higher elevation west slope Coast Range meadows that flank the western Willamette Valley in Yamhill, Washington and Tillamook Counties, Oregon. Known populations range in elevation from 45 to 600 meters (150 to 1,970 feet).

In the Willamette Valley, populations of *Sidalcea nelsoniana* occur at low elevations (below 200 meters [650 feet]) within a mosaic of urban and agricultural areas, with concentrations around the cities of Corvallis and Salem. In the Coast Range, *Sidalcea*

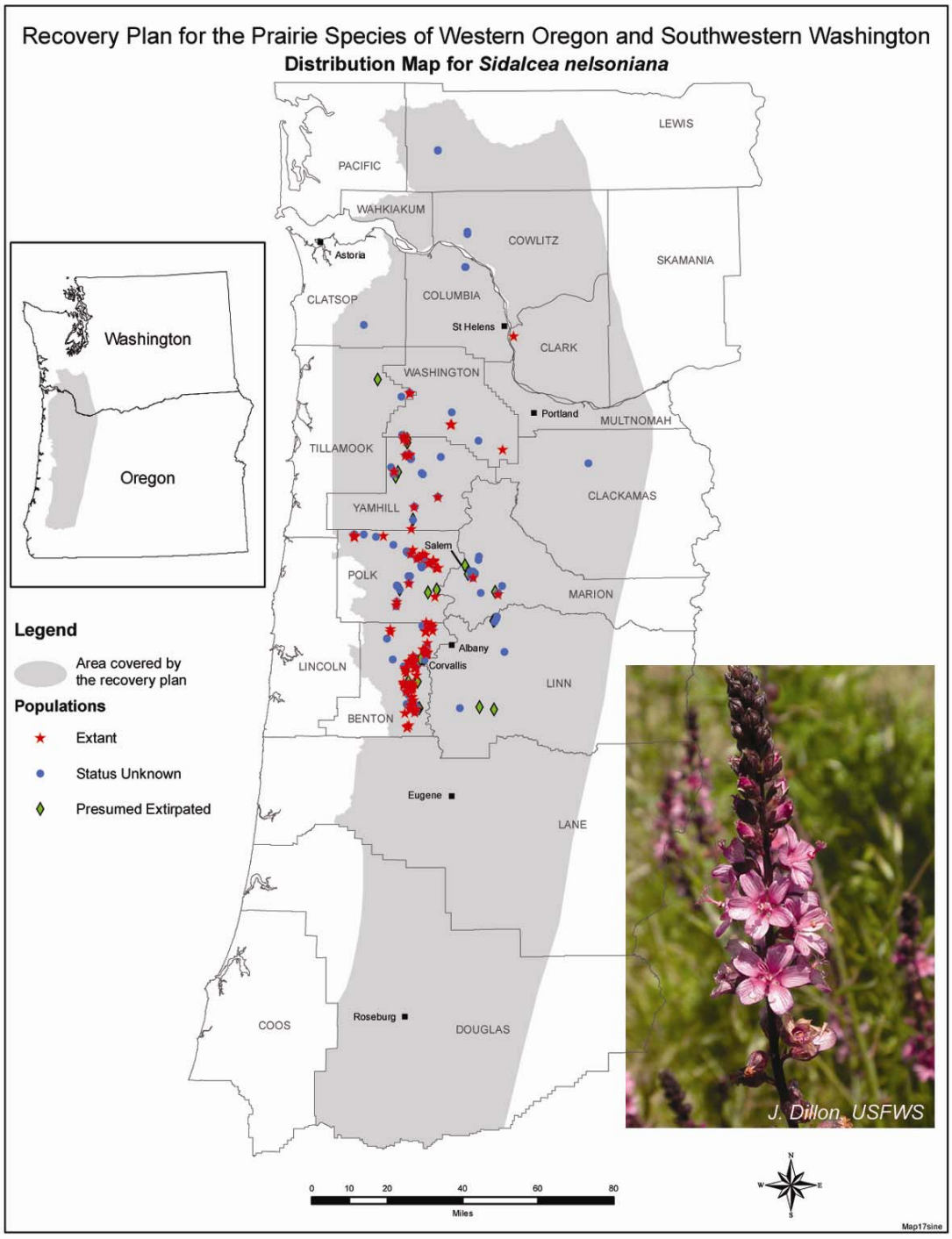

Figure II-5. *Sidalcea nelsoniana* distribution.

nelsoniana populations range in elevation from 490 to 600 meters (1,610 to 1,970 feet), and are found in open, grassy meadows within a larger matrix of coniferous forest.

Life History and Ecology

In the Willamette Valley, *Sidalcea nelsoniana* begins flowering as early as mid-May, and continues through August to early September, depending upon the moisture and climatic conditions of each site. Coast Range populations experience a shorter growing season and generally flower later and senesce earlier. *Sidalcea nelsoniana* inflorescences are **indeterminate**, and often simultaneously exhibit fruits, open flowers, and unopened buds. Seeds are deposited locally at or near the base of the parent plant and may be shed immediately or persist into winter within the dry flower parts that remain attached to the dead stems. Above-ground portions of the plant die back in the fall, usually followed by some degree of regrowth at the base, with the emergence of small, new leaves that persist through the winter directly above the root crown. It is not uncommon for some plants to continue producing some flowers into the fall and early winter, although this is usually limited to one or two small stems per plant, consequently with little seed production (U.S. Fish and Wildlife Service 1998).

Perfect-flowered *Sidalcea nelsoniana* are **protandrous**, with complete temporal separation of male and female phases in individual flowers (Gisler and Meinke 1998). This prevents self-fertilization, and combined with the bottom-to-top foraging observed among most bee visitors, also discourages **selfing** through **geitonogamy**. Outcrossing is encouraged because pollinators leave male-phase flowers at the top of one raceme and then fly to female phase flowers on the bottom of the next raceme. Some selfing will still occur in perfect-flowered plants, however, due to within-plant, between-raceme foraging. Female plants, which lack male flowers, are obligately outcrossed (Gisler and Meinke 1998). In most Willamette Valley (but not Coast Range) populations, female (male- sterile) *Sidalcea nelsoniana* plants vastly outnumber perfect plants. *Sidalcea nelsoniana* is also capable of vegetative expansion via rhizomes or laterally spreading root systems that form multiple crowns bearing distinct clusters of flowering stems (CH2MHill 1986, Glad *et al.* 1994).

Sidalcea nelsoniana is pollinated by a variety of insects, including at least 17 species of bees, 3 species of wasps, 9 species of flies, 6 species of beetles, and 5 species of **lepidopterans** (Gisler 2003). Three species of bumblebees (*Bombus californicus*, *B. sitkensis* and *B. vosnesenskii*) were the most common and active pollinators (Gisler 2003). One solitary bee pollinator, *Diadasia nigrifrons*, is a checker-mallow specialist, and may also pollinate *Sidalcea nelsoniana* in the Willamette Valley (Gisler and Meinke 1998).

Pre-dispersal seed predation by weevils (*Macrorhoptus sidalceae*) is extremely high in many populations, and may severely curtail, if not virtually eliminate, seed survival in many populations (Gisler and Meinke 1998). The weevils appear to be restricted to Willamette Valley, southwestern Washington and lower Coast Range populations (around Grand Ronde), but do not infest the Coast Range populations in Yamhill, Tillamook, and Washington Counties. The weevils are native, host-specific, and are themselves parasitized by tiny undescribed wasps (Gisler and Meinke 1998).

Habitat Characteristics

In the Willamette Valley, *Sidalcea nelsoniana* is known from wet prairies and stream sides. Although occasionally occurring in the understory of *Fraxinus latifolia* (Oregon ash) woodlands or among woody shrubs, Willamette Valley *Sidalcea nelsoniana* populations usually occupy open habitats supporting early seral plant species. These native prairie remnants are frequently found at the margins of sloughs, ditches, and streams; roadsides; fence rows; drainage swales; and fallow fields. Soil textures of the occupied sites vary from gravelly, well drained loams to poorly drained, hydric clay soils (CH2MHill 1986, Glad *et al.* 1994).

Some of the native plants commonly associated with *Sidalcea nelsoniana* in the Willamette Valley include: *Achillea millefolium* (yarrow), *Juncus effusus* (common rush), *Carex* spp. (sedge), *Spiraea douglasii* (western spiraea), *Crataegus douglasii* (Douglas' hawthorn), *Geum macrophyllum* (large-leaved avens), and *Fraxinus latifolia* (Oregon Department of Agriculture 1995). Most sites have been densely colonized by invasive weeds, especially introduced forage grasses. Common non-native species found with *Sidalcea nelsoniana* include *Festuca arundinacea*, *Rosa* spp. (rose), *Cirsium arvense* (Canada thistle), *Hypericum perforatum* (common St. John's wort), *Rubus* spp. (blackberry), *Phleum pratense* (timothy), *Holcus lanatus* (velvet grass), *Vicia* spp., *Chrysanthemum leucanthemum* (oxeye-daisy), *Agrostis capillaris*, *Alopecurus pratensis*, *Phalaris arundinacea*, *Geranium* spp. (geranium), *Lotus corniculatus* (bird's-foot trefoil) and *Daucus carota* (Oregon Department of Agriculture 1995).

Coast Range *Sidalcea nelsoniana* populations typically occur in open, wet to dry meadows, intermittent stream channels, and along margins of coniferous forests, with clay to loam soil textures (Glad *et al.* 1987). These areas generally support more native vegetation than Willamette Valley sites. Native plants commonly associated with *Sidalcea nelsoniana* in the Coast Range include *Senecio triangularis* (spear-head senecio), *Fragaria virginiana*,

Juncus spp., *Carex* spp., and *Achillea millefolium*; non-native associated species often include *Senecio jacobaea* (tansy ragwort), *Holcus lanatus*, and *Phleum pratense.*

A variety of animal species are associated with *Sidalcea nelsoniana.* Stems and inflorescences are commonly eaten by deer and elk. *Sidalcea nelsoniana* flowers are visited by a diverse assemblage of insects, including leafcutter bees (Megachilidae), honey bees (Apidae), bumble bees (Bombidae), hover flies (Syrphidae), butterflies (Hesperiidae), and pollen-foraging beetles (Cerambycidae and Meloidae). The species is also a host for various **phytophagous** insects such as aphids (Aphididae), stinkbugs (Pentatomidae), scentless plant bugs (Rhopalidae), spotted cucumber beetles (Chrysomelidae), plant bugs (Miridae), milkweed bugs (Lygaeidae), spittlebugs (Cercopidae), butterfly larvae (Lycaenidae: *Strymon melinus*; Nymphalidae: *Vanessa anabella*), and in the Willamette Valley, weevils (Curculionidae: *Macrohoptus sidalcae*). Other insects found in association with *Sidalcea nelsoniana* include ants (Formicidae) and earwigs (Forficulidae) (Bureau of Land Management 1985, CH2M Hill 1986, Oregon Department of Agriculture 1995).

Threats/Reasons for Listing

As with the other rare prairie plants addressed in this plan, *Sidalcea nelsoniana* is threatened by urban and agricultural development, ecological succession that results in shrub and tree encroachment of open prairie habitats, and competition with invasive weeds (U.S. Fish and Wildlife Service 1993b).

At many Willamette Valley sites, seedling establishment is inhibited by the dense thatch layer of non-native grasses (Gisler 2004). Other factors specific to *Sidalcea nelsoniana* include pre-dispersal seed predation by weevils (Gisler and Meinke 1998), the potential threat of inbreeding depression due to small population sizes, and habitat fragmentation (Gisler 2003).

There is a strong potential for interspecific hybridization among *Sidalcea nelsoniana* and its **congeners** in the region, although there are some ecological and genetic reproductive barriers to prevent it from occurring (Gisler 2003, 2004). *Sidalcea nelsoniana* flowers later in the year than sympatric populations of *Sidalcea malviflora* ssp. *virgata* (rose checker-mallow), but **allopatric** populations sometimes overlap in flowering periods. The two species are sexually compatible, thus human-mediated movement of the plants could result in formation of hybrids. *Sidalcea nelsoniana* and *S. cusickii* (Cusick's checker-mallow) are also fully compatible, and they also share pollinators and flowering times, but their

geographic ranges are **parapatric**, with nearest populations narrowly separated by less than a mile at the south end of Finley National Wildlife Refuge (Gisler 2004). If these species come into contact through human-mediated dispersal, hybridization could easily occur. *Sidalcea nelsoniana* is frequently found growing together with *S. campestris*, and they also share pollinators and flowering times, but they exhibit very low sexual compatibility (probably due to chromosomal pairing problems resulting from **polyploidy**) (Gisler 2004). Reproductive barriers among the checker-mallows in the Willamette Valley likely evolved in response to selective pressure against hybridization (Gisler 2003, 2004); managers should be aware of the potential for hybridization as plants are moved around within the region.

Additional discussion and a complete description of threats and listing factors as they apply to *Sidalcea nelsoniana* can be found in section III (Threats Assessment) of this recovery plan.

Conservation Measures

Extensive research has been conducted on the ecology and population biology of *Sidalcea nelsoniana*, methods of seed predator control, and propagation and reintroduction techniques (Gisler and Meinke 1998, 2001; Bartels and Wilson 2001; Gisler and Meinke 2001; Gisler 2003; Wilson 2004). The results of these studies have been used to direct the management of the species at sites managed for wet prairies.

Sidalcea nelsoniana has a highly complex breeding system that facilitates both outcrossing and selfing. Control of seed predation by native weevils may be needed to enhance reproductive success at some populations which are heavily infested with weevils (Gisler and Meinke 1998). Research into habitat management techniques indicates that burning may not be directly beneficial to *Sidalcea nelsoniana*, and that caution should be used in management of native prairie fragments with populations of *Sidalcea nelsoniana* (Bartels and Wilson 2001, Wilson 2004). The species has proved to be readily grown in controlled environments, and several approaches have successfully cultivated healthy plants for augmentation of existing populations (Gisler 2003). Seeds of this species have been banked at the Berry Botanic Garden in Portland, Oregon (Berry Botanic Garden 2005) and the University of Washington Botanic Garden.

Populations of *Sidalcea nelsoniana* are protected on lands managed by the U.S. Fish and Wildlife Service at William L. Finley and Baskett Slough National Wildlife Refuges, the Confederated Tribes of the Grand Ronde in Polk County, and by the Bureau of Land

Management at Walker Flat in Yamhill County, Oregon (see Appendix C). In December 2007, Ridgefield National Wildlife Refuge, in Clark County, Washington, outplanted 2,530 seedlings to establish a new population of *Sidalcea nelsoniana* at the refuge; monitoring and management of the new population is ongoing. A habitat conservation plan that addresses conservation of *Sidalcea nelsoniana* within Benton County is currently in preparation (Benton County 2009).

6. *Castilleja levisecta* Greenm. (Golden paintbrush)

A recovery plan for *Castilleja levisecta* was published in 2000 (U.S. Fish and Wildlife Service 2000b). That plan did not offer specific recovery tasks for the historical populations of *Castilleja levisecta* in Oregon. This recovery plan will provide specific tasks to restore the species in the Willamette Valley of Oregon. These tasks will be complementary to, but will not supersede, the recovery goals in the final recovery plan for the species.

The treatment of *Castilleja levisecta* that follows is an abbreviated version of the introduction from the Recovery Plan for the Golden Paintbrush (U.S. Fish and Wildlife Service 2000b), which includes a complete review of the species' ecology and status.

Listing Status and Critical Habitat

Castilleja levisecta is a perennial herb that was listed as threatened, without critical habitat, on June 11, 1997 (U.S. Fish and Wildlife Service 1997). Its taxonomy and physical description are summarized in Appendix F.

Population Trends and Distribution

Historically, *Castilleja levisecta* has been reported from more than 30 sites in the Puget Trough of Washington and British Columbia, and as far south as the Willamette Valley of Oregon (Hitchcock *et al.* 1959, Sheehan and Sprague 1984, Gamon 1995, Gamon *et al.* 2001; Figure II-6). Many populations have been extirpated as their habitats were converted for agricultural, residential, and commercial development. Eleven populations are currently known to exist in Washington and British Columbia; more than half of these populations occur on Whidbey Island and the San Juan Islands off the north coast of the Washington mainland, two are on Canadian islands, and one is in the Puget Trough near Olympia, Washington. In Oregon, *Castilleja levisecta* historically occurred in the grasslands and prairies of the Willamette Valley in Linn, Marion and Multnomah Counties;

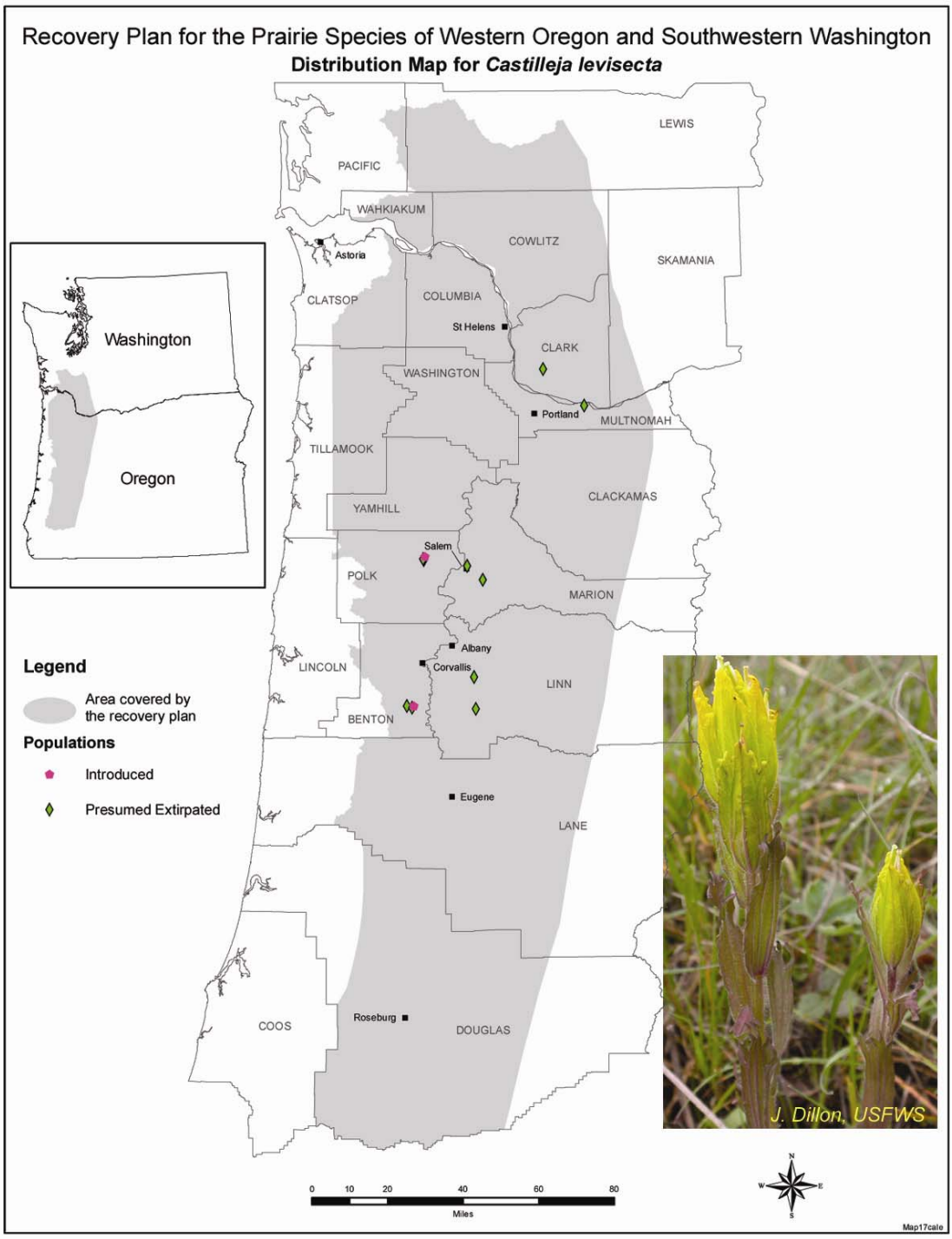

Figure II-6. *Castilleja levisecta* distribution.

the species has been extirpated from all of these sites as the habitat has been changed or modified by urbanization or agriculture. The last sighting of *Castilleja levisecta* in the wild in Oregon was during 1938 in Linn County; recent surveys have failed to re-locate *Castilleja levisecta* in Oregon (Sheehan and Sprague 1984, Caplow 2004). In 2005, small populations of *Castilleja levisecta* were planted in common garden plots at William L. Finley and Baskett Butte National Wildlife Refuges in the Willamette Valley. The propagules came from populations in Washington and Canada, and surveys in 2008 and 2009 found that a few plants have survived at both Refuges (Tom Kaye, Institute for Applied Ecology, Corvallis, Oregon, pers. comm., 2009).

Life History and Ecology

Castilleja levisecta is a short-lived perennial herb. Individual plants generally survive 5 to 6 years or longer. This species apparently reproduces exclusively by seed; vegetative spread has never been reported. Plants may flower as early as February, and flowers are observed into summer. The fruit is a **capsule**, which matures in August; by mid-summer, the plants senesce, although some plants produce shoots in the fall that overwinter. Capsules persist on the plants well into winter.

The genus *Castilleja,* like many others in the figwort family, is **hemi-parasitic** (Center for Plant Conservation 2005). Roots of paintbrushes are capable of forming parasitic connections to roots of other plants. Paintbrush plants are probably not host-specific (Mills and Kummerow 1988). It has been clearly shown that golden paintbrush grows well independently of a host plant and that they do not necessarily require a host to survive. This evidence suggests that this species of C*astilleja* is a facultative root parasite.

The breeding system of *Castilleja levisecta* has not been thoroughly documented. Evans *et al.* (1984) reported that a species of bumblebee, *Bombus californicus,* was observed visiting *Castilleja levisecta.* Pollinator exclusion experiments showed that fruits can be produced in the absence of pollinator visitation, but fruit set was almost five times greater in unbagged inflorescences compared to inflorescences bagged to prevent visits from pollinators (Wentworth 1994). Although seed dispersal has not been directly observed, the seeds are probably shaken from the seed capsules and fall a short distance from the parent plant. The seeds are light and could possibly be dispersed short distances by the wind.

Habitat Characteristics

Habitat descriptions for *Castilleja levisecta* are based on those extant populations in Washington and British Columbia; absent comparable habitat information for Oregon, we assume that the habitat of the extirpated populations in the Willamette Valley was similar. *Castilleja levisecta* occurs in upland prairies, on generally flat grasslands, including some that are characterized by mounded topography. Low deciduous shrubs are commonly present as small to large thickets. In the absence of fire, some of the sites have been colonized by trees, primarily *Pseudotsuga menziesii,* and shrubs, including *Rosa nutkana* (wild rose) and *Cytisus scoparius,* an aggressive non-native shrub.

The mainland population in Washington occurs in a gravelly, glacial outwash prairie. Most of the extant populations are on loamy sand or sandy loam soils derived from glacial origins; at the southern end of its historic range, populations occurred on clayey alluvial soils, in association with *Quercus garryana* (Oregon white oak) woodlands (Caplow 2004). Recent analyses of likely sites for reintroduction of *Castilleja levisecta* in Oregon found that habitats are dominated by non-native annuals, and will require management before successful reintroductions can be expected (Lawrence 2005).

Threats/Reasons for Listing

Threats to *Castilleja levisecta* include habitat modification as succession changes prairies and grasslands to shrub and forest lands; development for commercial, residential, and agricultural use; low potential for expansion of *Castilleja levisecta* populations and their **refugia** because existing habitat is constricted; recreational picking; and herbivory (U.S. Fish and Wildlife Service 1997).

Conservation Measures

Some research has been conducted on the population biology, fire ecology, propagation and restoration of *Castilleja levisecta* (Dunwiddie *et al.* 2001, Gamon *et al.* 2001, Kaye 2001, Kaye and Lawrence 2003, Caplow 2004, Lawrence 2005). The results of these studies have been used to direct the management of the species at sites managed for upland prairies, and are critical to the future reintroduction and recovery of the species. A reintroduction plan has been prepared (Caplow 2004), as directed by the Golden Paintbrush Recovery Plan (U.S. Fish and Wildlife Service 2000b); reintroduction into likely historical habitat is the best hope for the species to recover in the prairies of Oregon and southwestern Washington. Recent research has considered the most appropriate seed sources and site characteristics for the reintroduction of *Castilleja levisecta* to the Willamette Valley (Lawrence 2005). The findings of this study are consistent with those

recommended for the other prairie species addressed in this plan, in that the optimal sites for reintroduction were high quality prairies dominated by native perennial species with low abundance of non-native plant species. Furthermore, the study recommended against using genetic diversity, effective population size, or geographic distance in determining source material for reintroductions, instead suggesting that plant materials from Whidbey Island, Washington, had the greatest potential for successful reintroductions to the Willamette Valley (Lawrence 2005). Greenhouse trials and surveys of potential reintroduction sites in the Willamette Valley have recently been completed (Lawrence 2005). Seeds of this species have been banked at the Berry Botanic Garden in Portland, Oregon (Berry Botanic Garden 2005) and the University of Washington Botanic Garden.

B. NONLISTED SPECIES

1. Taylor's checkerspot butterfly (*Euphydryas editha taylori*)

Taylor's checkerspot butterfly is a candidate for Federal listing (U.S. Fish and Wildlife Service 2001) The species is listed as endangered by the State of Washington (Washington Natural Heritage Program 2008); the species has no state protection in Oregon since invertebrates are not protected under the Oregon Endangered Species Act. Its taxonomy and physical description are summarized in Appendix F.

Population Trends and Distribution

Historically, Taylor's checkerspot was likely distributed throughout prairies in the Willamette Valley, Puget Sound, and south Vancouver Island. Historic range and abundance are not precisely known because extensive searches did not occur until recently. Northwest prairies were formerly more common, larger, and interconnected, and likely would have supported a greater distribution and abundance of Taylor's checkerspot than exist today. Before its decline, the checkerspot was documented at more than 70 sites in British Columbia, Washington, and Oregon (U.S. Fish and Wildlife Service 2009a). These sites included coastal and inland prairies on southern Vancouver Island and surrounding islands in British Columbia and the San Juan Island archipelago, as well as open prairies on post-glacial gravelly outwash and balds in Washington's Puget Trough and Oregon's Willamette Valley. In Oregon, there were 13 recorded sites from which this subspecies had been either collected or observed over the last century (U.S. Fish and Wildlife Service 2009a).

At present populations remain in about nine sites in Washington (around the Puget Sound area and Olympic Peninsula) and two sites in British Columbia. There are two known extant populations in Oregon (Figure II-7), both in Benton County (Vaughan and Black 2002, U.S. Fish and Wildlife Service 2009a). One population occurs in a Bonneville Power Administration right-of-way and the other occurs in Benton County's Beazell Park. The combined population at these sites may exceed 1,000 individuals.

Life History and Ecology

Taylor's checkerspot butterflies produce one brood per year. They overwinter (diapause) in the fourth or fifth larval instar phase, usually in May. Adults emerge in the spring, and have a flight period as adults of 10 to 14 days during April and May, when they mate and lay clusters of as many as 1,200 eggs. Larvae emerge and grow until the fourth or fifth instar. Larvae feeding on wildflowers in Puget Trough have been documented to enter diapause in mid-June to early July, hibernating through the winter.

Habitat Characteristics

Habitat requirements for the Taylor's checkerspot consist of open prairies and savannas where food plants for larvae and nectar sources for adults are available. Taylor's checkerspot larvae have been documented feeding on members of the figwort or snapdragon family (Scrophulariaceae), including paintbrush (*Castilleja hispida*) as well as native and non-native *Plantago* spp. in the plantain family (Plantaginaceae) (Dornfield 1980, U.S. Fish and Wildlife Service 2005). The last remaining populations in Oregon depend upon the non-native *Plantago lanceolata*.

Threats/Reasons for Decline

The major limiting factors affecting this species are the significant loss of suitable habitat that is largely due to agricultural and urban development, encroachment of trees, and spread of invasive plants which threaten the native grasslands in which the species is found (Vaughan and Black 2002, U.S. Fish and Wildlife Service 2009a). Pesticide use and recreational activities pose a direct threat to the butterflies themselves. The impact of these threats has led to extirpation of many small populations. Most of the remaining checkerspot populations are a considerable distance from one another, likely well beyond dispersal distance. Natural re-colonization as colonies disappear is unlikely.

Figure II-7. Taylor's checkerspot butterfly distribution.

Conservation Measures

Various efforts to conserve Taylor's checkerspot in Washington are ongoing, including a multi-agency candidate conservation agreement, land acquisition, and habitat restoration projects (U.S. Fish and Wildlife Service 2005). The Bonneville Power Administration developed a management plan for Taylor's checkerspot butterfly populations in the vicinity of Cardwell Hill in Benton County, Oregon; the management plan specifies conservation measures for right-of-way maintenance to protect the butterfly and its habitat, and identifies specific opportunities and management activities that will preserve and enhance the species' habitat in the area (Bonneville Power Administration 2005). The Bonneville Power Administration has also set aside funds to purchase conservation easements on privately-owned sites with existing populations of Taylor's checkerspot butterflies to further the conservation of the species (U.S. Fish and Wildlife Service 2009b). A habitat conservation plan that addresses conservation of the Taylor's checkerspot butterfly within Benton County is currently in preparation (Benton County 2009).

2. *Delphinium leucophaeum* Greene (Pale larkspur)

Delphinium leucophaeum is a perennial herb that has been identified by the Oregon Fish and Wildlife Office as a species of concern (U.S. Fish and Wildlife Service 2008). Both the States of Oregon and Washington list the species as endangered (Oregon Department of Agriculture 2008, Washington Natural Heritage Program 2008). Its taxonomy and physical description are summarized in Appendix F.

Population Trends and Distribution

Delphinium leucophaeum is found primarily in the northern Willamette Valley, at fewer than 20 sites in Clackamas, Marion, Multnomah, Washington and Yamhill Counties, and in one site in Lewis County, Washington (Meinke 1982, Gisler 2004, Oregon Natural Heritage Information Center 2007, Washington Natural Heritage Program 2008) (Figure II-8). The species has been found at elevations from 40 to 150 meters (125 to 500 feet).

Life History and Ecology

Delphinium leucophaeum flowers in May and June and produces fruits through August. Seedlings germinate in the winter, and may take five years to first flowering (Washington Natural Heritage Program 2008). This species does not reproduce vegetatively in the wild (Darr 1980). The species' **hermaphroditic** flowers are pollinated by bumblebees (*Bombus californicus*) (Goodrich 1983). *Delphinium leucophaeum* is able to hybridize with other

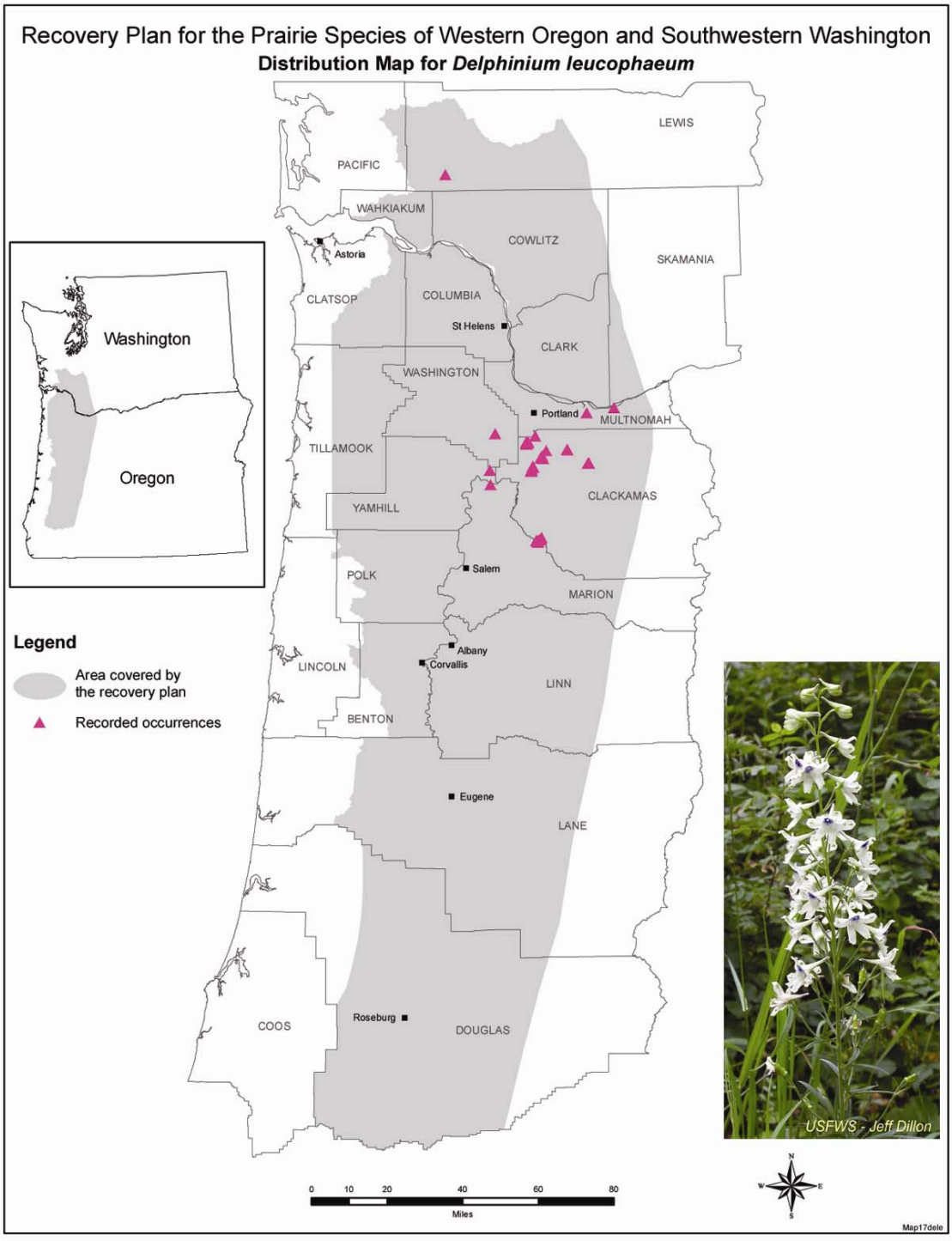

Figure II-8. *Delphinium leucophaeum* distribution.

Delphinium species, including the parapatric *Delphinium pavonaceum* (Meinke 1982, Goodrich 1983).

Habitat Characteristics

Delphinium leucophaeum occurs in a variety of habitat types, including edges of oak woodlands, dry roadside ditches, basalt cliffs, along river banks and on bluffs, on moist rocky slopes, lowland meadows and in the shade of oak and mixed oak/conifer stands (Darr 1980; Goodrich 1983; Keith Karoly, Reed College, *in litt*. 2006). Soils in most occupied habitats were high in organic matter, loose, and very shallow (5 to 7 centimeters [2 to 3 inches]) (Goodrich 1983). Associated species include *Quercus garryana*, *Holodiscus discolor* (ocean spray), *Polypodium glycorrhiza* (licorice fern), *Festuca rubra* (red fescue), *Elymus glaucus* and *Symphoricarpos albus* (snowberry) (Washington Natural Heritage Program 2008).

Threats/Reasons for Decline

Habitat loss, alteration of disturbance regimes, and habitat invasion by trees and shrubs put this species at risk of continued declines (Gisler 2004). The species is known from very few, small populations, which puts the species at risk of extinction from random **demographic** and **stochastic** events.

Conservation Measures

Delphinium leucophaeum occurs at only a few sites in Oregon and Washington, some of which are in protective ownership (The Nature Conservancy's Camassia Natural Area in Clackamas County, Metro's Willamette Narrows and Cooper Mountain Nature Park, and the City of Lake Oswego's Iron Mountain City Park) (see Appendix C). Several of the extant populations have been monitored over the years, documenting wide fluctuations in population size (Gisler 2004). The species has been successfully cultivated in greenhouse trials (Gisler 2004). Seeds of this species have been banked at the Berry Botanic Garden in Portland, Oregon (Berry Botanic Garden 2005).

3. *Delphinium oreganum* Howell (Willamette Valley larkspur)

Conservation Status

Delphinium oreganum is a perennial herb that has been identified by the Oregon Fish and Wildlife Office as a species of concern (U.S. Fish and Wildlife 2008) and a candidate for state listing in Oregon (Oregon Department of Agriculture 2008). Its taxonomy and physical description are summarized in Appendix F.

Population Trends and Distribution

Delphinium oreganum is endemic to the Willamette Valley and high elevation peaks in the northern Coast Range (Figure II-9). This species is found in Lane, Linn, Marion, Yamhill and Clatsop Counties, Oregon (Oregon Natural Heritage Information Center 2006 data).

Life History and Ecology

The blooming period is from late May to late June although blooms can be found earlier or later due to various factors such as elevation, moisture level, and age of individuals (Boyer 1999).

Habitat Characteristics

Delphinium oreganum is usually found growing along roadsides and well drained grassy areas (Boyer 1999). Sites are located at low elevations in the Willamette Valley and most commonly in wet prairies with shrub or *Fraxinus latifolia* overstory. The Saddle Mountain site is the only known Coast Range site and it is at a much higher elevation (700-975 meters [2,300-3,200 feet]) than the Willamette Valley populations (45-425 meters [150-1,400 feet]). The Saddle Mountain population is found on open, moderately moist slopes.

Threats/Reasons for Decline

The species is threatened by continued loss of habitat to urban, industrial and agricultural development, herbicides, disturbance associated with road maintenance, successional encroachment and habitat invasion by exotic species.

Conservation Measures

Seeds of this species have been banked at the Berry Botanic Garden in Portland, Oregon (Berry Botanic Garden 2005).

4. *Delphinium pavonaceum* Ewan (Peacock larkspur)

Conservation Status

Delphinium pavonaceum is a perennial herb that has been identified by the Oregon Fish and Wildlife Office as a species of concern (U.S. Fish and Wildlife Service 2008). It is endemic to the Willamette Valley, and is listed as endangered by the State of Oregon (Oregon Department of Agriculture 2008). Its taxonomy and physical description are summarized in Appendix F.

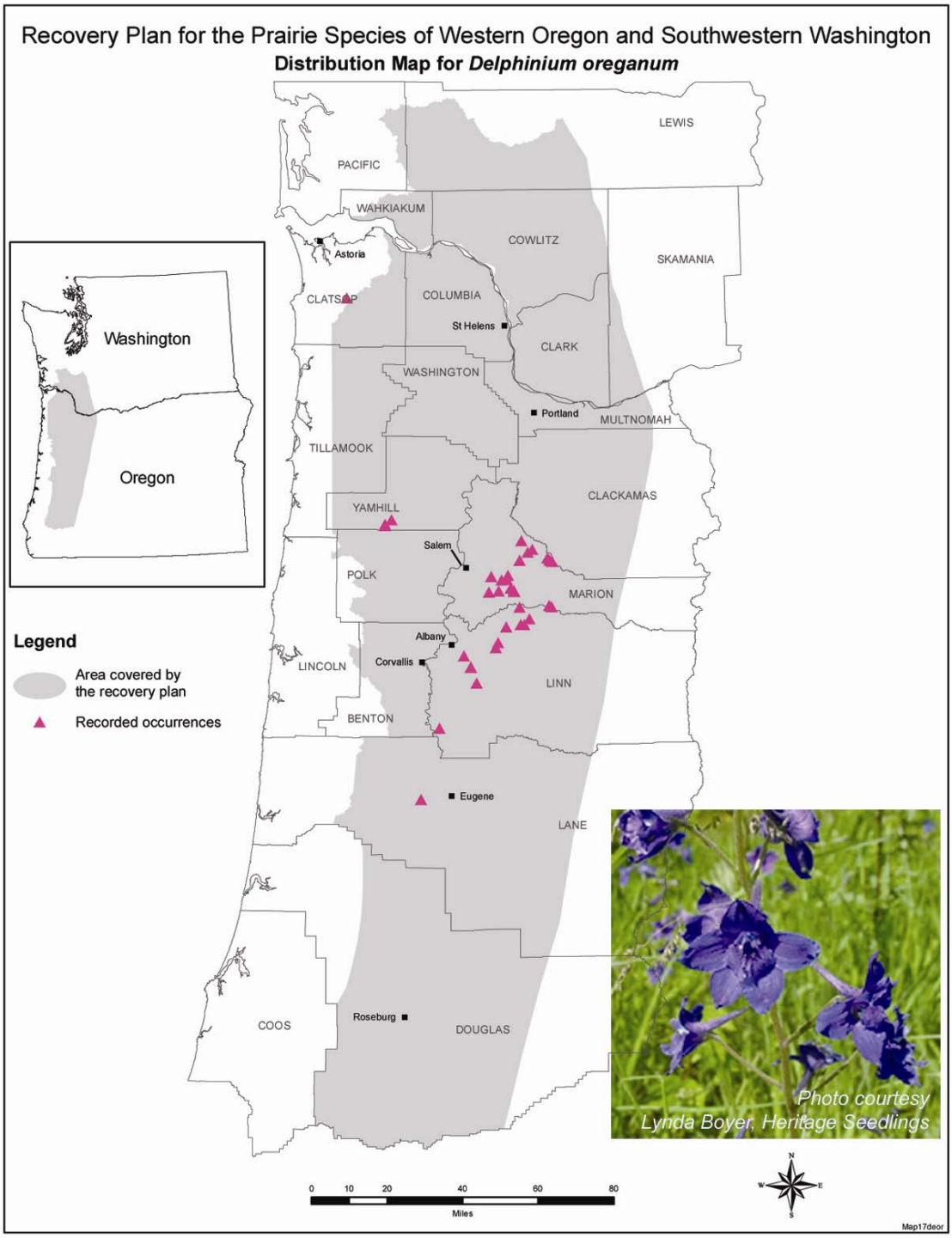

Figure II-9. *Delphinium oreganum* distribution.

Population Trends and Distribution

Currently, only 19 populations of *Delphinium pavonaceum* are known to persist, which are found generally in the southern Willamette Valley in Benton, Clackamas, Marion and Polk Counties (Gisler 2004, Oregon Natural Heritage Information Center 2004) (Figure II-10). The species occurs at elevations from 45 to 120 meters (150 to 400 feet) (Darr 1980, Gisler 2004). The largest populations occur on the William L. Finley National Wildlife Refuge in Benton County.

Life History and Ecology

Delphinium pavonaceum typically flowers from April to June. The plant does not spread vegetatively and reproduces only by seed; seedlings germinate in the winter and may take at least three years before flowering (Goodrich 1983). Flowers are pollinated by insects; bumblebees (*Bombus californicus* and *B. appositus*) and unidentified moths have been observed pollinating the flowers (Goodrich 1983, McKernan 2004). Infrequent fires appear to benefit the species (McKernan 2004). *Delphinium pavonaceum* is able to hybridize with other *Delphinium* species, including *D. leucophaeum* and *D. menziesii* (Meinke 1982, Goodrich 1983).

Habitat Characteristics

Delphinium pavonaceum is found in native wet prairie habitats, on the edges of *Fraxinus latifolia* and *Quercus garryana* woodlands, and along roadsides and fence rows, in soils that are generally moist heavy clay loams or dry, well drained heavy clays (Darr 1980, Meinke 1982, Gisler 2004).

Threats/Reasons for Decline

The species is threatened by continued loss of habitat to urban and agricultural development, herbicides, road maintenance, successional encroachment and habitat invasion by exotic species (Gisler 2004)

Conservation Measures

The largest extant populations of *Delphinium pavonaceum* occur on William L. Finley National Wildlife Refuge; active management at the refuge has focused on restoring native prairie habitats (McKernan 2004) (see Appendix C). Some work has been done to evaluate methods for growing plants from seed in controlled conditions for later reintroduction to the wild (Goodrich 1983). Seeds of this species have been banked at the Berry Botanic Garden in Portland, Oregon (Berry Botanic Garden 2005). A habitat conservation plan that

addresses conservation of *Delphinium pavonaceum* within Benton County is currently in preparation (Benton County 2009).

5. *Horkelia congesta* Dougl. ex Hook. ssp. *congesta* (Shaggy horkelia)

Conservation Status

Horkelia congesta ssp. *congesta* is a perennial herb that has been identified by the Oregon Fish and Wildlife Office as a species of concern (U.S. Fish and Wildlife Service 2008). It is endemic to the Willamette and Umpqua Valleys of western Oregon, and is a candidate for listing by the State of Oregon (Oregon Department of Agriculture 2008). Its taxonomy and physical description are summarized in Appendix F.

Population Trends and Distribution

Since its discovery, *Horkelia congesta* ssp. *congesta* has been reported from about 40 locations in 6 western Oregon counties (Douglas, Lane, Linn, Marion, and Washington Counties). Currently, it is known to persist at only 26 sites in 4 counties (Douglas, Benton, Lane, and Linn Counties), indicating that the species may have been extirpated from the northern portion of its range (Gisler 2004) (Figure II-11). A long-term monitoring program at the Bureau of Land Management's Long Tom Area of Critical Environmental Concern has documented a slow decline of the population over the last decade (Kaye 2002).

Life History and Ecology

Horkelia congesta ssp. *congesta* is an herbaceous perennial that blooms from April to June and reproduces by seed. Plants form rosettes of basal leaves and eventually produce one or more flowering stems. Occasionally, the root caudex splits beneath the soil surface, thus producing rosettes that appear separate but are connected underground. *Horkelia congesta* ssp. *congesta* does not appear capable of vegetative reproduction, and reproduces solely by seeds (Gisler 2004). No field studies have been conducted on the breeding system of the species. Solitary bees (*Halictus* sp. and *Andrena* sp.), syrphid flies, and muscid flies have been observed pollinating flowers in the wild (Gisler 2004).

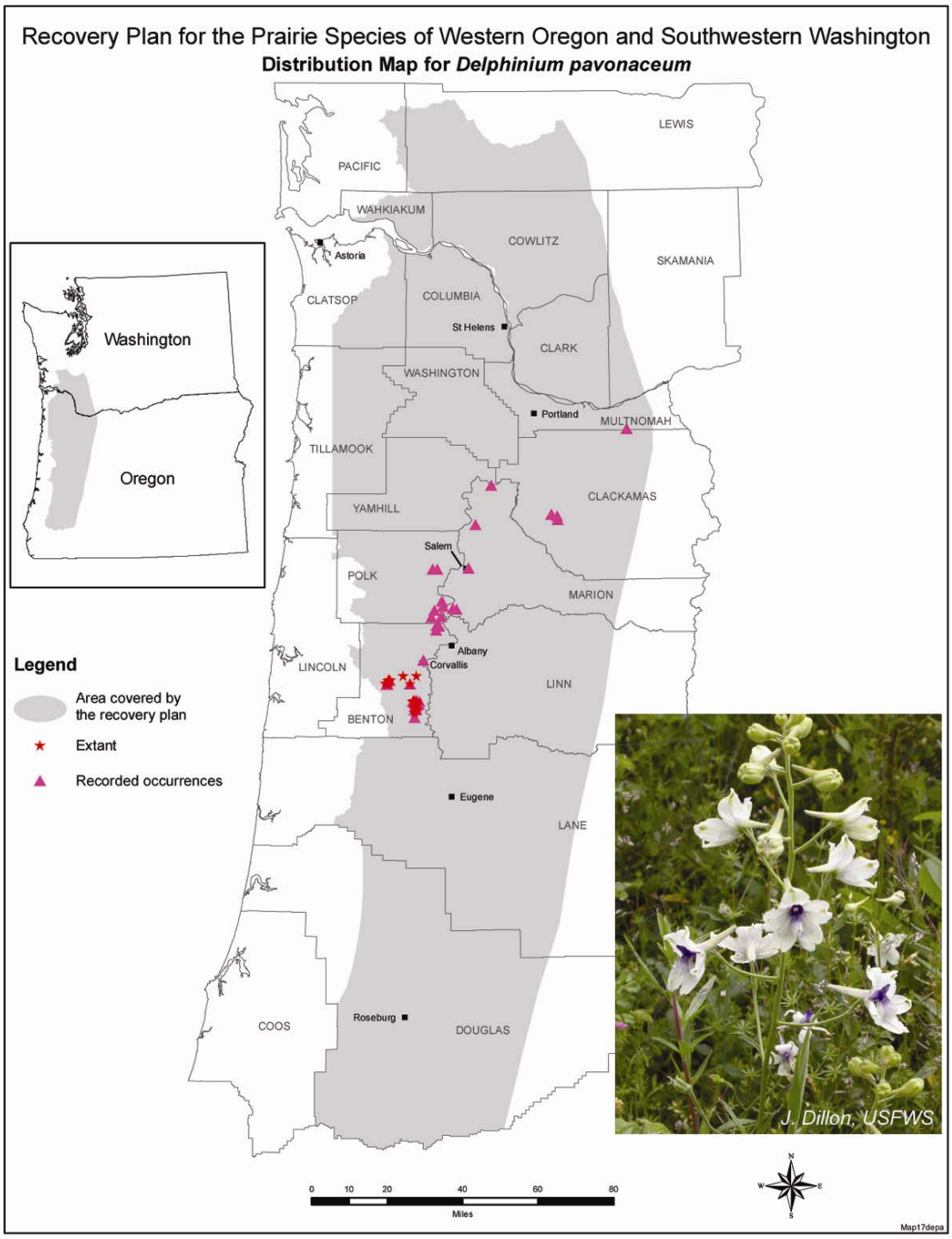

Figure II-10. *Delphinium pavonaceum* distribution.

Habitat Characteristics

Horkelia congesta ssp. *congesta* occurs in prairie and oak savanna remnants in the Willamette Valley and on grassy balds in the Umpqua Valley. In the Willamette Valley, the species occurs on slightly elevated sites in wet prairies, dry uplands, open areas and even the shady understory of oak and fir woodlands (Gisler 2004). Extant populations range in elevations from 80 to 450 meters (275 to 1,500 feet), with the higher elevation sites located in the southern portion of the range (Gisler 2004). The taxon has been found on clay loam, cobbly silty clay, cobbly loam, gravelly loam, silt clay loam, and silty clay loam.

Associated species include *Linanthus bicolor* (bicolored linanthus), *Lomatium bradshawii*, *Danthonia californica*, *Eriophyllum lanatum*, *Habenaria elegans* (elegant rein orchid), *Lomatium utriculatum* (fine-leaved desert parsley), *Carex tumulicola* (foot-hill sedge), *Camassia leichtlinii* (great camas), *Montia howellii* (Howell's montia), *Sidalcea campestris*, *Microcala quadrangularis* (microcala), *Lomatium nudicaule* (naked desert parsley), *Wyethia angustifolia* (narrow-leaved dwarf sunflower), *Orthocarpus attenuatus* (narrow-leaved orthocarpus), *Iris tenax*, *Sanicula crassicaulis tripartita* (Pacific black snakeroot), *Luzula comosa*, *Festuca rubra*, *Sidalcea malviflora* ssp. *virgata*, *Potentilla gracilis*, *Lupinus micranthus* (small-flowered lupine), *Lotus micranthus* (small-flowered trefoil), *Ranunculus occidentalis* (western buttercup), *Fragaria virginiana*, *Erigeron decumbens* var. *decumbens* and *Achillea millefolium* (Alverson 1990).

Threats/Reasons for Decline

The species is threatened by the continued loss of native prairie habitat, invasive weeds and successional changes to its grassland habitat (Gisler 2004). Grazing by deer is also a potential threat to small populations (Kaye 2002).

Conservation Measures

Horkelia congesta ssp. *congesta* has been the subject of several research and conservation projects. Long-term monitoring has been conducted at the Bureau of Land Management's Long Tom Area of Critical Environmental Concern (Kaye 2002, Gisler 2004), and studies have examined the feasibility of propagation as a tool for population augmentation or reintroduction (Kaye and Brandt 2005). Direct seeding can be an effective method of establishing plants at new sites or augmenting existing populations, and outplanting of container-grown plants from seed has a very high success rate (Kaye and Brandt 2005). Seeds of this species have been banked at the Berry Botanic Garden in Portland, Oregon (Berry Botanic Garden 2005).

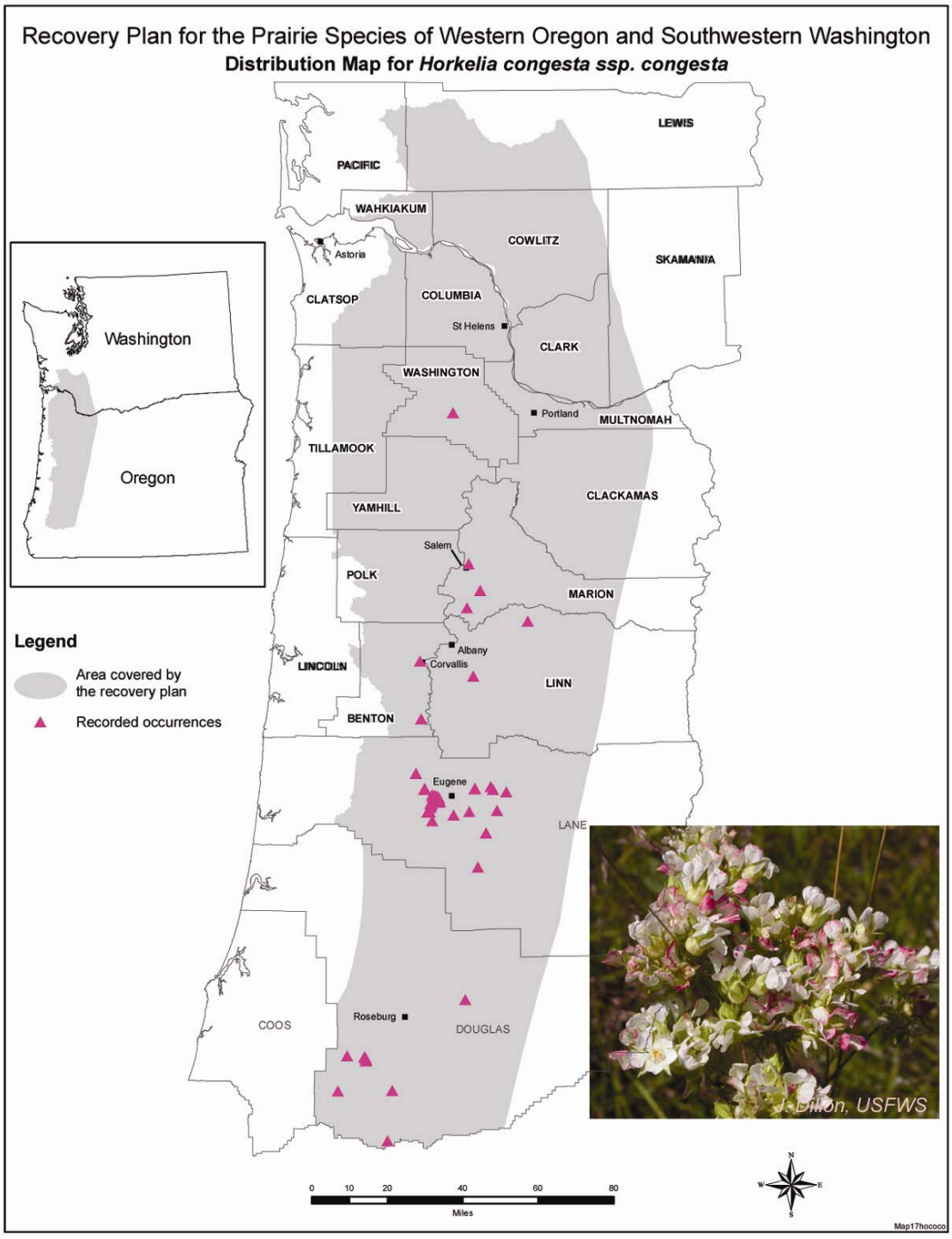

Figure II-11. *Horkelia congesta* ssp. *congesta* distribution.

6. *Sericocarpus rigidus* Lindl. (White-topped aster)

Conservation Status

Sericocarpus rigidus is a perennial herb that has been identified by the Oregon Fish and Wildlife Office as a species of concern (U.S. Fish and Wildlife Service 2008). The State of Oregon lists the species as threatened (Oregon Department of Agriculture 2008), and it is considered a state sensitive species in Washington (Washington Natural Heritage Program 2008). Its taxonomy and physical description are summarized in Appendix F.

Population Trends and Distribution

Sericocarpus rigidus is found from the Willamette Valley in Oregon, northwards through the Puget Trough region of western Washington and into Canada on Vancouver Island, British Columbia. About 96 populations have been identified, the majority of which are found in western Washington (Gisler 2004). Within the range of this recovery plan, populations of *Sericocarpus rigidus* occur in Clackamas, Linn, Marion, and Lane Counties, Oregon; no occurrences of *Sericocarpus rigidus* are currently known in Clark, Cowlitz or Lewis Counties, Washington (Figure II-12). The West Eugene Wetlands in Lane County has at least 16 sites with populations of *Sericocarpus rigidus*.

Sericocarpus rigidus expands vegetatively, thus, it is difficult to distinguish genetically distinct individuals in the field (Gamon and Salstrom 1992). The largest known population in the Willamette Valley, on land managed by the U.S. Army Corps of Engineers near Fern Ridge Reservoir in Lane County, was estimated at 1,001 to 10,000 flowering stems in 1996.

Life History and Ecology

Populations of *Sericocarpus rigidus* consist of one to many clones of 50 to 1000 ramets; shoots emerge from creeping rhizomes in April, and flowering occurs in July and August (Gamon and Salstrom 1992). Reproduction probably occurs primarily through vegetative means; seedlings have only rarely been observed in the wild (Gamon and Salstrom 1992).

The species is pollinated by insects; one butterfly and several types of bees have been observed visiting the flower (Gamon and Salstrom 1992). Populations in Washington are generally not limited by pollinators (Bigger 1999). Although some seed production results when pollinations occur within patches, seed set increases when pollen is moved among patches of plants (Giblin and Hamilton 1999), suggesting that inbreeding depression can limit sexual reproduction in this species.

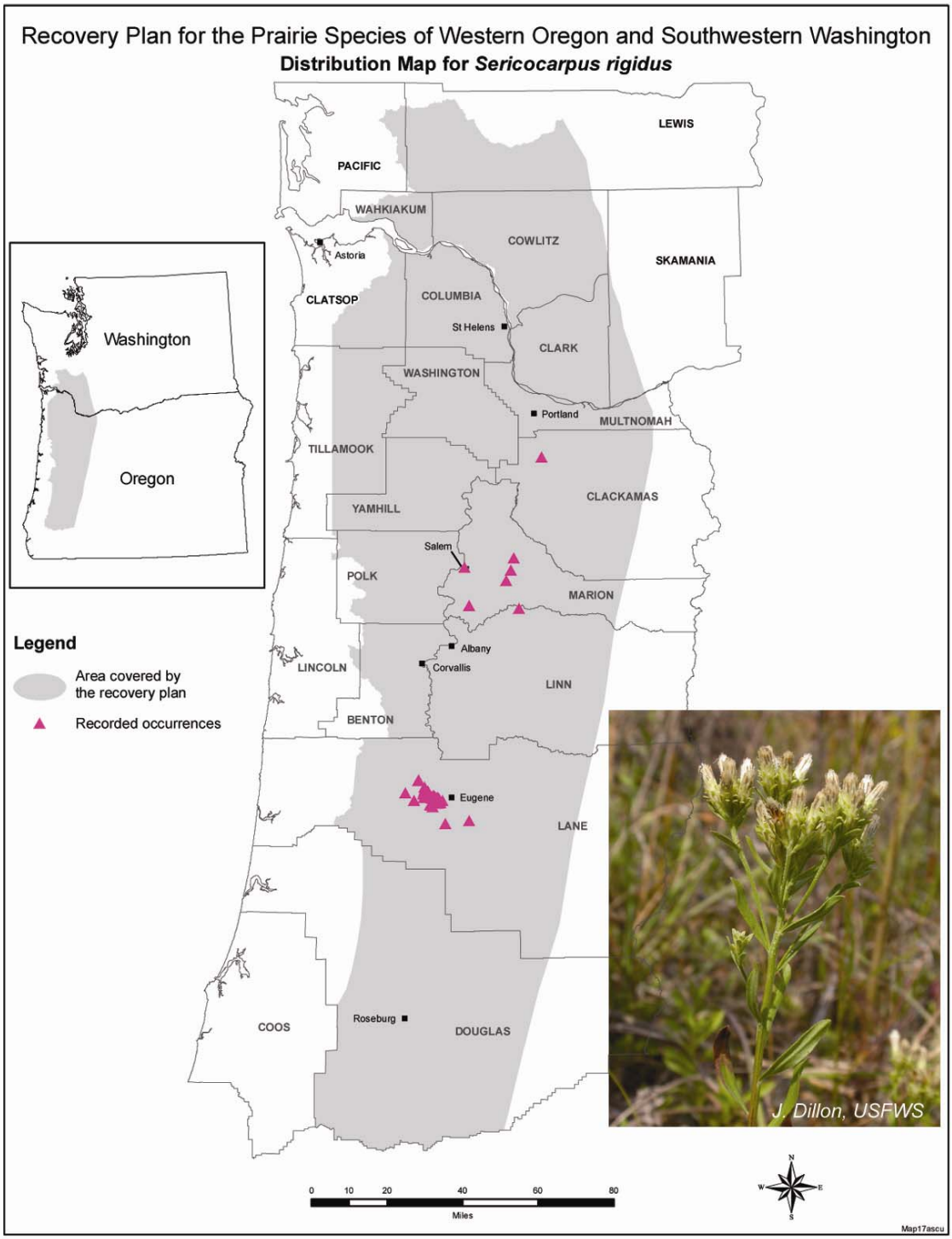

Figure II-12. *Sericocarpus rigidus* distribution.

Habitat Characteristics

Over most of its range, *Sericocarpus rigidus* is found in well-drained upland prairies, oak savannas and woodlands, but also occurs in wet prairie in Lane County (Alverson 1991). Populations are found at elevations of 30 to 175 meters (100 to 575 feet) above sea level, generally on clayey soils (Gamon and Salstrom 1992, Gisler 2004). The taxon has been found on very cobbly loam, very stony silt loam, silt loams, and silty clay loams and gravelly outwash soils (Gamon and Salstrom 1992). Soil associations include Dayton, Dixonville-Philomath-Hazelair complex, Natroy, Nekia, Salkum, Stayton, and Witzel. Associated species include *Viola adunca* (western violet), *Potentilla* sp. (cinquefoil), *Prunella vulgaris* var. *lanceolata* (heal-all), *Deschampsia cespitosa, Symphotrichum hallii*, and *Lomatium bradshawii* (Meinke 1982).

Threats/Reasons for Decline

As with all of the other species addressed in this recovery plan, habitat loss, alteration of disturbance regimes, and habitat invasion by trees, shrubs, and non-native weeds put this species at risk of continued declines (Gisler 2004).

Conservation Measures

Sericocarpus rigidus has been successfully propagated from seed and from rhizome cuttings (Gisler 2004). Attempts to transplant young plants into natural habitats have been most successful using rhizome cuttings (Kaye and Brandt 2005); in some studies, establishing new populations from seed has shown a low success rate (Clark *et al.* 2001, Kaye and Kuykendall 2001b). Seeds of this species have been banked at the Berry Botanic Garden in Portland, Oregon (Berry Botanic Garden 2005).

7. *Sisyrinchium hitchcockii* Henderson (Hitchcock's blue-eyed-grass)

Conservation Status

Sisyrinchium hitchcockii is a perennial herb that has been identified by the Oregon Fish and Wildlife Office as a species of concern (U.S. Fish and Wildlife Service 2008). It is not State listed in Oregon, but is on the Oregon Natural Heritage Information Center List 1 (taxa threatened with extinction throughout their range) (Oregon Natural Heritage Information Center 2007). Its taxonomy and physical description are summarized in Appendix F.

Population Trends and Distribution

There are four occurrence records in Lane County and five in Douglas County (Oregon Natural Heritage Information Center data 2006) (Figure II-13). Information is very sparse and of limited use in gauging population trends. Since potential habitat is declining, it is very likely that the plant species is also declining.

Life History and Ecology

Sisyrinchium hitchcockii blooms mid-May into July. The species is pollinated by solitary bees in the Megachilidae family (Henderson 1976).

Habitat Characteristics

Sisyrinchium hitchcockii has been documented in valley grassland and oak savannas from Humboldt County in northern California to the Willamette Valley, Oregon (Henderson 1976).

Threats/Reasons for Decline

Willamette Valley and Umpqua Valley prairies and oak savannas, which are presumed to provide habitat for the species, are threatened by development (residential, industrial and agricultural).

Conservation Measures

Seeds of this species have been banked at the Berry Botanic Garden in Portland, Oregon (Berry Botanic Garden 2005).

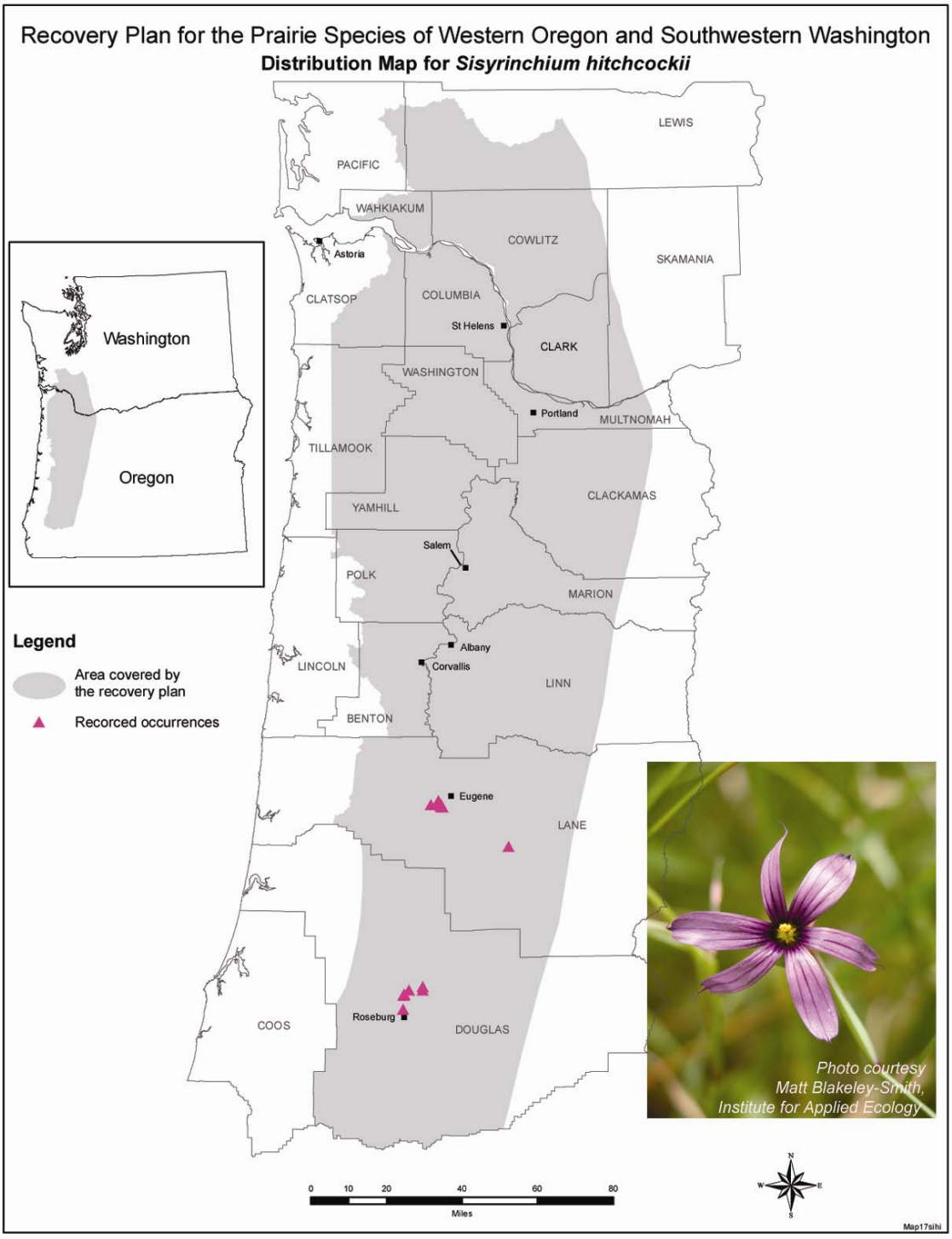

Figure II-13. *Sisyrinchium hitchcockii* distribution.

III. THREATS ASSESSMENT

The major factors in the decline of western Oregon and southwestern Washington prairie species have been: (1) alteration of natural and human-mediated disturbance processes (*e.g.*, fire and flooding) that maintained the early seral stage of the plant communities; (2) habitat conversion to agricultural landscapes through livestock grazing and croplands; (3) urbanization, which results in the permanent loss of native prairies; and (4) invasion by non-native plants (Altman *et al.* 2001, Wilson *et al.* 2003). The loss, degradation and fragmentation of prairies have had cascading effects to the species dependent on those habitats, resulting in smaller population sizes, loss of genetic diversity, reduced gene flow among populations, destruction of population structure, and increased susceptibility to local population extirpation caused by environmental catastrophes.

An analysis of threats is an essential component of our listing, delisting, and reclassification decisions. Section 4(a)(1) of the Endangered Species Act directs us to determine the status of species with respect to the following five factors:

A. The present or threatened destruction, modification, or curtailment of habitat or range;

B. Overutilization for commercial, recreational, scientific, or educational purposes;

C. Disease or predation;

D. Inadequacy of existing regulatory mechanisms; and

E. Other natural or man-made factors affecting the continued existence of a species.

The analyses conducted by the U.S. Fish and Wildlife Service that resulted in the listing of Fender's blue butterfly, *Erigeron decumbens* var. *decumbens*, *Lomatium bradshawii*, *Lupinus sulphureus* ssp. *kincaidii*, *Sidalcea nelsoniana* and *Castilleja levisecta* (U.S. Fish and Wildlife Service 1988, 1993b, 1997, 2000a) assessed the threats to the species' continued existence; habitat loss was considered to be one of the largest, and generally least reversible, of the causes of the species' decline. Where populations of the species persist in the wild, we identified 24 distinct threats; each threat is described below, and is classified according to the five factors listed above.

1. Conversion to non-habitat land uses (Factor A). Conversion of natural prairie habitats into non-urban uses, including agriculture, tree farms, golf courses, and other land uses, directly eliminates habitat of prairie plants and wildlife.

2. Adjacent land use practices (Factor A). Exogenous impacts from nearby lands, which could include herbicide or insecticide drift, spreading invasive or noxious weeds, or escaped grazing animals, degrade prairie habitats by reducing the viability of remnant populations of prairie species.

3. Historic management / disturbance (Factor A). The effects of past management, which have included plowing, cultivation or grazing, may continue to limit the productivity, suitability or quality of prairie habitats.

4. Housing / urban development (Factor A). Permanent loss of habitat through conversion to urban and residential development has been identified as the single largest threat to the prairies of the region (U.S. Fish and Wildlife Service 2000a). This is especially a concern where prairie habitat abuts existing urban areas, such as near the town of Dallas (Polk County, Oregon) and in the West Eugene Wetlands (Lane County, Oregon).

5. Hydrologic alterations (Factor A). Changes in the natural hydrology of a site, such as by ditching or draining a wet prairie, can alter the annual duration of soil saturation, which in turn affects the species composition of the site.

6. Improper prairie management (Factor A). Management practices to maintain native prairie composition and structure require proper timing and techniques to achieve desired results; although mowing, grazing and burning are techniques that can be useful in restoring native prairies, if applied at the wrong season, at the wrong frequency, or at the wrong scale, these activities could be detrimental to restoring native prairie species.

7. Invasive species (Factor A). Invasive non-native species are a threat in virtually all known prairie remnants in the region. Invasive plant species dramatically change the structure of prairies, often forming tall, dense patches that shade out the natives, and compete for water and nutrients (Wilson *et al*. 2003). Among the most common and difficult-to-manage invasive plant species are *Agrostis* spp., *Arrhenatherum elatius, Brachypodium sylvaticum, Centaurea* x *pratensis* (meadow knapweed), *Cytisus scoparius,*

Festuca arundinacea, *Phalaris arundinacea, Pyrus communis*, *Rosa eglanteria* and *Rubus armeniacus*.

Moreover, transgenic glyphosate-resistant strains of *Agrostis stolonifera* (creeping bentgrass) that have recently been commercially developed for the golf course industry would pose a serious threat if they should escape into native prairie habitat or if herbicide resistance genes should be transferred by introgression into wild populations of *Agrostis* in western Oregon or southwestern Washington (Reichman *et al*. 2006; Kate Norman, pers. comm. 2010b). Field trials in central Oregon have documented pollen-mediated transfer of glyphosate resistance genes into *Agrostis* populations at distances up to 21 kilometers (13 miles) (Watrud *et al*. 2004), as well as the persistence of high proportions of transgenic individuals despite eradication efforts (Zapiola *et al.* 2008). Because almost all remaining native prairie habitats in western Oregon and southwestern Washington are within a 21-kilometer radius of a golf course or grass seed farm, it is unlikely that establishment of glyphosate-resistant *Agrostis* in prairie habitat can be reliably prevented if transgenic strains are commercially deployed in the region. The targeted use of herbicides is a critically important tool to control invasive plant species. Because glyphosate-based products are the only herbicides that are both labeled for use in wet areas and do not place non-target plant species at risk by moving in the soil, invasion of glyphosate-resistant *Agrostis* into wet prairie habitat would be difficult or impossible to counteract and could severely affect listed plant species.

8. Isolation / fragmentation (Factor A). Destruction of prairie habitats throughout the region has resulted in the increased isolation and fragmentation of the remaining habitat patches, which has resulted in smaller population sizes, loss of genetic diversity, reduced gene flow among populations, disruption of metapopulation structure, and increased susceptibility to local population extirpation caused by environmental catastrophes.

9. Road development / maintenance (Factor A). The species addressed in this recovery plan occur in many small, fragmented populations, many of which are adjacent to roads. Routine roadside maintenance generally involves herbicide application or mowing, which reduces or even eliminates populations.

10. Utilities installation and maintenance (Factor A). Similar to roadside maintenance, clearing and maintaining utility corridors can directly remove or fragment populations.

11. Timber harvest / silviculture / logging (Factor A). Conversion of native prairies to conifer plantations is a major threat. When sites are prepared for tree planting, soil disturbance and herbicide application are common activities which may negatively affect adjacent prairie habitats. Establishment of tree farms in or immediately adjacent to prairies will eventually shade out some habitat, and may also increase the effects of fragmentation, if insect pollinators are unable to travel through forested habitat. Ultimately, tree harvest can also cause intense habitat disturbance and may reduce the size or quality of adjacent prairies. However, selective cutting of invasive trees that are colonizing prairie may also be useful as a prairie restoration technique.

12. Wildfire / burning (Factor A). Similar to improper prairie management, wildfires and intentional burning can be a negative force if applied at the wrong time of year, such as before the end of the growing season, if the fire destroys prairie plants before they set seed for the next growing season.

13. Field research activities (Factor B). Increasing our knowledge of prairie ecology is vital to the successful restoration of the species covered in this recovery plan, however, research itself can be a threat. For example, increased foot traffic in fragile habitats may result in crushing sensitive plants or butterfly larvae, collection of specimens may further reduce small population sizes, and seeds of invasive plants may be carried in on boots or equipment.

14. Recreation (Factor B). As attractive open spaces in a largely forested region, prairies attract human recreation, which can have negative effects. For example, off-road vehicles, hikers, cyclists and horses may crush or uproot plants or kill butterfly larvae, and seeds of invasive species may be spread by foot traffic, vehicle tires and horse manure.

15. Over-collecting / poaching (Factor B). Rare butterflies are often the target of collectors, and the rarity of Fender's blue butterfly makes it vulnerable to poaching; rare plants are less likely to be collected, although removal for herbarium specimens may be a concern.

16. Herbivores / predators (Factor C). Herbivory and predation are a part of the natural life cycle of prairie plants and wildlife, respectively. These forces may become a threat, however, when populations are small, and loss of even a very few individuals affects the viability of the population. In some cases, prolific populations of native wildlife such as deer, gophers, and voles have had serious negative impacts to plant populations.

17. Livestock grazing (Factor C). Grazing removes vegetative and reproductive plant structures, which can be destructive if it occurs at an inappropriate scale or time. Selective foraging on native plants may also lead to the dominance of less-palatable non-natives. Depending on the intensity of the grazing, and the type of livestock, the effect can also include substantial disturbance of the substrate; Fender's blue butterfly larvae may also be trampled. Grazers also can increase the spread of non-native plant seeds into native habitats.

18. Parasites (Factor C). Similar to the herbivore / predator threat, seed parasites, gall-forming insects, and butterfly parasitoids are all a part of the natural environment. As populations of the listed prairie species become very small, parasites can reduce the viability of small populations, making them increasingly vulnerable to local extirpation. Non-native parasites introduced for agricultural purposes may also have unintended negative effects to rare species.

19. Habitat vandalism (Factor D). The deliberate destruction of individuals or habitat occasionally occurs when rare species cause unpopular restrictions on use of public or private lands; although not a common occurrence, vandalism could further reduce habitat function and destroy individual plants or animals.

20. Succession to native woody plants (Factor E). Among the most urgent threats to western prairies, succession to native shrublands or forest occurs when the historical prairie disturbance regime has been suppressed. Common native species that invade and ultimately take over prairie habitats in the absence of periodic disturbance include: *Crataegus douglasii, Fraxinus latifolia, Quercus garryana, Pseudotsuga menziesii* and *Toxicodendron diversilobum*.

21. Impaired ecological functions (Factor E). Frequently an effect of fragmentation and isolation, impaired ecological function occurs when remnant prairie patches become too small to sustain adequate numbers of nectar or host plants for butterflies, and inter-patch distance exceeds the dispersal abilities of invertebrate pollinators of plants. The collapse or disruption of these processes may ultimately destroy remnant prairie patches.

22. Small population size / low genetic variability (Factor E). Again, a frequent result of fragmentation and isolation is that small populations may be at risk of inbreeding depression; as patches get smaller and more separated from adjacent populations, the local

pool of genetic material shrinks, potentially resulting in a loss of resilience to environmental change. Small populations are also at risk of extirpation due to stochastic events, such as unusually wet or dry years, or unseasonable fires.

23. Pesticide use on-site (Factor E). Herbicides and insecticides, if not carefully applied, may have direct impacts to sensitive prairie species, or may have indirect impacts through damage to host plants or pollinators; in either case, the effects of improperly applied pesticides may further reduce population size.

24. Hybridization (Factor E).
Hybridization has been identified as a threat for *Lupinus sulphureus* ssp. *kincaidii* and *Sidalcea nelsoniana*. Hybrids of *Lupinus sulphureus* ssp. *kincaidii* and *Lupinus arbustus* have been detected at Baskett Slough National Wildlife Refuge. Interspecific hybridization between *Sidalcea nelsoniana* and the other *Sidalcea* species in the Willamette Valley, particularly with *S. cusickii*, is a concern; human-mediated dispersal of these taxa beyond their native ranges could allow hybridization.

Many of the threats above are interconnected, resulting from widespread changes in land use and management associated with agricultural and urban development within prairie habitats of western Oregon and southwestern Washington. Without frequent disturbance, prairie habitats are naturally colonized by trees and become forest habitat through successional processes. Historically, Willamette Valley prairies were periodically burned, either by wildfires or by fires set by Native Americans (Johannessen *et al.* 1971). Since Euro-American settlers arrived, fire suppression has allowed shrubs and trees to invade grassland habitat. Common native shrub and tree species that encroach on undisturbed prairies include *Pseudotsuga menziesii, Quercus garryana, Fraxinus latifolia, Crataegus douglasii* and *Toxicodendron diversilobum*. One of the most significant threats to prairie species is this continued encroachment into prairie habitats by woody vegetation, which ultimately can replace the open prairies with woody plant communities. Moreover, prairies have been widely invaded by non-native plants, which shade out or crowd out important native species. Fast growing non-native shrubs (*Rubus armeniacus* and *Cytisus scoparius*), non-native grasses such as *Agrostis* sp. and *Arrhenatherum elatius,* and non-native forbs, such as *Centaurea* x *pratensis,* can form dense monocultures and virtually take over the prairies. This threat would be exacerbated if invading plants expressed herbicide-resistance genes that prevented land managers from controlling them with targeted use of herbicides. These plants compete for space, water and nutrients with the native prairie species. Ultimately, they inhibit the growth and reproduction of native prairie plants (*e.g. Lupinus*

*sulphureu*s ssp. *kincaidii*, the larval host plant of Fender's blue butterfly and native nectar sources are shaded out by non-native plants) (Hammond 1996, Schultz *et al.* 2003, Wilson *et al.* 2003). Thus, when highly invasive non-native plants become dominant they can effectively preclude butterflies from using the native plant species they need to survive and reproduce (Hammond 1996). Native plant seedling establishment is also inhibited by the dense thatch layer formed by non-native grasses; at many Willamette Valley sites, *Sidalcea nelsoniana* seedlings are excluded by such thatch layers (Gisler 2004).

The extensive conversion of prairie habitat to agriculture, urban development, and other uses (such as tree farms, golf courses, and networks of roads and utility corridors) has directly reduced the amount of habitat available to prairie species, as well as fragmenting the remaining habitat into small patches that are isolated from one another and increasingly affected by spillover impacts of management and invasive plant populations on adjacent lands. Restriction of prairie habitat to small patches can result in a variety of adverse effects to native prairie species, including inbreeding and loss of genetic diversity; vulnerability to extinction from stochastic fluctuations in population size and demographic composition with small population size and lack of immigration; and the inability of patches to support viable populations of associated species such as pollinators, larval host plants, or nectar sources. Habitat fragmentation has isolated the remaining populations of Fender's blue butterfly to such an extent that butterfly movement among suitable habitat patches may now occur only rarely (Schultz 1998). The rarity of host lupine patches and fragmentation of habitat are the major ecological factors limiting reproduction, dispersal, and subsequent colonization of new habitat (Hammond and Wilson 1992, 1993; Hammond 1994; Schultz 1997; Schultz and Dlugosch 1999). Extirpation of remaining small populations is expected from localized events and probable low genetic diversity associated with small populations (Schultz and Hammond 2003).

Drift of herbicides and insecticides from nearby applications can affect Fender's blue butterfly and listed plant species either directly or indirectly through effects on various pollinators, larval host plants, and nectar sources. Fender's blue butterflies may be threatened by the application of pesticides used to control invertebrates that pose a threat to human health or agricultural products. The Oregon Department of Agriculture's Gypsy Moth Eradication Program sprays Btk (*Bacillus thuringiensis* var. *kurstaki*) whenever an infestation of the non-native gypsy moth (*Lymantria dispar*) is detected (Oregon Department of Agriculture 2006). Btk, a bacterium which is lethal to all butterfly and moth larvae, has been shown to drift at toxic concentrations over 3 kilometers (2 miles) from the point of application (Barry *et al*. 1993). The state's gypsy moth control program could

incidentally kill Fender's blue butterfly larvae when Btk is sprayed near a Fender's blue butterfly population. There is evidence that Btk application in the Northwest has reduced populations of non-target butterflies (Black *et al*. 2002).

The application of mosquito adulticides to control the spread of West Nile Virus also poses the risk of incidental harm to Fender's blue butterflies. The Oregon Department of Human Services' program to control West Nile Virus focuses on reduction of breeding habitat for the mosquito carriers of the disease and the use of larvicides to kill mosquito larvae (Oregon Department of Human Services 2006); however, the program recognizes that there are some instances in which the use of mosquito adulticides (*e.g.*, Malathion and pyrethrins) is justified (Oregon Department of Human Services 2003). The pesticides used to kill adult mosquitoes are also lethal to other invertebrates, including Fender's blue butterflies. The potential for pesticide drift in lethal concentrations is of concern when habitat for the Fender's blue butterfly is nearby.

The human population density and urban development in the Willamette Valley have resulted in increased recreational pressure and potential for vandalism in prairie habitat. Hikers, cyclists, horseback riders, and off-road vehicles can affect prairie species through trampling, erosion, and introduction of weed seeds. The presence of nearby improvements and population centers also contributes to restrictions on the use of habitat management methods such as prescribed burning.

Most of the land in the Willamette Valley is privately owned, and many of the remaining populations of rare prairie species occur on private lands. Plant populations occurring on private lands are particularly vulnerable to threats of development, because state and Federal plant protection laws have little effect on private lands. Effective cooperation with private landowners, both those with property supporting prairie species and those on adjoining lands, is crucial for conservation and recovery of native prairie species.

The Recovery Team and a group of experts familiar with the rare species and habitats in the region reviewed the threats to the listed species at each known remaining site (Table III-1). The threats most frequently identified as severe were: (1) invasive species, (2) small population size / low genetic variability, (3) succession to native woody plants, (4) impaired ecological function, and (5) isolation / fragmentation. These rankings reflect the general assessment by Altman *et al.* (2001) that alteration of the natural and historical disturbance regime and loss of prairie habitats to development have resulted in small, fragmented populations of increasingly rare species threatened by continued degradation of

the natural processes needed to maintain their native habitats. *Castilleja levisecta* is not shown in Table III-1 because no wild populations of the species are known to exist in the area covered by this recovery plan.

Recovery of Fender's blue butterfly, *Erigeron decumbens* var. *decumbens*, *Lomatium bradshawii*, *Lupinus sulphureus* ssp. *kincaidii*, *Sidalcea nelsoniana* and *Castilleja levisecta* will focus on controlling and reversing the threats to the species and their habitats. Conservation recommendations for candidate and other nonlisted species addressed in this recovery plan (Taylor's checkerspot butterfly, *Delphinium leucophaeum, Delphinium oreganum, Delphinium pavonaceum*, *Horkelia congesta* ssp. *congesta, Sericocarpus rigidus* and *Sisyrinchium hitchcockii*) will seek to protect and restore populations and habitats to preclude the further decline of these species, and possibly the eventual need to list them as threatened or endangered.

Table III-1. Threat matrix. Threats are evaluated at all sites and pooled for each species. Severest threats for each species shown as "XX". See text for description of threats.

Listing Factor	Threat	Species*				
		BLUE	LUSUKI	ERDEDE	SINE	LOBR
A	On-site agriculture conversion and management practices	XX	X		X	X
	Adjacent land use practices	XX	X	X	X	X
	Historic management / disturbance	XX	X		X	X
	Housing / urban development	XX	X	X	X	X
	Hydrologic alterations	X	X	X	X	X
	Improper prairie management	X	X	X	X	X
	Invasive species	XX	X	XX	XX	XX
	Isolation / fragmentation	XX	X	X	X	X
	Road development / maintenance	X	X	X	X	X
	Utilities installation and maintenance	X	X	X	X	X
	Timber harvest / silviculture / logging	X	X	X	X	
	Wildfire / burning	X	X	X	X	X
B	Field research activities	X	X	X		X
	Recreation	X	X	X	X	X
	Over-collecting / poaching	X			X	
C	Herbivores / predators	X	X		X	X
	Livestock grazing	X	X	X	X	X
	Parasites	X			X	
D	Habitat vandalism	X	X	X	X	X
E	Succession to native woody plants	XX	X	XX	XX	XX
	Impaired ecological functions	XX	X	X	X	X
	Small population size / low genetic variability	XX	XX	X	X	XX
	Pesticide use on-site	X	X	X	X	X
	Hybridization		X		X	

*Key to species abbreviations:
BLUE = Fender's blue butterfly
LUSUKI = *Lupinus sulphureus* ssp. *kincaidii*
ERDEDE = *Erigeron decumbens* var. *decumbens*
SINE = *Sidalcea nelsoniana*
LOBR = *Lomatium bradshawii*

IV. RECOVERY

A. RECOVERY STRATEGY AND RATIONALE

1. Overview

An endangered species is "any species which is in danger of extinction throughout all or a significant portion of its range," and a threatened species is "any species which is likely to become endangered within the foreseeable future throughout all or a significant portion of its range" (Endangered Species Act, Section 3). It follows then that a species will no longer be considered threatened or endangered once the degree of risk to the species has been reduced to the point that it is no longer in danger of extinction (or likely to become so) throughout all or a significant portion of its range, and it is likely to remain at this low degree of risk into the foreseeable future. The fundamental precept of any recovery strategy must therefore be focused on reducing extinction risk and ensuring the persistence of the species. The first step in this process is identifying the possible sources of risk as well as the factors that influence the long-term viability of a species.

The threats analyses conducted for the listing determinations and in section III above showed that all of the listed species addressed in this plan have declined as their native prairie habitats have been destroyed, fragmented and degraded. Recovery for the listed prairie species of western Oregon and southwestern Washington will require restoration and maintenance of prairie habitats, protection and enhancement of populations, and management to maintain ecosystem functions, including healthy pollinator populations. The recovery plan calls for multiple viable populations of the listed prairie species in protected habitats distributed across their historical ranges. We consider a viable population to be one that has sufficient numbers, population trend and distribution of reproductive individuals so as to provide a high likelihood of persisting into the foreseeable future despite demographic, genetic and environmental uncertainties, including random catastrophic events.

The recovery strategy, criteria and actions proposed in this recovery plan are based on the following fundamental concepts for reducing the risk of extinction and ensuring, to the extent possible, the persistence of the species into the foreseeable future:

1. Reduce or eliminate the systematic threats to the species identified and described in section III (Threats Assessment);

2. Reduce risk from random, chance events (demographic, environmental, and genetic uncertainties) and natural catastrophes by:

a. ensuring that populations are at or above the minimum population targets; and

b. increasing the probability of persistence into the foreseeable future by ensuring the preservation of multiple potentially interacting populations distributed across each species' historical range;

3. Conserve genetic variability within the species to provide for both short-term fitness and the preservation of the evolutionary potential for the species to adapt to changing conditions;

4. Provide for long-term survival of the species by:

a. protecting and securing habitat sufficient to support the target population sizes and maintain connectivity between subpopulations;

b. restoring and maintaining high quality, diverse prairie habitats dominated by native species and with healthy native pollinator populations through active management;

c. monitoring populations to ensure that population trends are generally stable or increasing and to provide feedback for adaptive management; and

d. for the plant species, seed banking in an appropriate repository to provide a back-up supply of genetic stock that represents as much of the available genetic diversity within the species as possible.

A key component of the recovery strategy is the maintenance of populations of each species distributed across its historical range. Nunney and Campbell (1993) suggest a conservation strategy of protecting and maintaining multiple reserves for each species, each supporting at least the estimated minimum viable population size and containing **heterogeneous** habitat that effectively divides the population into subpopulations. Populations that are represented at multiple sites in this way have a greater chance of being buffered from the negative effects of

environmental variation, have a reduced chance of being simultaneously eliminated by a single catastrophic event, and stand a better chance of achieving natural levels of gene flow and maintaining ecological processes (Simberloff and Abele 1982, Soulé and Simberloff 1986, Simberloff 1988, Menges 1991, Fahrig and Merriam 1994, Neel and Cummings 2003). Maintaining the potential for occasional genetic exchange among units of a subdivided population is critical to long-term fitness; as few as one migrant per generation among subpopulations can maintain the essential level of gene flow (Newman and Tallmon 2001, Wang 2004). In addition, to ensure retention of allelic and **genotypic** diversity, populations should be conserved across the geographic range of the species, as reciprocal transplant studies often show local adaptive differentiation in plant populations (Waser and Price 1985, Hamrick *et al*. 1991). Neel and Cummings (2003) found that from 53 to 100 percent of populations are needed to capture all alleles and meet the genetic diversity conservation standard of the Center for Plant Conservation. Multiple reserve populations distributed across the range of the species also provide for variation in habitat quality or community structure (Shaffer 1981). We have divided the geographic area covered by this recovery plan into 10 recovery zones (Figure IV-1), which will provide a framework for establishing populations of listed species across their historical ranges.

While the recovery strategy for the listed species in this plan emphasizes maintenance of populations on permanently-protected parcels with conservation-oriented management plans in place, habitats that are not permanently protected will also perform a function as connections between subpopulations, stepping stones, and buffers around protected habitats. For example, habitats for listed species that are covered under the Safe Harbor Agreement program of the Fish and Wildlife Service can advance the recovery of listed species by providing conservation on private or other non-Federal properties. Actions taken under a Safe Harbor Agreement must provide a net conservation benefit that contributes to the recovery of the covered species, although the agreement does not have to provide permanent conservation for the enrolled property. Examples of the conservation benefits of Safe Harbor Agreements may include reduced habitat fragmentation; maintenance, restoration, or enhancement of existing habitats; increases in habitat connectivity; stabilized or increased numbers or distribution; the creation of buffers for protected areas; and opportunities to test and develop new habitat management techniques. Safe Harbor Agreements are an important conservation tool for engaging private landowners in recovery of listed prairie species in the region.

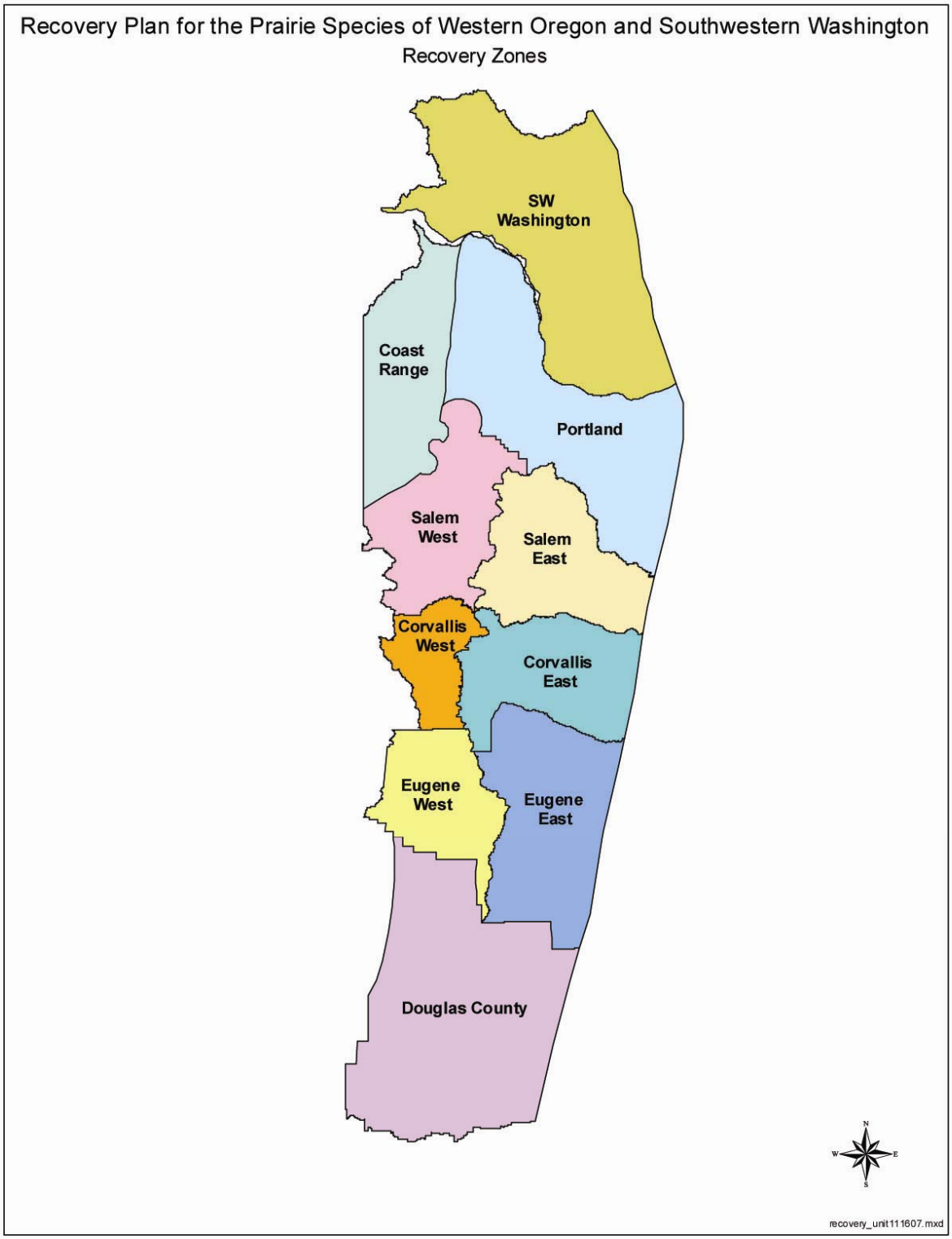

Figure IV-1. Recovery zones.

The recovery criteria for the listed species covered in this recovery plan focus on the importance of protecting existing populations. However, maintenance of suitable but currently unoccupied habitats is also important to recovery of rare species that occur in a mosaic of occupied and unoccupied suitable habitats. In this context, it is likely that only a subset of the available habitat will be occupied at any given time, and distribution of populations will shift as habitat conditions change. Currently, recovery actions focus on managing occupied patches, however it is also important to preserve the regional and local dynamics of patchy populations by protecting areas that could be occupied in the future as habitat suitability changes over time (Freckleton and Watkinson 2002).

Although this recovery plan provides estimates of the minimum population sizes by which to gauge probable long-term persistence and viability of the populations, it should be recognized that the numbers of individuals for these disturbance-adapted species naturally vary widely from year-to-year depending upon environmental conditions. This means that the suggested minimum population numbers are meant to serve as a general index of population viability when considered in conjunction with the other criteria for prairie management, connectivity, quality and diversity, rather than as an absolute stand-alone threshold to be met for recovery. The Recovery Team considers that protection and appropriate management of the habitat for restoration and maintenance of native prairies is of greater importance than the absolute total numbers of individuals present in each recovery zone.

An essential component of prairie quality is the presence of healthy pollinator populations. Pollinator ecology in these ecosystems is not well known, but at a minimum, maintenance of nesting sites *(e.g.*, bare ground, woody structure adjacent to prairie habitat) and a wide diversity of flowering plants will provide important habitat elements for native pollinating insects, which are essential to the survival of the listed plant species addressed here. Additional research into the specific pollinators of the listed plants, and the habitat needs of the pollinators is identified in the Recovery Actions section below.

While the widespread loss and degradation of prairie ecosystems in western Oregon and southwestern Washington has been the key factor underlying the decline of the plant and animal species associated with these communities, changing climate will place an even greater stress on the region's prairie habitats and the species that depend on them. The Intergovernmental Panel on Climate Change (IPCC) has concluded that recent warming is already strongly affecting terrestrial biological systems (IPCC 2007); this is evident in earlier timing of spring events such as migration and egg-laying, and in poleward and upward shifts in plant and animal distribution

(IPCC 2007). The IPCC has further concluded that the resilience of many ecosystems is likely to be exceeded this century by an unprecedented combination of climate change, associated disturbances (*e.g.*, flooding, drought, wildfire, insects, ocean acidification) and other global change drivers (IPCC 2007). Projections for the Willamette Valley include a rate of climate change that exceeds the ability of native species to adapt and an increase in invasive species that compete with native species (Climate Leadership Initiative and the National Center for Conservation Science and Policy 2009).

Although climate change is almost certain to affect prairie habitats, there is great uncertainty about the direction and specific effects of climate change on listed prairie species. The U.S. Fish and Wildlife Service has developed a strategic plan to address the threat of climate change to vulnerable species and ecosystems; goals of this plan include maintaining ecosystem integrity by protecting and restoring key ecological processes such as pollination, seed dispersal, nutrient cycling, natural disturbance cycles and predator-prey relationships (U.S. Fish and Wildlife Service 2009c). Our recovery program will implement these goals by attempting to establish conditions that allow populations of target species to be resilient to changing environmental conditions and to persist as viable populations into the future. The recovery goals for the listed species covered by this recovery plan will stress maintaining large populations distributed across their entire historical range, with management plans focusing on protecting sites with high habitat heterogeneity and a range of elevations. Maintenance of large populations is essential to buffering environmental variation and ensuring the continuation of evolutionary processes (Traill *et al*. 2010); habitat heterogeneity and elevational gradients within reserves will provide a large range of microhabitats, and therefore will allow for the greatest amount of internal species movement under changing environmental conditions (Halpin 1997). Additional recovery actions to address climate change will focus on monitoring species status and response to changing conditions, and seeking expert input and consensus on recommendations to prepare for future environmental change.

2. Fender's Blue Butterfly

In this section, we describe the foundation for determining target abundance goals and distribution across recovery zones for recovery of Fender's blue butterfly. Schultz and Hammond (2003) investigated population viability using diffusion approximation methods developed by Dennis *et al*. (1991). These methods predict extinction risk based on mean population growth rate, **variance** in growth rate and population size. Extinction risk is highly sensitive to variability in population growth rate. Schultz and Hammond (2003) estimated that

Fender's blue butterfly populations experience very high variance in population growth rate (0.112 to 1.715). Maintaining populations with variance this high requires mean population growth rates to be comparably high (in the range of 1.4 or higher; Schultz and Hammond 2003). However, the variation in population growth rate is, biologically, a combination of demographic and environmental stochasticity. As populations get larger, the influence of demographic stochasticity declines, so the overall variance in growth rate declines. Thus, at population sizes large enough to have a low extinction risk, a somewhat lower variance in population growth rate can reasonably be assumed.

Based on the population viability model for the Fender's blue butterfly, Schultz and Hammond (2003) concluded that recovery of the species would require a minimum average growth rate of 1.55 at three independent sites in each of three zones that span the species' historical range. This recommendation is based on the minimum growth rate needed for a 95 percent probability that at least one site survives 100 years given an initial population size of 300 individuals, a variance in population growth rate of 0.79 and three independent sites (Schultz and Hammond 2003). A key assumption of this modeling effort was that within-patch extinction is irreversible; that is, once a population disappears, recolonization is impossible. This assumption represents the worst case scenario, and as the recommendations in this recovery plan are implemented, permanent patch extinction would likely become the exception rather than the rule. Recovery tasks identified in the Recovery Actions section below emphasize establishing connections among populations with stepping-stone habitats to allow natural recolonization; population reintroduction and augmentation programs may also be developed as part of the recovery effort for the species.

The importance of patch size as it relates to population persistence has also been investigated recently. A model was used to evaluate the likelihood of population persistence of 12 existing populations of Fender's blue butterfly; the population that had the highest probability of persisting 100 years was an isolated one at Butterfly Meadows in the McDonald State Forest, a large (5-hectare [12-acre]) site (Schultz and Hammond 2003). Crone and Schultz (2003) concluded that Fender's blue butterfly requires patches of at least 2 - 6 hectares (5 -15 acres) to persist in the absence of immigration from other patches. The most conservative estimate of minimum patch size (6 hectares [15 acres]) should be sufficient to buffer against environmental factors and high stochastic variance in growth rates.

A more recent study modeled the existing patchwork of Fender's blue butterfly populations and fragmented prairie habitats in the West Eugene Wetlands area to evaluate the region's potential to support a viable population of the species (McIntire *et al*. 2007). This study assumed that all

historical upland prairies in the region could be restored to high quality habitat, and concluded that management of existing habitats, restoration of degraded sites and establishing connectivity among sites could support a very large viable population of Fender's blue butterflies, which would be sufficient for long-term persistence of the species in the Eugene area.

In order to set downlisting and delisting goals for Fender's blue butterfly populations, new modeling was done to establish targets based on minimum, rather than average, population levels (Cheryl Schultz, Washington State University, Vancouver, pers. comm., 2009). Targets based on minimum population size relate directly to minimum acceptable extinction risk and avoid the "noise" inherent in averaging population counts across years, which can mask potentially large variations due to environmental stochasticity. Minimum population size is also a less expensive and labor-intensive metric of population status than are average population counts; population monitoring can be considered completed when the minimum number of adult butterflies is detected, rather than continuing with an exhaustive effort to do a complete count of the population. A simple diffusion approximation model (Dennis *et al*. 1991) was used to calculate extinction probabilities, using population data collected at The Nature Conservancy's Willow Creek Preserve in the Main Area. This data set was chosen because it has been consistently collected for over 15 years, and long-term management has produced high quality habitat at the site (Fitzpatrick and Elias 2007). The model calculated the probability that each subpopulation within a network would persist using single-population extinction probabilities, P_e, for subpopulations with N butterflies each; the model then calculated the probability that the network would persist as $1- P_e M$, where M (metapopulation size) is the number of subpopulations, which assumes subpopulations are independent and is reasonable based on McIntire *et al*. (2007). The minimum population size for each network was calculated as $N \times M$ (*i.e*., the number of butterflies per subpopulation multiplied by the number of subpopulations). This modeling allows us to establish downlisting and delisting criteria tied to specific extinction probabilities (*e.g*., a 5 percent extinction probability equates to 95 percent probability of persistence for the species over the next 100 years). The model output provides a range of options (various combinations of networks and independent populations) that would achieve the desired persistence probability in each recovery zone. This strategy explicitly takes advantage of the benefits of multiple networks and independent populations by spreading the risk of stochastic events such as fire and exotic species invasions, as well as providing plentiful habitat heterogeneity (*i.e*., shady sites or north-facing aspects may be better in hotter years, open sites or south-facing aspects may fare better in cooler years).

It is important to note that setting goals using a minimum population count, as discussed above, does not mean managing for small populations. In every case, the minimum population count over a given period of years used in the recovery criteria corresponds to a substantially larger average population size over that time period. For example, over a period of 10 years, a network that has a minimum count of 1,000 adult butterflies (*i.e.*, the population count in each of 10 consecutive years never falls below 1,000 individuals) would likely have an average count of approximately 6,000 adult butterflies. In contrast, if we set targets using the average population count over 10 years, years with very large counts would mask the large variance inherent in an invertebrate population, and the result could be that we would ignore years with very low population counts, which might have important implications for the probability of population persistence.

We have used the results of this new modeling to set population targets for downlisting and delisting of Fender's blue butterfly. We recognize, however, that counts of adult Fender's blue butterflies during the brief flight season are an imperfect method for tracking the populations, because the species is difficult to count, surveys require a high level of field experience, and bad weather during the flight season often results in incomplete counts (Fitzpatrick 2009). Another concern is that the cost of surveying the large number of widely scattered populations has already exceeded the available budgets of some land managers. In the future we may evaluate other methods of tracking population size that use metrics other than adult counts. Our recovery targets may be revised in the future based on new data and refined modeling.

In this recovery plan, we attempt to adapt these theoretical models to practical application. To do so, we begin with these principles: 1) that recovery of Fender's blue butterfly will require large interconnected populations in a complex environment, and 2) that these populations must occur on protected sites managed for high quality prairie habitat. Variance in population growth rate is normally high for insect populations; stochastic factors, especially variation in weather from year to year, will periodically reduce population numbers. Given this, maintaining high quality habitats and connectivity among sites will be critical to allow Fender's blue butterfly populations to rebound after bad weather years.

Fender's blue butterfly is listed as endangered. In the recovery program for the species, we set goals for downlisting and delisting. Recovery goals for downlisting and delisting differ both quantitatively and qualitatively. Goals for downlisting to threatened will focus on protecting existing populations, securing the habitat and managing for high quality prairie habitats. Goals for delisting will focus on creating new populations, expanding existing populations, managing

for larger and more connected populations, and maintaining robust populations which will likely persist in a variable environment over the long term.

We set recovery targets for the Fender's blue butterfly in terms of "functioning networks" and independent populations. A functioning network is the term we use to describe a metapopulation that consists of several potentially interacting subpopulations of Fender's blue butterfly distributed across a landscape. A functioning network must be composed of three or more subpopulations, each occupying habitat of at least the minimum patch size (currently defined as 6 hectares [15 acres]) and separated by no more than the maximum separation distance (currently defined as approximately 2 kilometers [1.2 miles]) from the next nearest subpopulation or connected by stepping-stone patches of lupine less than 1 kilometer (0.6 mile) apart. We set the maximum distance separating subpopulations within a functioning network based on the known flight distance of an adult Fender's blue butterfly; this distance is currently understood to be about 2 kilometers (1.2 miles) (Schultz 1998). Small patches of lupine and nectar plants may form stepping stones between more distant subpopulations; these patches should be less than 1 kilometer (0.6 mile) apart. There is no minimum size necessary for a patch to function as a stepping stone, as long as the patch contains both lupine and nectar plants and the intervening habitats are relatively free from barriers to butterfly movement. If, at some point in the future, functioning networks merge such that two networks become one larger network, the intent of these criteria would still be met. An independent population is an isolated population that meets certain minimum size and habitat quality criteria, and which would be likely to persist in the long-term. An independent population must be at least the minimum patch size (currently defined as 6 hectares [15 acres]).

Populations must be distributed across the historical range of the species. Three recovery zones have been delineated for Fender's blue butterfly that encompass the historical range: Salem (combines the Salem East and Salem West recovery zones), Corvallis (combines the Corvallis East and Corvallis West recovery zones), and Eugene (combines the Eugene East and Eugene West recovery zones) (Figure IV-2).

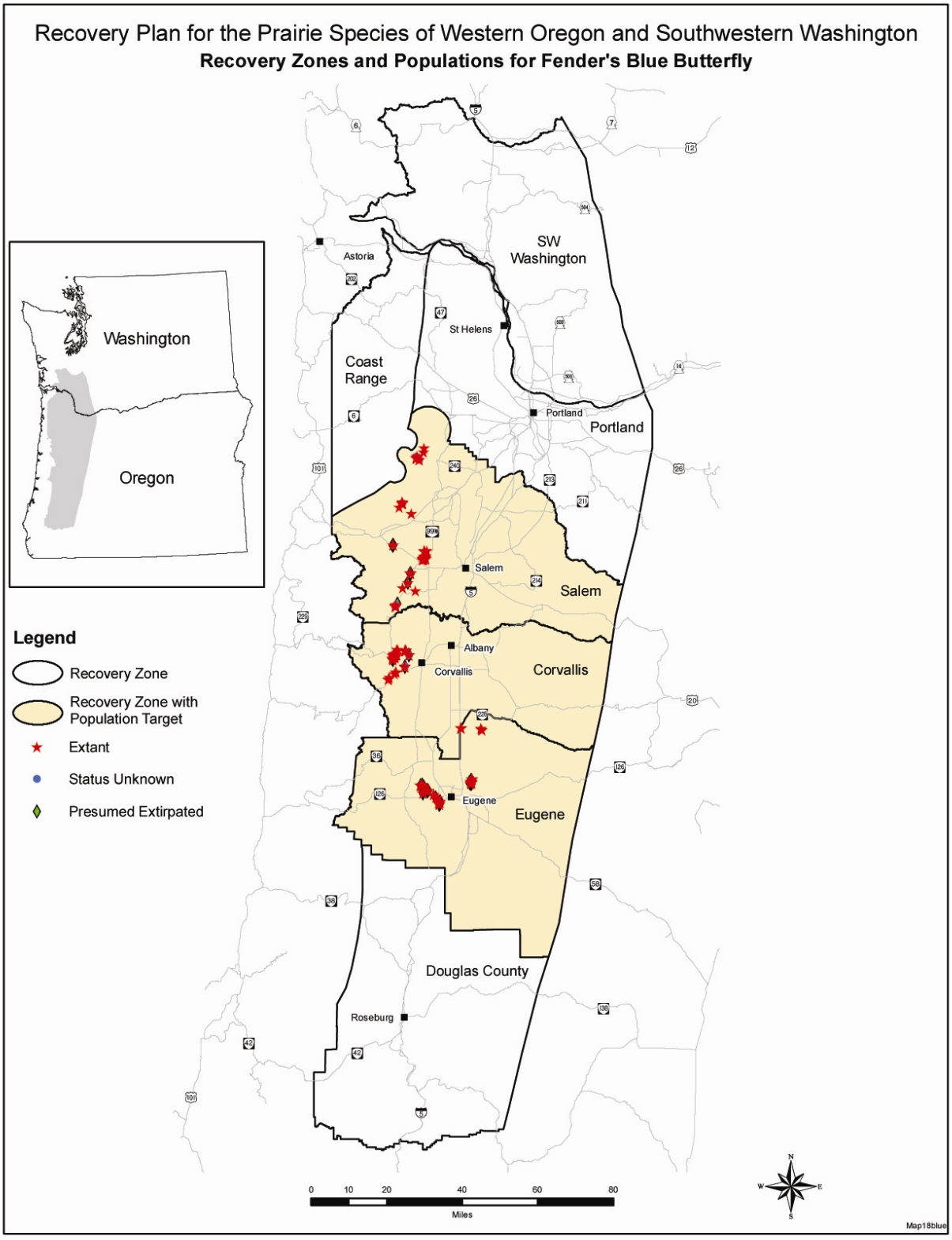

Figure IV-2. Fender's blue butterfly recovery zones.

To downlist Fender's blue butterfly to threatened, we set an extinction risk threshold of 90 percent probability of persistence for 25 years; we believe this is consistent with the standard for classifying a species as threatened ("…likely to become endangered within the foreseeable future throughout all or a significant portion of its range," Endangered Species Act, Section 3). To achieve this standard, each recovery zone must have two functioning networks or one functioning network and two independent populations. One functioning network in each recovery zone must meet a minimum population criterion (a count of 200 adult butterflies) each year for at least 10 years; the 200 butterflies should be distributed among the subpopulation sites in the network. Two functioning networks or one functioning network and two independent populations in each zone must be protected and managed for high quality prairie habitat; see section B below for specific criteria and Figure IV-3 for a schematic illustration of this concept.

To delist Fender's blue butterfly, we set an extinction risk threshold of 95 percent probability of persistence for 100 years; we believe this is consistent with the standard for recovery (*i.e.,* to reduce the degree of risk to the species to the point that it is no longer in danger of extinction, or likely to become so, throughout all or a significant portion of its range, and it is likely to remain at this low degree of risk into the foreseeable future). This standard may be achieved with a variety of combinations of networks and independent populations in each recovery zone. The conservation opportunities differ in each of the three recovery zones for the Fender's blue butterfly, thus rather than establish a one-size-fits-all standard, we modeled several combinations of networks and independent populations; this allows the recovery program to assess conservation opportunities as they become available. Each recovery zone will likely have a unique combination of networks and independent populations (see Figure IV-4 for potential functioning networks and independent populations in each zone). A substantial portion of each functioning network and independent population must be protected and managed for high quality prairie habitat; see section B below for specific criteria.

As described in the paragraphs above, we set downlisting and delisting criteria in terms of extinction risk thresholds of 90 and 95 percent probability of persistence, respectively. The Endangered Species Act does not specify, nor has the Service established, standard extinction risk thresholds for recovery. In the case of the Fender's blue butterfly, the Recovery Team determined, based on recent viability analysis modeling of the best available data, that these population goals were appropriate to meet the standards for downlisting to threatened or delisting (*i.e.*, removal from the Federal List of Endangered and Threatened Wildlife and Plants). We do not mean to imply that these extinction risk thresholds should be applied to other species unless a similar rigorous analysis of the data is conducted.

Illustration of population size and connectivity targets for downlisting Fender's blue butterfly to threatened status. Each recovery zone has a target of 2 networks or 1 network and 2 independent populations. A functioning network must be composed of 3 or more subpopulations, each at least the minimum patch size (currently defined as 6 ha [15 acres]) and separated by no more than the maximum separation distance (currently defined as approximately 2 km [1.2 miles]) from the next nearest subpopulation or connected by stepping stone patches of lupine less than 1 km (0.6 mile) apart. Independent populations must be at least 6 ha (15 acres). One network must have a minimum count of 200 adult butterflies for 10 consecutive years. In the second network or 2 independent populations, there must be a population of butterflies present for 10 consecutive years, but there is no minimum population criterion. All population sites must be protected and managed for high quality prairie habitat.

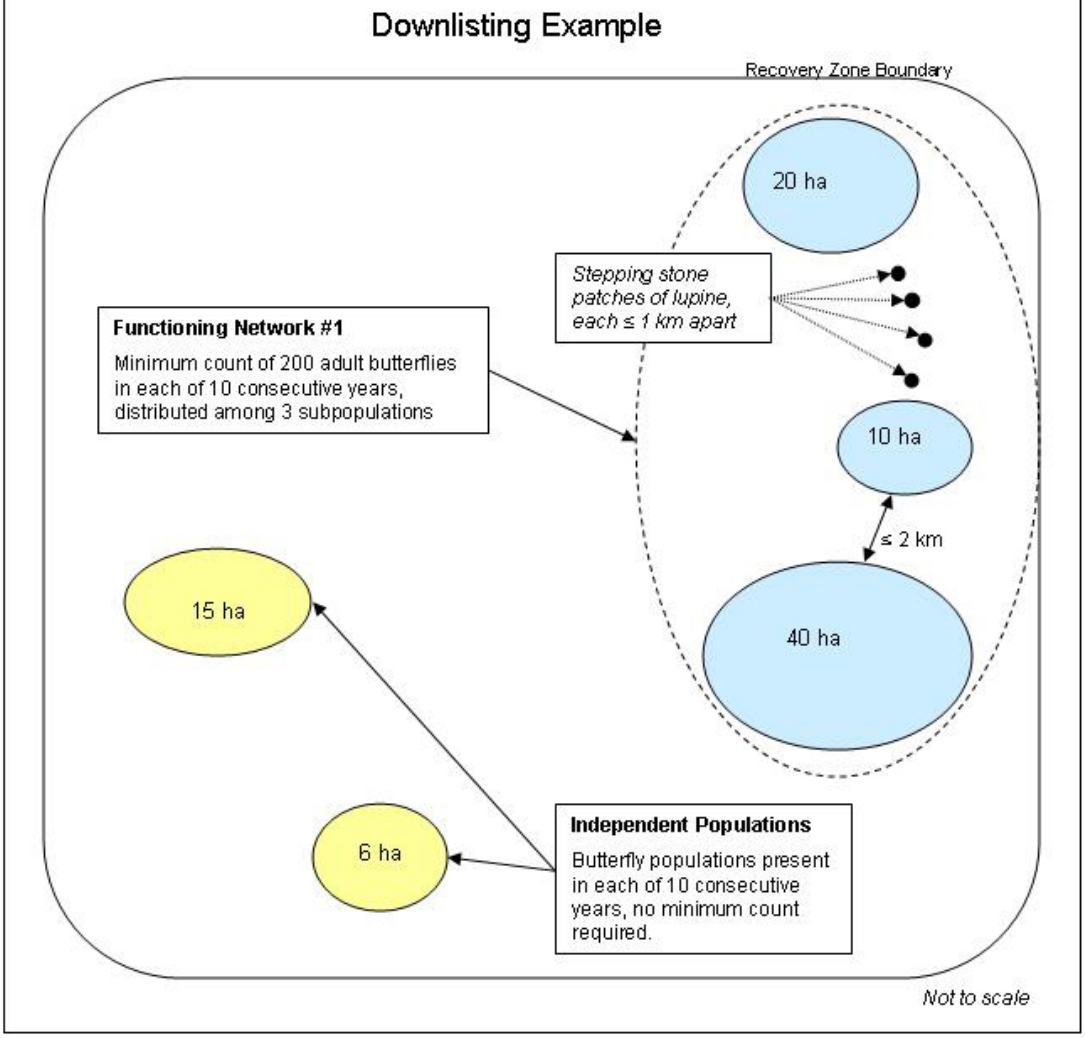

Figure IV-3. Illustration of downlisting goals for Fender's blue butterfly.

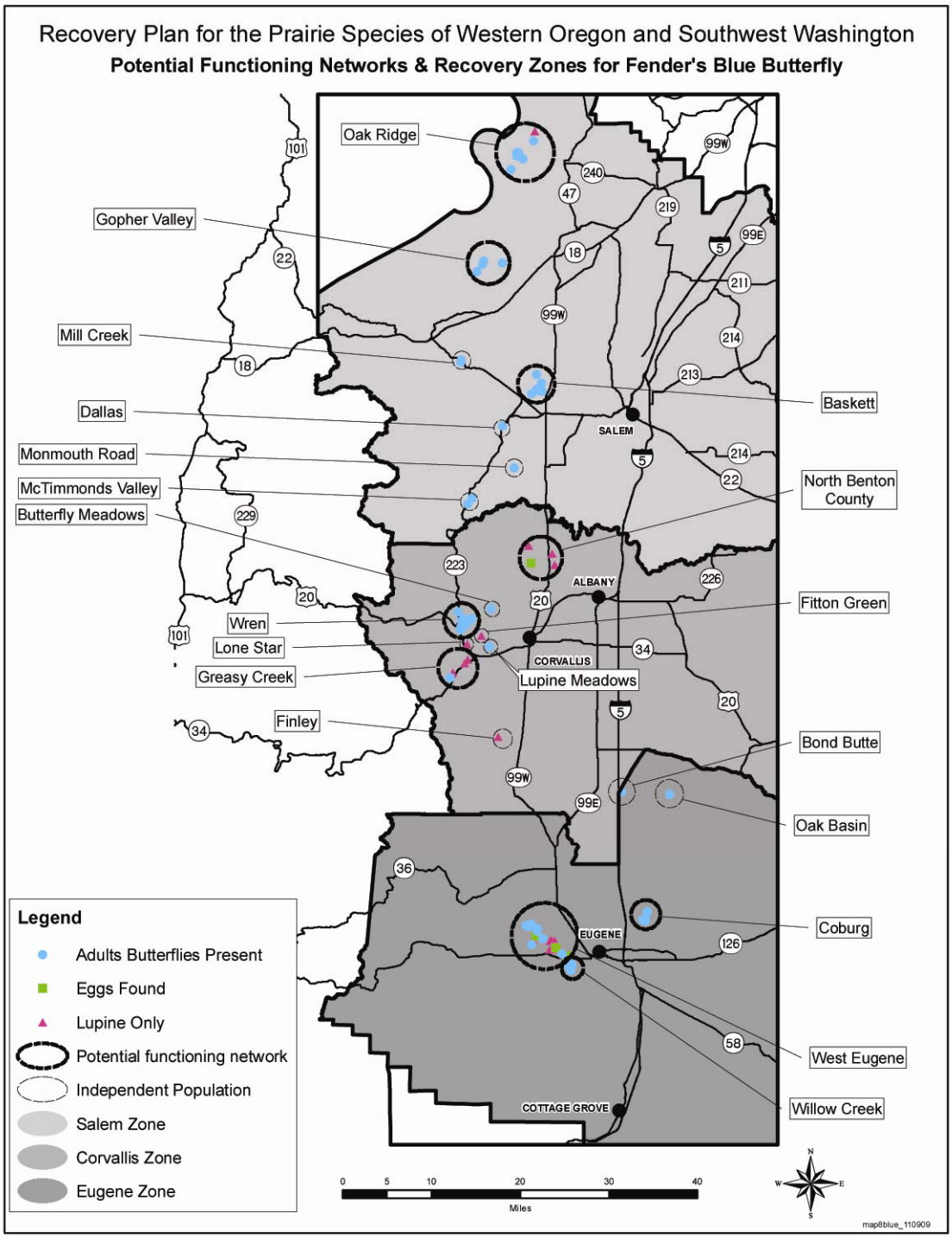

Figure IV-4. Potential functioning networks for Fender's blue butterfly.

The Recovery Team has identified potential functioning networks and independent populations of the Fender's blue butterfly (Table IV-1, Figure IV-4); these areas are those that we currently understand to have the greatest potential for supporting viable populations of Fender's blue butterfly. Nine of the potential functioning networks build on designated critical habitat units for Fender's blue butterfly; these units were identified as "the largest, best quality sites that significantly contribute to both local metapopulation function and rangewide distribution" (U.S. Fish and Wildlife Service 2006a). Thus, critical habitat units are a logical starting point for development of functioning networks for Fender's blue butterfly recovery. Several of the potential sites do not currently support populations of Fender's blue butterfly, and would require reintroduction. It is important to note that there may be additional, currently unidentified sites that could also contribute to recovery by supporting a functioning network of Fender's blue butterflies. Recovery will not necessarily be limited to the establishment of functioning networks at the specific sites named in this recovery plan.

Table IV-1. Potential Functioning Networks and Independent Populations for Fender's blue butterfly recovery.				
Recovery Zone	**Population** FN = Functioning Network IP = Independent Population	**Constituent Sites**	**Protection Status** 0 = None 1 = Safe Harbor Agreement 2 = Public ownership 3 = Conservation easement	**Notes** (habitat information, ownership[1] and alternate site names)
Salem	Oak Ridge (FN)	Areas 1-4	1	Private & County; Hammond Areas 1-5
		Hacker Road	2	County
		Area 5	1	Lupine only; Private, enrolled in SHA
		Old Moores Valley Road	2	County
	Gopher Valley (FN)	Yamhill Oaks Preserve	3	TNC & County roadside
		Area 1	0	Private & County; Hammond Area 1
		Deer Creek Park	2	County
		Muddy Valley	1	Not currently occupied Private
	Baskett (FN)	On Refuge Areas 1-10	2	USFWS; Hammond Areas 1-10
		Baskett Butte East 1	3	Private
		Baskett Butte East 2	3	Private
		Baskett Butte North	1	Private
	Monmouth Road (IP)	Monmouth Road	2	Surrounding area not surveyed; Private & ODOT roadside patch
	McTimmonds Valley (IP)	McTimmonds Valley	2	Surrounding area not surveyed; Private & ODOT roadside patch
	Dallas (IP)	Areas 1-4	1 (partial coverage)	Private; Hammond Areas 1-4
	Mill Creek (IP)	Area 1	2	Surrounding area not surveyed; ODOT
		Area 2	0	Private; Hammond Areas 1-2
Corvallis	Wren (FN)	Sites 1-10	1 & 3 on various areas	Private; Hammond areas 1-7, Isaacs Area 8, Howell Area 9, Elks Rifle Range Area 10
		Powerline	2	BPA
	Fitton Green (IP or FN)	Fitton Green	2	Lupine introduced; County
	Lone Star (IP or FN)	Lone Star	3	No lupine currently, but site is managed for FBB; Greenbelt Land Trust

Table IV-1. Potential Functioning Networks and Independent Populations for Fender's blue butterfly recovery.				
Recovery Zone	**Population** FN = Functioning Network IP = Independent Population	**Constituent Sites**	**Protection Status** 0 = None 1 = Safe Harbor Agreement 2 = Public ownership 3 = Conservation easement	**Notes** (habitat information, ownership[1] and alternate site names)
	Lupine Meadows (IP)	Lupine Meadows	3	Greenbelt Land Trust
	Butterfly Meadows (IP or FN)	Areas 1 - 11	2 on small piece & 0	OSU & Private
	Greasy Creek (FN)	Henkle Way Area 1	0 & 2	Private & County
		Hwy 34	2	Fender's found in 2009; ODOT
		Area 2	0	Fender's found in 2009; Private
		Area 3	0	Fender's found in 2009; Private
	North Benton County (IP or FN)	E.E. Wilson	2	Lupine only, no Fender's; ODFW
		Camp Adair	2	Lupine only, no Fender's; National Guard
		Soap Creek Ranch	2	Fender's eggs found in 2007 and 2009; OSU
	Finley (IP)	William L. Finley National Wildlife Refuge	2	Lupine only, no Fender's; USFWS
Eugene	Oak Basin (IP)	Main	2	BLM
		RFI 10 N	2	BLM
		RFI 10 S	2	BLM
		Area 4	1	Private
	Coburg (FN)	North Ridge	0	Private
		Saddle	3 on approx. 3/4 & 0 on ¼	TNC & Private
		West Slope	3	TNC
		South Slope	3	TNC
	Bond Butte (IP)	Bond Butte	2	ODOT
		Bond Butte	0	Private
	Willow Creek (FN)	Fir Grove (previously Burn Area)	3	TNC
		Willow Creek Bailey Hill	3	TNC
		Willow Creek Main	3	TNC
		Willow Creek North Area	3	TNC
	West Eugene (FN)	Big Spires	2	ACOE
		Eaton Lane (N & S)	2	ACOE
		Fir Butte	2	BLM
		N. Fisher Butte	2	ACOE
		N. Green Oaks	2	ACOE
		S. Green Oaks	2	ACOE
		Oxbow West	2	BLM

Table IV-1. Potential Functioning Networks and Independent Populations for Fender's blue butterfly recovery.				
Recovery Zone	**Population** FN = Functioning Network IP = Independent Population	**Constituent Sites**	**Protection Status** 0 = None 1 = Safe Harbor Agreement 2 = Public ownership 3 = Conservation easement	**Notes** (habitat information, ownership[1] and alternate site names)
		Horkelia Prairie	2	Eggs first documented in 2004; larvae documented in 2009; ACOE
		Shore Lane	2	ACOE
		Spires Lane E & W	2	ACOE
		Isabelle	2	Eggs only; Eugene
		West Lawn Cemetery	0	Lupine only, no Fender's; Private
		Turtle swale	2	Eggs only in 2004; BLM
		Dragonfly Bend	2	Lupine only, no Fender's; Eugene
		Briggs Site easement	3	Planted lupine in 2007 & 2008; no Fender's; BLM
		Hillaire Rd.	0	Lupine only, no Fender's; Private
		Schultz Experiment site 2	2	Lupine only, no Fender's; BLM
		Royal Amazon	2	Lupine only; these sites could connect one large network in Eugene zone; ACOE
		N. Greenhill	2	Lupine only, no Fender's: BLM

[1] Abbreviations:
ACOE = Army Corps of Engineers
BLM = Bureau of Land Management
BPA = Bonneville Power Administration
ODFW = Oregon Department of Fish and Wildlife
ODOT = Oregon Dept. of Transportation
OSU = Oregon State University
TNC = The Nature Conservancy
USFWS = U.S. Fish and Wildlife Service

3. Prairie Plants

(a) *Erigeron decumbens* var. *decumbens*, *Lomatium bradshawii*, *Lupinus sulphureus* ssp. *kincaidii* and *Sidalcea nelsoniana*

In this section, we describe the foundation for determining target abundance goals and distribution across recovery zones for recovery of *Erigeron decumbens* var. *decumbens*, *Lomatium bradshawii*, *Lupinus sulphureus* ssp. *kincaidii* and *Sidalcea nelsoniana.* The Recovery Team developed a basic model to determine how many populations of each species

should be required for delisting. One premise of this exercise was that for recovery to occur, a sufficient number of healthy populations should be present to ensure a very high likelihood that a species will survive for at least 100 years. The model examined species extinction risk as a function of the number of populations and the risk of individual population extinction. The Recovery Team agreed that the risk of species extinction over a century should be no greater than 0.1 percent. The team also felt that for most individual populations, a 100-year extinction probability of 60 percent was a conservative estimate. With these values, the model predicted that at least 14 populations would be sufficient for species maintenance (Figure IV-5). The model assumed that extinction risk is not correlated among populations; that is, population declines across the range of a species are independent. This assumption may not be valid for regional non-population-specific threats, such as climate change or vole outbreaks, but the Recovery Team agreed that the model provided a useful conceptual tool for gauging the relative importance of population number and local extinction risk on species recovery. If significant autocorrelation among populations were to occur, the number of populations necessary to stave off extinction would need to be higher. Also, if the actual risk of individual population extinction was lower than 60 percent, which would result from habitat management and protection activities, the number of populations could be lower.

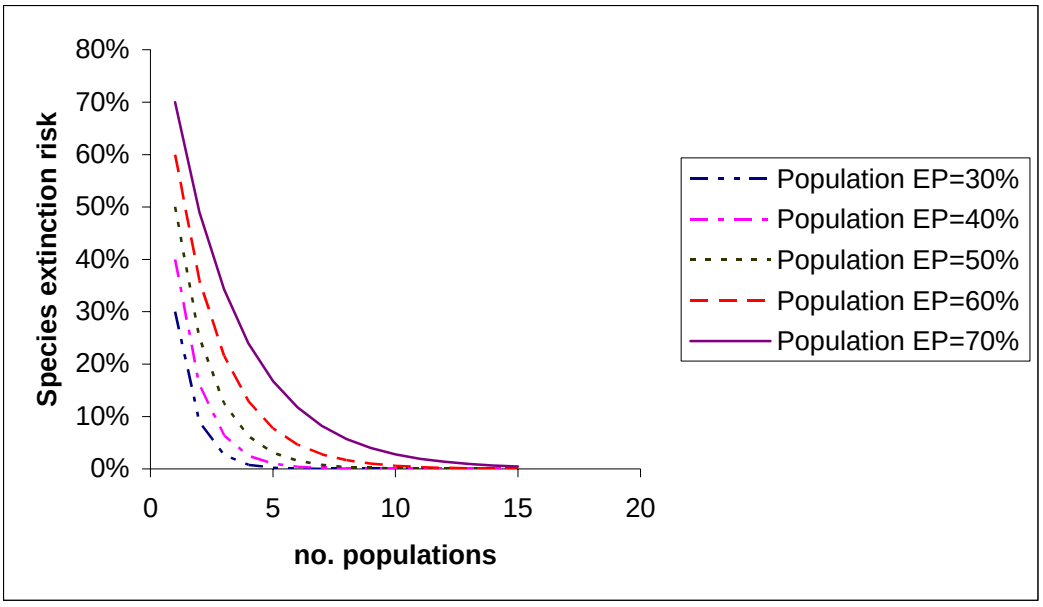

Figure IV-5. Effect of population number on species extinction risk, given levels of extinction probability (EP) of individual populations ranging from 30 percent to 70 percent.

The Recovery Team elected to build in additional redundancy and set a target of 20 populations spread across a species' range as the goal for recovery. There should be at least 2 populations in each recovery zone for which historical data indicate that the species occurred, although there may be a few exceptions for zones in which limited conservation opportunities exist. These targets will provide a substantial safeguard against extinction for the listed plant species. If new information on individual population extinction risks, differences in risks among populations, and correlations among populations is developed as part of the recovery program, the model results may be updated to refine the recovery guidelines. See Figures IV-6, IV-7, IV-8 and IV-9 and Appendix B, Table B-1 for the current known distribution of plant populations by recovery zone.

Critical habitat has been designated for *Erigeron decumbens* var. *decumbens* and *Lupinus sulphureus* ssp. *kincaidii* (U.S. Fish and Wildlife Service 2006a). Designated critical habitat units for these species were identified as "the largest, best quality sites that significantly contribute to both local metapopulation function and rangewide distribution" (U.S. Fish and Wildlife Service 2006a). Thus, in recovery zones with designated critical habitat, critical habitat units are a logical core for recovery populations of *Erigeron decumbens* var. *decumbens* and *Lupinus sulphureus* ssp. *kincaidii*.

The Recovery Team's analysis did not establish the minimum size of populations needed to confer a low risk of population extinction. However, by reviewing their collective professional experience, the Recovery Team concluded that each occupied recovery zone should have a goal of at least 10,000 plants subdivided into at least two populations. The target may be achieved with a combination of at least two populations which must number at least 2,000 individuals; scattered independent populations must number at least 200 individuals. Some recovery zones have larger target numbers, based on historical abundance data. In recovery zones with a target of 10,000 plants, there must be at least two separate populations; if the target is 15,000 plants, then there must be at least three separate populations. Populations may be subdivided into subpopulations in a patchy landscape, although there must be the potential for genetic interchange, via pollinator movement, among the component subpopulations. Recent models have shown that as few as one migrant per generation may be sufficient to prevent inbreeding in disjunct subpopulations (Newman and Tallmon 2001, Wang 2004). Connected populations should be within "stepping-stone" distance, which is defined as within pollinator flight distance of another subpopulation. See Figure IV-10 for a schematic illustration of this concept. The maximum separation distance between populations will vary with the plant and the pollinator species. Additional research is needed to identify the main pollinators of each listed plant; until

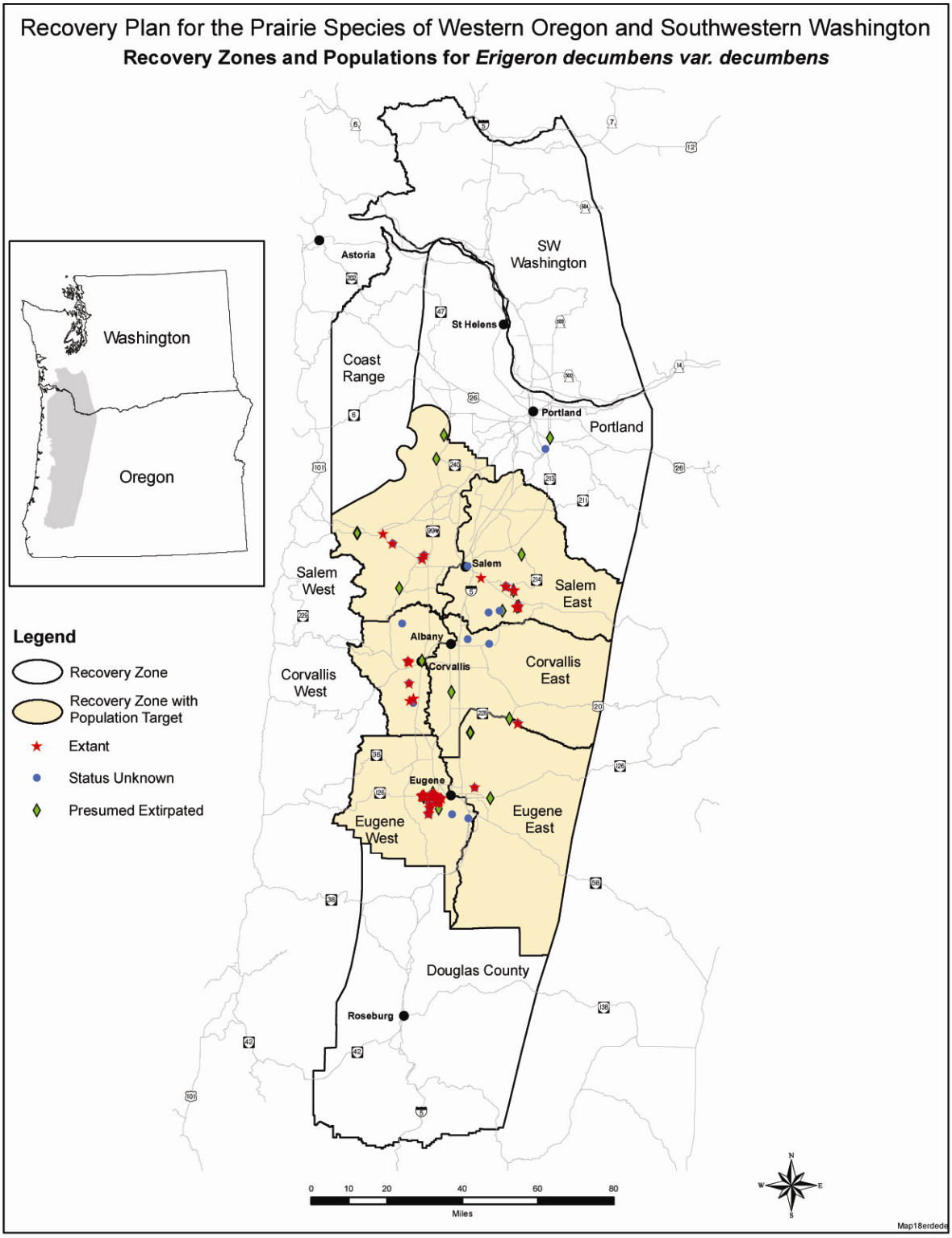

Figure IV-6. *Erigeron decumbens* var. *decumbens* recovery zones.

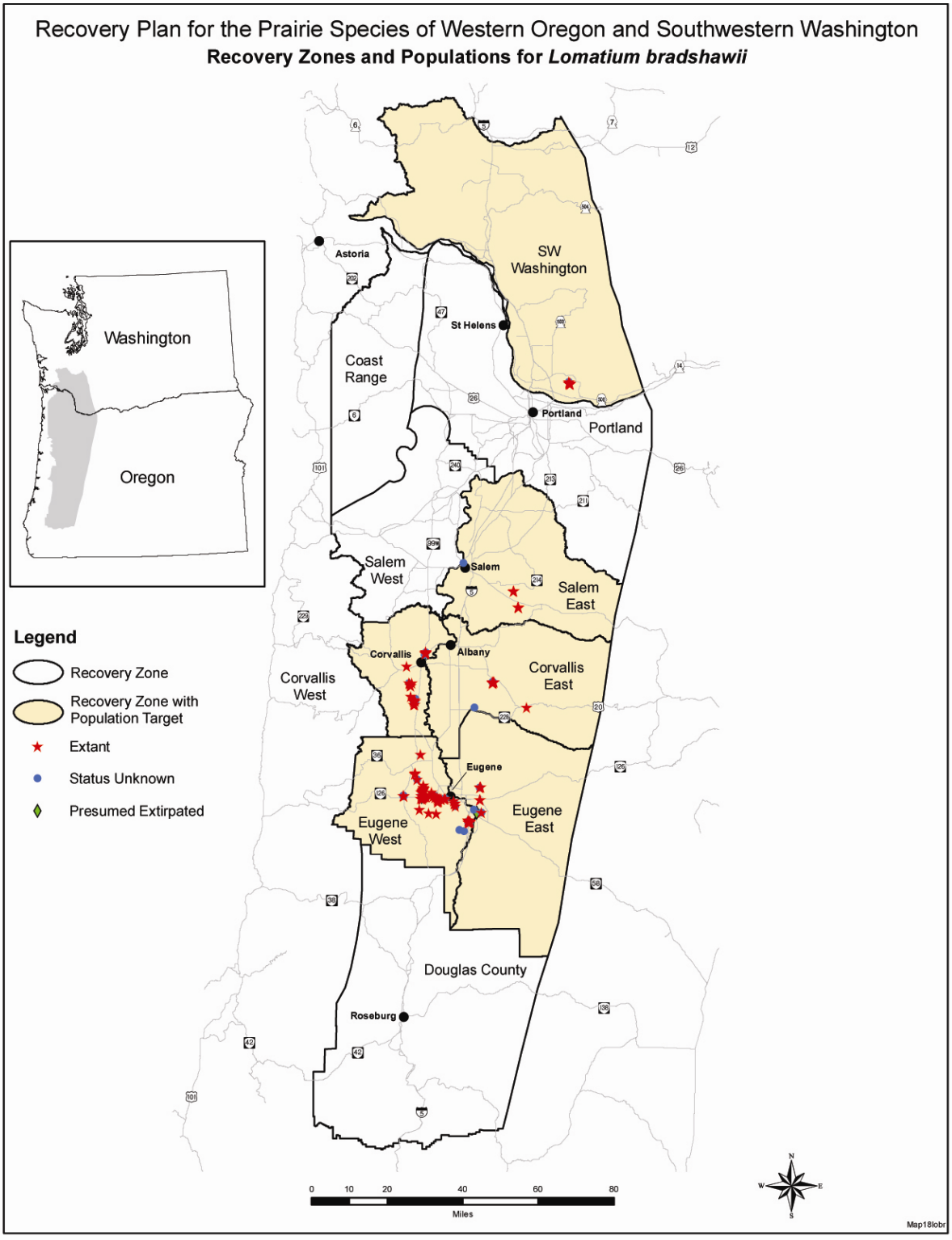

Figure IV-7. *Lomatium bradshawii* recovery zones.

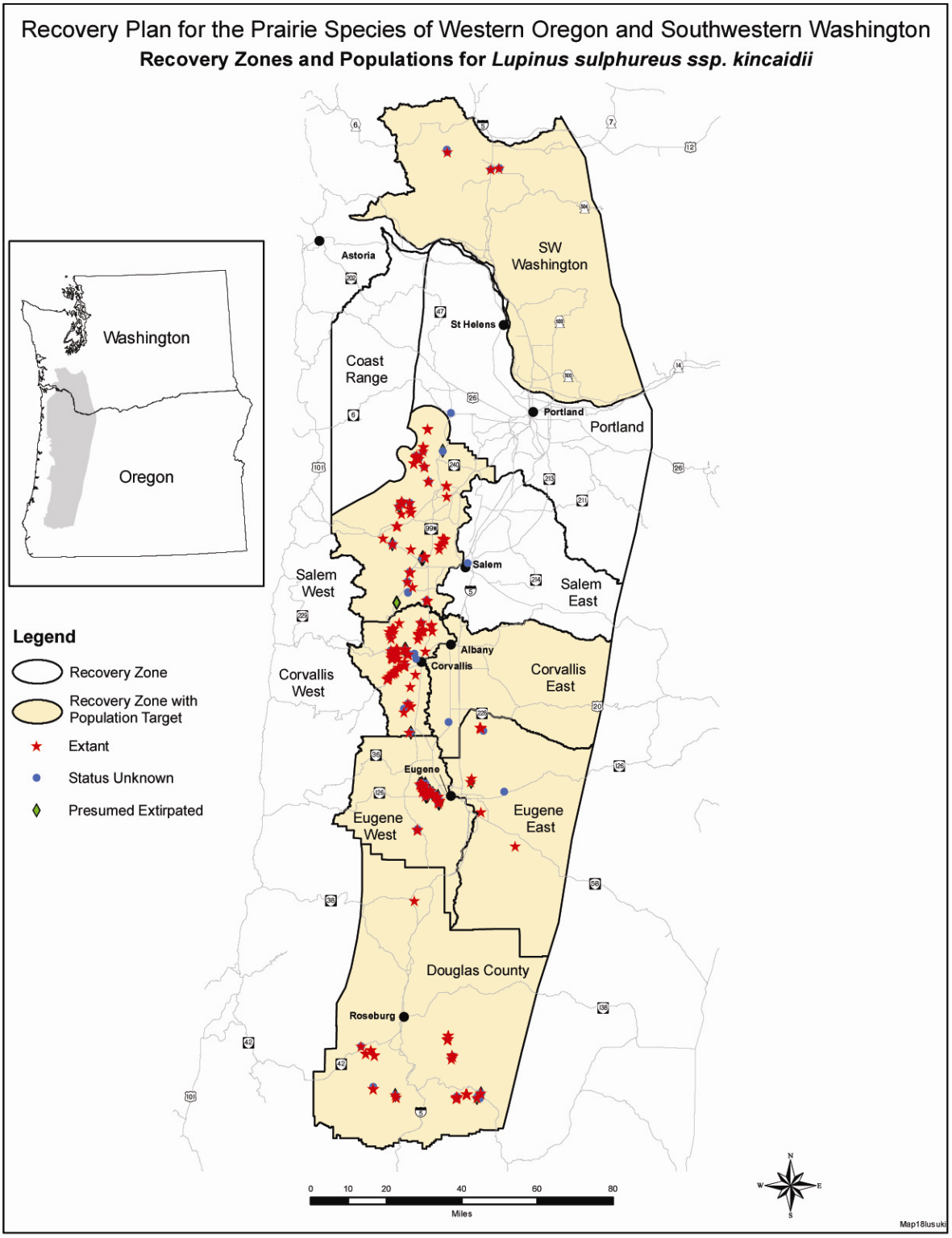

Figure IV-8. *Lupinus sulphureus* ssp. *kincaidii* recovery zones.

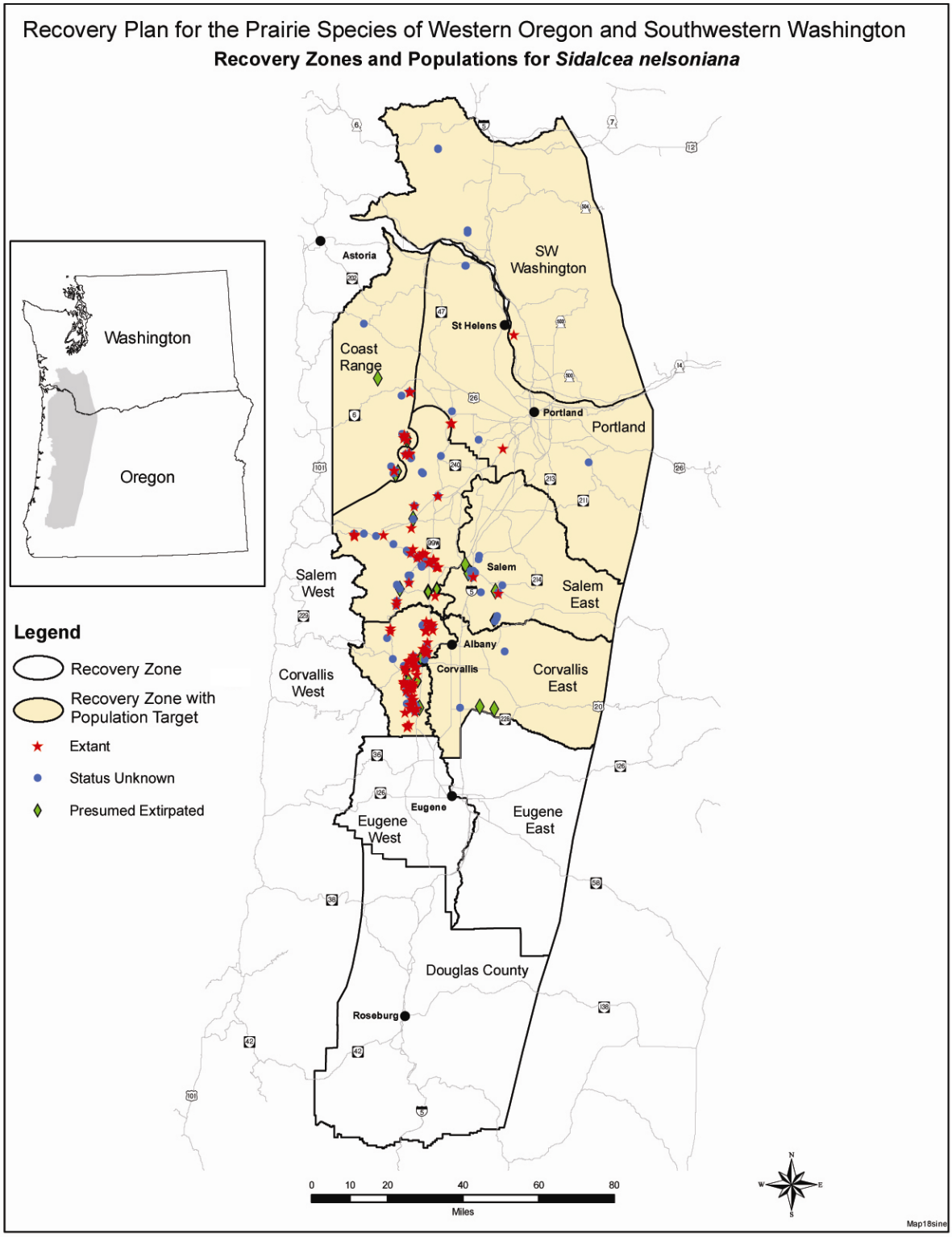

Figure IV-9. *Sidalcea nelsoniana* recovery zones.

Illustration of plant population size and connectivity targets. In a recovery zone with a target of 10,000 plants, the target may be achieved with 2 large populations or a combination of smaller populations, of which 2 populations have at least 2,000 plants, plus other scattered independent populations of at least 200 plants, totaling 10,000 plants in the recovery zone. Populations may be composed of interacting subpopulations of any size, as long as they are within pollinator travel distance of each other.

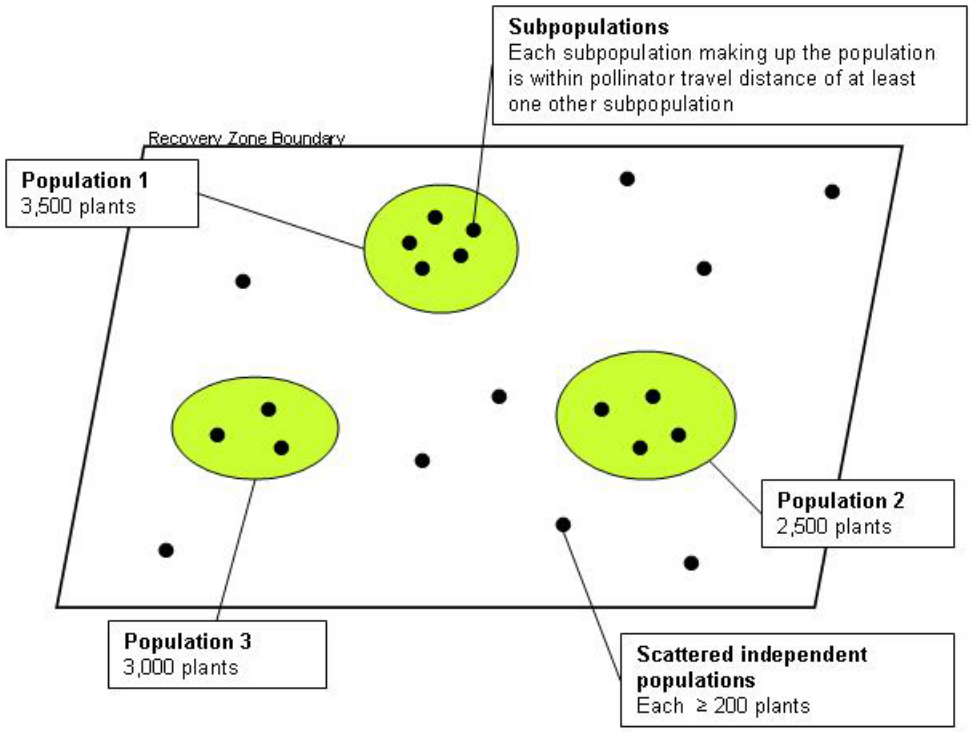

Figure IV-10. Illustration of delisting goals for listed plants.

better information is available, we recommend that subpopulations be separated by no more than 3 kilometers (2 miles) to be considered within stepping-stone distance.

Determining the number of individuals in a population is problematic for two of the listed plant species addressed in this plan. *Lupinus sulphureus* ssp. *kincaidii* and *Sidalcea nelsoniana* exhibit clonal or clumping growth, and it may not be possible to distinguish individual plants. Therefore, population targets for *Lupinus sulphureus* ssp. *kincaidii* are expressed in terms of foliar cover, which is a measure of the area occupied by the plants (Kaye and Thorpe 2006). The degree of clumping in *Sidalcea nelsoniana* differs from site to site. Population targets for *Sidalcea nelsoniana* are expressed as total number of plants, which may be measured in terms of foliar cover where individual plants cannot be distinguished.

The recovery zones shown in Figure IV-1 may also provide useful guidance in decisions to transfer seeds and propagules of plants among sites in the range of this recovery plan. In general, seeds or propagules used to augment or establish a population should be taken from a population within the same recovery zone, unless there is better information to support a different decision. We recommend that managers use plant materials from the closest population with the most similar habitat to the recipient population that has a sufficient population to support seed collection. If none are available, plant material should come from the next nearest zone with similar habitat type. Further genetic research, identified below in the Recovery Actions section, may refine the seed transfer zone concept for each of the listed plant species in this recovery plan.

(b) *Castilleja levisecta*

Our conservation strategy for *Castilleja levisecta* is to provide target population sizes and recovery zones for restoration of the species in the Willamette Valley (see Figure IV-11). This is consistent with the objectives set for the species in its recovery plan (U.S. Fish and Wildlife Service 2000b).

B. RECOVERY GOALS, OBJECTIVES AND CRITERIA

The primary goal of this plan is to remove the threats to the species and achieve recovery sufficient to downlist and eventually delist the endangered Fender's blue butterfly, *Erigeron decumbens* var. *decumbens,* and *Lomatium bradshawii*, and delist the threatened *Lupinus sulphureus* ssp. *kincaidii* and *Sidalcea nelsoniana*. It is also a goal of this plan to contribute to

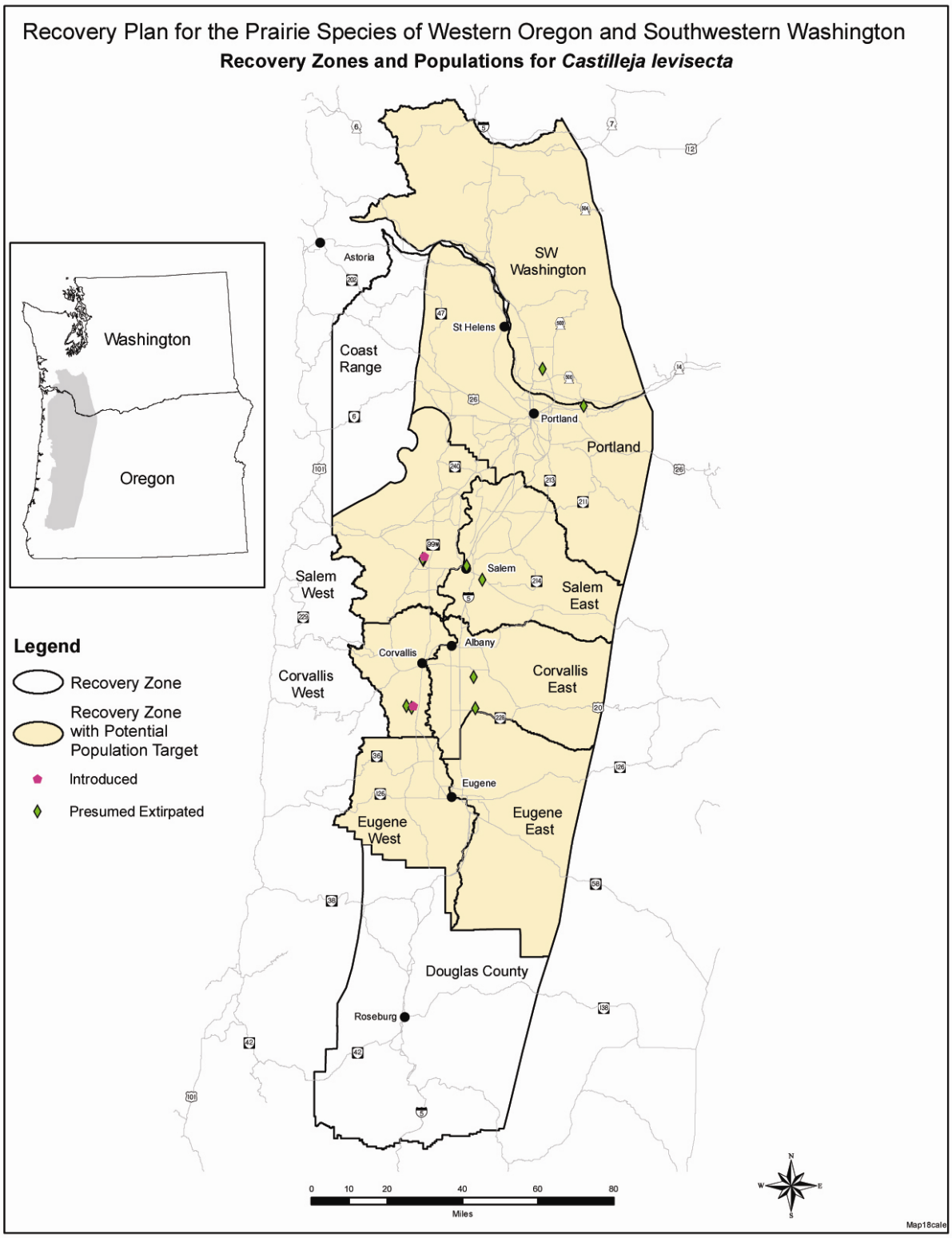

Figure IV-11. *Castilleja levisecta* recovery zones.

the recovery of *Castilleja levisecta*, although this species has its own recovery plan and recovery criteria (U.S. Fish and Wildlife Service 2000b).

An additional goal is to focus on the restoration of both native upland and wet prairie ecosystems within this region. Such an ecosystem approach takes into consideration the needs of nonlisted species that are endemic to prairie habitats. Consequently, many of the recovery actions proposed in this plan may help to stabilize and enhance populations of species such as Taylor's checkerspot butterfly, *Delphinium leucophaeum, Delphinium oreganum, Delphinium pavonaceum, Horkelia congesta* ssp. *congesta, Sericocarpus rigidus* and *Sisyrinchium hitchcockii* and preclude the need to extend the protections of the Endangered Species Act to other of the region's prairie species in the future.

To reach the goal of recovery for the threatened and endangered prairie species, the objectives are to restore and maintain multiple viable populations of each species distributed across its historical range. A key component of this objective is the protection and restoration of functional upland and wet prairie ecosystems to provide high quality, diverse habitats for the prairie species. Sufficient connectivity must be achieved among the constituent subpopulations to ensure adequate gene flow and prevent the problems associated with the isolation of small populations. Current threats to the species must be controlled or eliminated, and populations must be protected and managed appropriately to ensure that the species are no longer in danger of extinction within the foreseeable future nor likely to become so. The recovery criteria presented below represent our best estimate for measuring when these objectives will have been met for each of the species in this plan. Criteria for downlisting and delisting may be revised, as necessary, if additional information provided by the recommended research projects, new modeling and monitoring programs indicates that a change in any of the criteria is appropriate.

We set recovery criteria to serve as objective, measurable guidelines to assist us in determining when a listed species has recovered to the point that the protections afforded by the Endangered Species Act are no longer necessary. However, the actual change in status (downlisting or delisting) requires a separate rulemaking process based upon an analysis of the same five factors considered in the listing of a species (see section III, Threats Assessment). 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 downlisting or delisting of the species is warranted (*i.e.*, that the species no longer meets the definition of threatened or endangered under the Act) as the outcome of a formal analysis in a subsequent regulatory rulemaking. Alternatively, due to unforeseen changes in threats or advances in our knowledge of the species, a future analysis of

the five listing factors may lead to a recommendation to downlist or delist, even though precise compliance with the recovery criteria defined in the recovery plan has not been achieved.

1. Downlisting Criteria

(a) Fender's Blue Butterfly

Reclassification from Endangered to Threatened will be considered for the Fender's blue butterfly when all of the following conditions have been met:

1. Distribution and abundance. Each recovery zone has one functioning network with a minimum count of 200 butterflies, distributed among three subpopulations, for at least 10 years; in addition to this network, there must be a second functioning network or two independent populations with butterflies present each year in each recovery zone (Table IV-2).

2. Habitat quality and management. Sites supporting populations of Fender's blue butterflies considered in Criterion 1(a)1 above must meet these criteria:

a. Prairie quality. Sites supporting populations of Fender's blue butterflies must be managed for high quality prairie habitat. High quality prairie habitat consists of a diversity of native, non-woody plant species, various nectar plants that bloom throughout the flight season of Fender's blue butterfly, low frequency of non-native plant species and encroaching woody species, and essential habitat elements (*e.g.*, nest sites and food plants) for native pollinators. At least one of the larval host plant species, *Lupinus sulphureus* ssp. *kincaidii, L. arbustus* or *L. albicaulis*, must be present. See Appendix D for suggested criteria for evaluating prairie quality and diversity.

b. Security of habitat. A substantial portion of the habitat for each population should either be owned or managed by a government agency or private conservation organization that identifies maintenance of the Fender's blue butterfly and the prairie ecosystem upon which it depends as the primary management objective for the site, or the site must be protected by a permanent or long-term conservation easement or covenant that commits present and future landowners to the conservation of the species.

Table IV-2. Distribution and Abundance Goals for Fender's Blue Butterfly.

DOWNLISTING GOALS

Downlisting goals are set at a 90% probability of persistence for 25 years. Attainment of these population targets in all three recovery zones, together with the criteria for distribution, habitat quality and management described in the text, would indicate that the species' status has improved and could be considered for reclassification to threatened. Note that the minimum population size in the table represents the minimum population count in a network in each of 10 consecutive years. The average population size in a network corresponding to these minima would be substantially larger.

Recovery Zone*	Number of functioning networks (FN) and independent populations (IP) in a recovery zone	Minimum population size in one network/zone over 10 years
Salem (Salem East + Salem West)	2 FN or 1 FN + 2 IP	200
Corvallis (Corvallis East + Corvallis West)	2 FN or 1 FN + 2 IP	200
Eugene (Eugene East + Eugene West).	2 FN or 1 FN + 2 IP	200

DELISTING GOALS

Delisting goals are set at a 95% probability of persistence for 100 years. Each row below represents a combination of functioning networks and independent populations within a recovery zone. If each of the three recovery zones meets the criteria in one row below, the species would be projected to have a 95 percent probability of persistence for 100 years. Attainment of these population targets, together with the criteria for distribution, habitat quality and management described in the text, would indicate that the species has recovered and could be considered for delisting. Note that the minimum population size in the table represents the minimum population count in a network or independent population in each of 10 consecutive years. The average population size in a network or independent population corresponding to these minima would be substantially larger.

Number of functioning networks (FN) and independent populations (IP) in a recovery zone	Minimum population size per network over 10 years	Minimum population size per independent population over 10 years
2 FN + 0 IP	4500	n/a
2 FN + 2 IP	800	3000
2 FN + 2 IP	1000	1000
2 FN + 2 IP	1500	500
2 FN + 3 IP	1000	700
2 FN + 3 IP	1500	300
3 FN + 0 IP	1000	n/a
3 FN + 1 IP	800	200
3 FN + 2 IP	500	250
4 FN + 0 IP	400	n/a

*We have set population targets for Fender's blue butterfly in the following recovery zones: Salem (Salem East + Salem West), Corvallis (Corvallis East + Corvallis West) and Eugene (Eugene East + Eugene West); see Figure IV-2. The other recovery zones shown in Figure IV-1 are not within the historical range of the species.

c. Management, monitoring, and control of threats. Each population site and stepping stone patch must be managed to ensure the maintenance or restoration of high quality prairie habitat to support the Fender's blue butterfly and to control threats. Use of herbicides, mowing, burning or livestock grazing in management should be implemented with appropriate methods and timing to avoid impacts to Fender's blue butterfly or its nectar or host plants. Management should be coordinated with adjacent landowners to minimize effects of pesticide drift, changes in hydrology, timber harvest, or road/utility maintenance. Other potential threats relating to scientific research, overcollection, vandalism, recreational impacts, or natural herbivory/predation/parasitism should be successfully managed so as not to significantly impair recovery of the species.

Each population shall have in place a management and monitoring plan approved by the U.S. Fish and Wildlife Service that includes identification of appropriate management response to any potential declines that may be detected in habitat quality or the Fender's blue butterfly population during the course of monitoring. Management plans should include a focus on protecting habitat heterogeneity within protected sites and across a range of elevations and aspects to buffer the potential effects of climate change.

(b) *Erigeron decumbens* var. *decumbens* and *Lomatium bradshawii*

Reclassification from Endangered to Threatened will be considered for *Erigeron decumbens* var. *decumbens* and *Lomatium bradshawii* when all of the following conditions have been met:

1. Distribution and abundance. For each species, the distribution of populations should reflect the extent of the species' historical geographic distribution to the extent practicable. Subpopulations contributing to larger interacting populations should be within pollinator flight distance (3 kilometers [2 miles]) of each other. See Tables IV-3 and IV-4 for distribution and abundance goals for each species.

2. Population trend and evidence of reproduction. For each species, the number of individuals in the population shall have been stable or increasing over a period of at least 10 years. The term "stable" in this context does not mean that the population size is static over time; over a period of 10 years, the number of individuals in the population may exhibit

Table IV-3. Distribution and Abundance Goals for *Erigeron decumbens* var. *decumbens*				
Status: Endangered				
Recovery Zone	**Downlisting Goals**		**Delisting Goals**	
	Minimum # of Populations / Zone	**Target # of Plants / Zone**	**Minimum # of Populations / Zone**	**Target # of Plants / Zone**
SW Washington	0	0	0	0
Portland	0	0	0	0
Coast Range	*	*	*	*
Salem East	1	5,000	3	15,000
Salem West	2	10,000	3	15.000
Corvallis East	1	5,000	2	10,000
Corvallis West	2	10,000	2	10,000
Eugene East	1	5,000	2	10,000
Eugene West	3	15,000	3	15,000
Douglas County	*	*	*	*
+ additional populations (may occur in any zone within species' range)	2	10,000	5	25,000
Total	12	60,000	20	100,000
* This recovery zone is not within the historical range of the species.				

Table IV-4. Distribution and Abundance Goals for *Lomatium bradshawii*				
Status: Endangered				
Recovery Zone	**Downlisting Goals**		**Delisting Goals**	
	Minimum # of Populations / Zone	**Target # of Plants / Zone**	**Minimum # of Populations / Zone**	**Target # of Plants / Zone**
SW Washington	1	5,000	2	10,000
Portland	0	0	0	0
Coast Range	*	*	*	*
Salem East	1	5,000	2	10,000
Salem West	0	0	0	0
Corvallis East	2	10,000	3	15,000
Corvallis West	2	10,000	2	10,000
Eugene East	1	5,000	3	15,000
Eugene West	3	15,000	3	15,000
Douglas County	*	*	*	*
+ additional populations (may occur in any zone within species' range)	2	10,000	5	25,000
Total	12	60,000	20	100,000
* This recovery zone is not within the historical range of the species.				

natural year-to-year variability, but the trend must not be declining. Populations must show evidence of reproduction by seed set or presence of seedlings.

3. Habitat quality and management. Sites supporting populations of listed plants considered in Criterion 1(b)1 above must meet these criteria:

a. Prairie quality. Sites supporting populations of the listed plant species must be managed for high quality prairie habitat. High quality prairie habitat consists of a diversity of native, non-woody plant species, low frequency of aggressive non-native plant species and encroaching woody species, and essential habitat elements (*e.g.*, nest sites and food plants) for native pollinators. See Appendix D for suggested criteria for evaluating prairie quality and diversity.

b. Security of habitat. For each listed species, a substantial portion of the habitat for the populations should either be owned or managed by a government agency or private conservation organization that identifies maintenance of the species and the prairie ecosystem upon which it depends as the primary management objective for the site, or the site must be protected by a permanent or long-term conservation easement or covenant that commits present and future landowners to the conservation of the species.

c. Management, monitoring, and control of threats. Each population must be managed appropriately to ensure the maintenance or restoration of quality prairie habitat for each species and to control threats to the species. Use of herbicides, mowing, burning or livestock grazing in management should be implemented with appropriate methods and timing to avoid impacts to listed plant species. Management should be coordinated with adjacent landowners to minimize effects of pesticide drift, changes in hydrology, timber harvest, or road/utility maintenance. Species that may hybridize with *Sidalcea nelsoniana* or *Lupinus sulphureus* ssp. *kincaidii* should be managed as appropriate to avoid contact with these taxa. Other potential threats relating to scientific research, overcollection, vandalism, recreational impacts, or natural herbivory/parasitism should be successfully managed so as not to significantly impair recovery of the species.

Management and monitoring plans must be approved by the U.S. Fish and Wildlife Service, and should include standardized monitoring and performance criteria by which

to assess their effectiveness following implementation and to allow for adaptive management, as necessary. Management plans should include a focus on protecting habitat heterogeneity within protected sites and across a range of elevations and aspects to buffer the potential effects of climate change.

2. Delisting Criteria

(a) Fender's Blue Butterfly

Delisting will be considered for the Fender's blue butterfly when all of the following conditions have been met:

1. Distribution and abundance. Each of the three recovery zones has a combination of functioning networks and independent populations such that the probability of persistence is 95 percent over the next 100 years; see Table IV-2 for options that would achieve this standard. Annual population surveys in each functioning network and independent population must count at least the minimum number of adult butterflies specified in Table IV-2 for 10 consecutive years.

2. Habitat quality and management. Sites supporting populations of Fender's blue butterflies considered in Criterion 2(a)1 above must meet these criteria:

a. Prairie quality. Same as Downlisting Criterion 1(a)(2)(a)

b. Security of habitat. Same as Downlisting Criterion 1(a)(2)(b)

c. Management, monitoring, and control of threats. Same as Downlisting Criterion 1(a)(2)(c)

3. Post-delisting monitoring plan and agreements to continue post-delisting monitoring are in place and ready for implementation at the time of delisting. Monitoring of populations following delisting will verify the ongoing recovery of the species, provide a basis for determining whether the species should be again placed under the protection of the Endangered Species Act, and provide a means of assessing the continuing effectiveness of management actions.

(b) *Erigeron decumbens* var. *decumbens*, *Lomatium bradshawii*, *Lupinus sulphureus* ssp. *kincaidii* and *Sidalcea nelsoniana*

Delisting will be considered for four prairie plant species (*Erigeron decumbens* var. *decumbens*, *Lomatium bradshawii*, *Lupinus sulphureus* ssp. *kincaidii*, and *Sidalcea nelsoniana*) when all of the following conditions have been met:

1. Distribution and abundance. For each species, the distribution of populations should reflect the extent of the species' historical geographic distribution to the extent practicable. See Tables IV-3, IV-4, IV-5 and IV-6 for distribution and abundance goals for each species.

2. Population trend and evidence of reproduction. For each species, the number of individuals in the population (or area of foliar cover for *Lupinus sulphureus* ssp. *kincaidii* or *Sidalcea nelsoniana*) shall have been stable or increasing over a period of at least 15 years. Stable does not mean that the population size is static over time; over a period of 15 years, the number of individuals in the population may exhibit natural year-to-year variability, but the trend must not be declining. Populations must show evidence of reproduction by seed set or presence of seedlings.

3. Habitat quality and management. Sites supporting populations of listed plants considered in Criterion 2(b)(i)1 above must meet these criteria:

- **a. Prairie quality**. Same as Downlisting Criterion 1(b)(3)(a)

- **b. Security of habitat.** Same as Downlisting Criterion 1(b)(3)(b)

- **c. Management, monitoring, and control of threats.** Same as Downlisting Criterion 1(b)(3)(c)

4. Genetic material is stored in a facility approved by the Center for Plant Conservation. For each plant species, the stored genetic material in the form of seeds must represent the species' geographic distribution and genetic diversity through collections across the full range of the species. Collections from large populations are particularly important as reservoirs of genetic variability within the species.

Table IV-5. Distribution and Abundance Goals for *Lupinus sulphureus* ssp. *kincaidii*		
Status: Threatened		
Recovery Zone	**Delisting Goals**	
	Minimum # of Populations / Zone	**Target Foliar Cover / Zone**
SW Washington	2	5,000 m^2
Portland	0	0
Coast Range	*	*
Salem East	1	2,500 m^2
Salem West	3	7,500 m^2
Corvallis East	2	5,000 m^2
Corvallis West	3	7,500 m^2
Eugene East	2	5,000 m^2
Eugene West	3	7,500 m^2
Douglas County	2	5,000 m^2
+ additional populations (may occur in any zone within species' range)	2	5,000 m^2
Total	20	50,000 m^2
* This recovery zone is not within the historical range of the species.		

Table IV-6. Distribution and Abundance Goals for *Sidalcea nelsoniana*		
Status: Threatened		
Recovery Zone	**Delisting Goals**	
	Minimum # of Populations / Zone	**Target # of Plants (or Foliar Cover) / Zone**
SW Washington	2	10,000 (5,000 m^2)
Portland	1	5,000 (2,500 m^2)
Coast Range	3	15,000 (7,500 m^2)
Salem East	2	10,000 (5,000 m^2)
Salem West	4	20,000 (10,000 m^2)
Corvallis East	2	10,000 (5,000 m^2)
Corvallis West	4	20,000 (10,000 m^2)
Eugene East	*	*
Eugene West	*	*
Douglas County	*	*
+ additional populations (may occur in any zone within species' range)	2	10,000 (5,000 m^2)
Total	20	100,000 (50,000 m^2)
* This recovery zone is not within the historical range of the species.		

5. Post-delisting monitoring plans and agreements to continue post-delisting monitoring are in place and ready for implementation at the time of delisting. Monitoring of populations following delisting will verify the ongoing recovery of the species, provide a basis for determining whether the species should be again placed under the protection of the Endangered Species Act, and provide a means of assessing the continuing effectiveness of management actions.

(c) *Castilleja levisecta*

Recovery goals for *Castilleja levisecta* were set in the recovery plan for the species (U.S. Fish and Wildlife Service 2000b). Meeting the following conditions in the Willamette Valley will substantially contribute to the species' recovery and may allow the species to be delisted, if recovery goals set in the recovery plan have been met throughout the rest of the species' range:

1. Distribution and abundance. Establish a total of five populations distributed across at least three of the following recovery zones: Southwest Washington, Portland, Salem East, Salem West, Corvallis East, Corvallis West, Eugene East, Eugene West. Priority should be given to reestablishing populations in zones for which there are historical records (Southwest Washington, Portland, Salem East, Corvallis East). See Table IV-7 for distribution and abundance goals for *Castilleja levisecta*.

2. Population trend and evidence of reproduction. Populations must maintain a 5-year running average population size of at least 1,000 individuals. Populations must show evidence of reproduction by seed set or presence of seedlings.

3. Habitat quality and management.

- **a. Prairie quality**. Habitat supporting populations of the species must be managed for high quality prairie values. High quality prairie habitat consists of a diversity of native, non-woody plant species, low frequency of non-native plant species and encroaching woody species, and habitat elements (*e.g.*, nest sites and food plants) for native pollinators. See Appendix D for suggested criteria for evaluating prairie quality and diversity.

Table IV-7. Distribution and Abundance Goals for *Castilleja levisecta*		
Status: Threatened		
Recovery Zone Name	**Conservation Goals in the Willamette Valley**	
	Target # of Populations	**Target # of Flowering Individuals / Population**
SW Washington	A total of 5 populations, distributed across at least 3 of these zones	1,000
Portland		
Salem East		
Salem West		
Corvallis East		
Corvallis West		
Eugene East		
Eugene West		
Coast Range	*	*
Douglas County	*	*
Total	5	5,000
* This recovery zone is not within the historical range of the species.		

b. Security of habitat. A substantial portion of the habitat for the populations should either be owned or managed by a government agency or private conservation organization that identifies maintenance of the species and the prairie ecosystem upon which it depends as the primary management objective for the site, or the site must be protected by a permanent or long-term conservation easement or covenant that commits present and future landowners to the conservation of the species.

c. Management, monitoring, and control of threats. Each population must be managed appropriately to ensure the maintenance or restoration of quality prairie habitat and to control threats to the species. Management and monitoring plans must be approved by the U.S. Fish and Wildlife Service, and should include standardized monitoring and performance criteria by which to assess their effectiveness following implementation and to allow for adaptive management, as necessary. Management plans should include a focus on protecting habitat heterogeneity within protected sites and across a range of elevations and aspects to buffer the potential effects of climate change. Use of herbicides, mowing, burning or livestock grazing in management should be implemented with appropriate methods and timing to avoid impacts to

listed plant species. Management should be coordinated with adjacent landowners to minimize effects of pesticide drift, changes in hydrology, timber harvest, or road/utility maintenance. Other potential threats relating to scientific research, overcollection, vandalism, recreational impacts, or natural herbivory/parasitism should be successfully managed so as not to significantly impair recovery of the species

The recovery criteria above address the threats to the species and the five listing factors previously discussed in section III. Meeting the downlisting or delisting criteria would indicate that the threats to the species that resulted in its listing as threatened or endangered have been ameliorated. The specific threats addressed by each criterion are specified in Tables IV-8 and IV-9.

C. RECOVERY ACTIONS

1. Preserve, restore, and manage populations and habitat for the listed prairie species covered by this plan.

The listed prairie species of western Oregon and southwestern Washington addressed by this plan are now found only in small, highly fragmented upland and wet prairie habitat remnants. The first step in the recovery of these species is to identify and protect the remaining populations with the greatest potential for restoration. The next step is to augment and, if necessary, reintroduce populations to restore connectivity between those that are currently isolated from one another to restore gene flow and create a population structure that provides for resiliency in a dynamic natural environment. Recovery for all of these species will depend upon the successful establishment of a network of protected populations in managed, suitable prairie habitats distributed across their historical range. As a large portion of the remnant prairie habitats within the range of these species is in private ownership, recovery will to a large extent depend upon the successful development of partnerships with private landowners and support of their efforts to protect, restore and manage native prairie habitats in the region.

1.1 Preserve, restore, and manage populations and habitat for Fender's blue butterfly.

1.1.1 Evaluate the status of extant populations.

Fender's blue butterfly is endemic to prairie habitats in the Willamette Valley of Oregon, where it occurs in relatively few, isolated populations. Although several sites have been monitored for

Table IV-8. Crosswalk between downlisting / delisting criteria and threat factors for Fender's blue butterfly. Each of the downlisting and delisting criteria address the threats that face the species; attainment of the downlisting or delisting criteria would indicate that the causative threats have been ameliorated.

Downlisting / Delisting Criteria	**Criterion Addresses These Threats**	
	Threat Factor	**Threat Type** (see section III and Table III-1 for a full description of threats)
Distribution and abundance targets [Criteria 1(a)(1) & 2(a)(1), Table IV-2]	A	Isolation / fragmentation
	E	Small population size / low genetic variability
Prairie quality [Criteria 1(a)(2)(a) & 2(a)(2)(a)]	A	Invasive species
	E	Succession to native woody plants
		Impaired ecological functions
Security of habitat [Criteria 1(a)(2)(b) & 2(a)(2)(b)]	A	Historic management / disturbance
	D	Habitat vandalism
Management, monitoring and control of threats [Criteria 1(a)(2)(c) & 2(a)(2)(c)]	A	On-site agriculture conversion and management practices
		Adjacent land use practices
		Housing / urban development
		Hydrologic alterations
		Improper prairie management
		Invasive species
		Road development / maintenance
		Utilities installation and maintenance
		Timber harvest / silviculture / logging
		Wildfire / burning
	B	Field research activities
		Recreation
		Over-collecting / poaching
	C	Herbivores / predators
		Livestock grazing
		Parasites
	D	Habitat vandalism
	E	Succession to native woody plants
		Impaired ecological functions
		Pesticide use on-site

Table IV-9. Crosswalk between downlisting / delisting criteria and threat factors for *Erigeron decumbens* var. *decumbens, Lomatium bradshawii, Lupinus sulphureus* ssp. *kincaidii, Sidalcea nelsoniana* and *Castilleja levisecta*. Each of the downlisting and delisting criteria address the threats that face the species; attainment of the downlisting or delisting criteria would indicate that the causative threats have been ameliorated.

Downlisting / Delisting Criteria	Criterion Addresses These Threats	
	Threat Factor	**Threat Type** (see section III and Table III-1 for a full description of threats)
Distribution and abundance targets [Criteria 1(b)(1) & 2(b)(1), Tables IV-3 to IV-7]	A	Isolation / fragmentation
	E	Small population size / low genetic variability
Population trend and evidence of reproduction [Criteria 1(b)(2) & 2(b)(2)]	E	Small population size / low genetic variability
		Impaired ecological functions
Prairie quality [Criteria 1(b)(3)(a) & 2(b)(3)(a)]	A	Invasive species
	E	Succession to native woody plants
		Impaired ecological functions
Security of habitat [Criteria 1(b)(3)(b) & 2(b)(3)(b)]	A	Historic management / disturbance
	D	Habitat vandalism
Management, monitoring and control of threats [Criteria 1(b)(3)(c) & 2(b)(3)(c)]	A	On-site agriculture conversion and management practices
		Adjacent land use practices
		Housing / urban development
		Hydrologic alterations
		Improper prairie management
		Invasive species
		Road development / maintenance
		Utilities installation and maintenance
		Timber harvest / silviculture / logging
		Wildfire / burning
	B	Field research activities
		Recreation
		Over-collecting / poaching
	C	Herbivores / predators
		Livestock grazing
		Parasites
	D	Habitat vandalism
	E	Succession to native woody plants
		Impaired ecological functions
		Pesticide use on-site
		Hybridization
Genetic material is stored in a facility approved by the Center for Plant Conservation [Criteria 2(b)(4)]	E	Small population size / low genetic variability

over 10 years, we lack information on the status of many populations that occur on private lands, where permission for access to the property has not been granted to surveyors. An assessment of population status is required to provide the current population baseline information and to determine when the populations have achieved the targets set in the recovery criteria, thereby allowing for consideration of downlisting or delisting. This information is also necessary to evaluate the efficacy of management programs and allow for adaptive management, as necessary, of individual populations to guide the species toward its recovery goals.

1.1.1.1 Develop a standardized population monitoring protocol.

Several different monitoring protocols have been used to assess Fender's blue butterfly populations (Fitzpatrick 2009). The development and implementation of one standardized monitoring protocol across the range of the butterfly would allow for greater accuracy in tracking population trends over time and allow for direct comparisons among populations. The monitoring method should provide sufficient statistical precision, but not be unduly time intensive or costly to implement, especially for larger populations. Methods should also be designed to achieve a desired level of statistical precision around population estimates or estimates of population change. The monitoring protocol should also avoid or minimize harm to the species (*e.g.*, through larval mortality, capture of adults or trampling of the habitat). In developing a new monitoring protocol, consider evaluating metrics other than adult counts (*i.e.*, larvae or egg counts).

1.1.1.2 Survey existing populations and surrounding suitable habitats to determine geographic extent of populations.

At known population sites, survey existing populations and work with adjacent landowners to evaluate the geographic extent of those populations.

1.1.1.3 Attempt to locate additional populations of Fender's blue butterfly by surveying suitable habitats in areas not currently known to support populations.

Through partnerships with private landowners, we have recently identified several new population sites. There are still several areas within the range of the species in which we should focus on finding populations using presence/absence surveys. Three of the most important areas are: Mill Creek in Polk County, Greasy Creek Valley in Benton County, and the Beef Barn area in Benton County.

1.1.2 Identify and protect sites within potential functioning networks and independent populations.

Fender's blue butterfly is at risk of extinction throughout its range; therefore the protection and active management of populations in potential functioning networks and independent population sites across the recovery zones are critical to ensuring the continued existence of the species. Full recovery of Fender's blue butterfly will require restoring lands to expand existing sites as well as creating new sites through habitat restoration, management, and reintroduction of the butterfly.

1.1.2.1 Identify and evaluate sites and populations for inclusion in the development of potential functioning networks and independent populations.

Potential functioning networks and independent populations have been identified for Fender's blue butterfly (Figure IV-4); pending the outcome of additional surveys and assessment of suitable habitats, there may be other, more suitable sites for establishment of functioning networks or independent populations. Currently, subpopulation sites in Yamhill and Benton Counties have the highest priority for protection.

The status of the extant populations must be carefully evaluated and management strategies developed to achieve functioning networks and independent populations of Fender's blue butterflies in each recovery zone. Considerations will include factors such as current population size, land ownership, habitat quality, surrounding land uses, availability of contiguous land area to provide for potential population or habitat expansion, site management needs, feasibility of providing needed management treatments, and security of sites from vandalism and disturbance. The preservation of populations found in unique ecological

conditions is also an important consideration (*e.g.*, stable climax grasslands on valley hillsides, as opposed to early successional grasslands on the valley floor). The restoration of a mosaic of appropriate lupine habitat "stepping stones" to expand and maintain population networks is fundamental to the conservation strategy for Fender's blue butterfly. There is no minimum size necessary for a patch to function as a stepping stone, as long as the patch contains lupine host plants and nectar plants and the intervening habitats are relatively free from barriers to butterfly movement.

1.1.2.2 Evaluate protected status of populations and sites identified for inclusion in all functioning networks and independent populations and ensure long-term protection of those not yet secured.

A substantial portion of each population contributing to functioning networks and each independent population must be under some form of permanent or long-term protection to ensure their persistence. Some of the largest remaining populations of Fender's blue butterfly are already under protective ownership or management (see Appendix C), but many extant populations are not yet secured. Protections will also be required for reintroduced populations. Some of the possible mechanisms for protecting habitat for Fender's blue butterfly include conservation easements, management agreements, habitat conservation plans, Safe Harbor Agreements and acquisition of land from willing sellers. The appropriate mechanism will depend upon the extent of rights needed to maintain the habitat, but will also depend upon the interest of the landowner(s). Landowners of occupied sites or sites identified as having the potential to contribute to the recovery of Fender's blue butterfly through restoration and management activities should be contacted and provided the opportunity to participate in the recovery program, informed as to the various conservation tools available to them (see Recovery Action 3.1), and offered assistance with management, restoration, and monitoring of Fender's blue butterfly populations and appropriate prairie habitat for the butterfly on their property.

1.1.3 Develop and implement management plans for each functioning network and independent population.

Comprehensive management plans will be essential to the maintenance of the populations within each functioning network and at independent population sites, to respond in the event of a decline, and to buffer the populations from the influences of environmental variation that could adversely affect them. Site-specific management plans that specify how each of these three functions will be carried out must be developed for each functioning network and independent population. Management plans should include a focus on protecting habitat heterogeneity within protected sites and across a range of elevations and aspects to buffer the potential effects of climate change.

1.1.4 Manage all functioning networks and independent populations to reduce threats and expand and increase populations.

All populations and sites that comprise the functioning networks and independent populations must be managed to provide the appropriate habitat for Fender's blue butterfly, meet the minimum patch size and connectivity requirements, and control the threats to the species. The appropriate habitat for Fender's blue butterfly has three key features: the presence of a larval host plant (most often *Lupinus sulphureus* ssp. *kincaidii*, and occasionally *L. arbustus* or *L. albicaulis*), native forbs for adult nectar sources, and a mixture of native grasses and forbs that maintain the historical short-grass structure of the upland prairies (Wilson *et al.* 1997, Schultz 2001).

1.1.4.1 Set back succession and reduce competition from non-native plants.

Fender's blue butterfly is found in upland prairie and oak savanna habitats characterized by short-grass stature dominated by native grasses (*Festuca idahoensis* ssp. *roemeri* and *Danthonia californica*) and forbs. These species tend to be intolerant of shade, and are therefore adversely affected by the presence of trees or shrubs. Competition with invasive non-native plant species is also a threat to these systems. Active management is required to maintain suitable prairie habitat to support Fender's blue butterfly. Management strategies include periodic prescribed burning, mowing, and manual removal of woody vegetation. Optimal intensity, timing, and frequency of these treatments may vary on a site-by-site basis, and will need to be refined through future research and management experience. Spot application of herbicides under carefully controlled conditions may also be effective in eliminating or reducing non-natives.

1.1.4.1.1 Prescribed fire.

Controlled burns are a common management tool for maintaining open grassland habitats. Research on the effects of fire on Fender's blue butterfly has shown that although fire likely kills all larvae in burned patches, these patches may be recolonized by females from nearby unburned source patches, with a significant increase in the abundance of eggs that are subsequently laid in the burned plots (Wilson and Clark 1997). Due to the lethality to larvae, however, controlled burns should be confined to no more than one-third of the area occupied by Fender's blue butterflies at any site, to ensure the preservation of a source population for recolonization.

Burning should be conducted in the late summer and early fall (September or October), after plant communities have set seed and senesced. Due to air quality concerns and other social issues, controlled burning is not an option in all areas. Prescribed burning requires careful site preparation and permitting, and should be performed only by qualified personnel with careful consideration to public safety in mind.

1.1.4.1.2 Mowing.

As described below for management of *Lupinus sulphureus* ssp. *kincaidii*, annual mowing has only positive effects on Fender's blue butterfly at several life history stages (egg laying, egg to larva survival, etc.), and need not be limited to only a portion of the site, as with burning. In considering mowing as an option, land managers will need to assess the quantity and identity of non-native plants at the site that may respond positively to this technique. Mowing should generally be done in late summer (August or September), after the listed plants have become dormant and Fender's blue butterfly larvae (if present) have entered diapause. The most appropriate timing and methods of mowing, however, should be considered on a site-by-site basis.

1.1.4.1.3 Manual removal of woody plants.

In the Willamette Valley, *Lupinus sulphureus* ssp. *kincaidii* does not tolerate shading by woody plants; therefore trees and shrubs that are not eliminated by burning or mowing must be manually removed. Following cutting, burning, or mowing, stumps should be treated with herbicide to prevent resprouting the following year.

1.1.4.1.4 Habitat management using other methods as appropriate, pending results of ongoing and planned research.

Prairie restoration is an evolving discipline. New strategies and techniques should be applied to protecting and managing Fender's blue butterfly habitats as they become available.

1.1.4.2 Restore native prairie species, with an emphasis on larval host plants and adult nectaring sources.

Although the total eradication of invasive non-native plants is unlikely, many species can be controlled through the careful and appropriate application of herbicides or mechanical control methods (*e.g.*, rotary line trimmers, pruners, or hand-pulling). Herbicides should be applied when native prairie plants are dormant, although research into carefully controlled application of herbicides (*e.g*., hand-wicking) during the growing season should be investigated (see Recovery Action 1.3.1). At sites where Fender's blue butterflies are present, and until current research quantifies the potential impact of herbicides, herbicide applications should proceed with caution, with emphasis on spot-treatment and timed when native plants are dormant. Ground disturbing activities often encourage the growth of non-native weedy species from a persistent seed bank and, if applied, should be judiciously used. Sites should be replanted with common native prairie species and various nectar species.

1.1.4.2.1 Restore and enhance populations of larval host plants.

Perennial lupines are the larval host plants for Fender's blue butterfly. *Lupinus sulphureus* ssp. *kincaidii* is used by the butterfly most frequently, and an emphasis on the restoration of *L. sulphureus* ssp. *kincaidii* serves the dual purpose of achieving

the recovery goals for this threatened species as well. Two other lupines (*Lupinus arbustus* and *L. albicaulis*) are also used by Fender's blue butterfly, although the latter is considered inferior because it is relatively short-lived.

1.1.4.2.2 Restore and enhance populations of nectar sources.

Adult Fender's blue butterflies require a wide variety of nectar sources to provide a consistent and abundant food supply. Native species of forbs are considered superior sources of nectar, although a few exotic plants are heavily used at some sites (Schultz and Dlugosch 1999). Some suggested nectar species are shown in Appendix D.

1.1.4.3 Evaluate and reduce grazing impacts from domestic stock, and assess the use of livestock grazing as a habitat management tool.

Any grazing by domestic stock at sites managed for Fender's blue butterfly must be closely managed and monitored to maintain prairie quality and ensure the welfare of the butterfly population on site. Light grazing may be compatible with management for Fender's blue butterfly, and if properly managed, it may even be beneficial. No definitive data yet exist and this must be verified through active monitoring of the population. Effective grazing management may include the construction and maintenance of fencing, allowing for rest years, and revising grazing rotation schedules and stock levels to maintain high quality prairie habitats with a diversity of native nectar species for Fender's blue butterfly. Grazing should be evaluated as a tool to maintain prairie structure and the risk of trampling of Fender's blue butterfly eggs and larvae by livestock (*e.g.*, horses, cattle, goats, and sheep) should be assessed.

1.1.4.4 Evaluate and reduce impacts of wild herbivores, especially deer and voles.

There may be a connection between high thatch levels and vole abundance. Prairie management practices that reduce thatch appear to control vole populations, but this link should be investigated. Fencing of some sites may be required if grazing by deer poses a significant threat to prairie quality for the Fender's blue butterfly.

1.1.4.5 Address threat from collection.

The rarity of Fender's blue butterfly makes it appealing for butterfly collectors, although take of this endangered species is prohibited under section 9 of the Endangered Species Act. The U.S. Fish and Wildlife Service and other law enforcement agencies are responsible for investigating suspected violations of the take prohibition, whether by collection or other means. The preferred method for addressing collection is by preventing its occurrence, through outreach and education to inform potential collectors of the magnitude of the negative impact of collecting on the species, and to discourage any such actions. Informing potential collectors of the legal ramifications of any such action is a less preferred method of discouragement.

1.1.5 Coordinate with recovery efforts for *Lupinus sulphureus* ssp. *kincaidii.*

This plan also addresses recovery actions for the primary larval host plant of the Fender's blue butterfly, *Lupinus sulphureus* ssp. *kincaidii*. For those areas where both Fender's blue butterfly and *L. sulphureus* ssp. *kincaidii* occur, recovery actions should be closely coordinated to simultaneously provide benefits for Fender's blue butterfly as actions are taken to enhance or restore populations of the lupine whenever practicable or appropriate. Lupine patches should be spaced more closely together in areas where Fender's blue butterfly may also occur, or where they may be intended for reintroduction.

1.1.6 Reintroduce and augment populations and restore habitat, as necessary, to meet recovery goals.

The establishment of additional populations will require the identification and preparation of appropriate reintroduction sites within each of the recovery zones, as necessary, and the successful reintroduction of butterflies. In addition, some of the existing populations of Fender's blue butterfly are so small that population augmentation may be required to prevent further declines and to accelerate dispersal and colonization into adjacent suitable or restored habitats.

1.1.6.1 Develop reintroduction protocol.

A protocol should be developed to guide reintroduction of Fender's blue butterfly.

1.1.6.1.1 Develop a translocation protocol for establishing new populations or augment existing populations using individuals from existing populations.

Translocation (*i.e.*, moving individuals from an existing wild population to another site) may be used as a tool to achieve population size or genetic goals. If translocation is considered, a protocol is needed to address issues that will likely affect the success of the translocation and the potential effect to the donor populations. Issues to be considered include: minimum size of donor population, minimum number of individuals to be translocated, genetic considerations, and a monitoring strategy.

1.1.6.2 Identify reintroduction and augmentation sites and establish connectivity among populations to create functioning networks and meet viability goals.

Sites identified for potential reintroductions should meet certain minimum criteria for habitat quality, quantity, connectivity, and long-term management and protection. A protocol detailing the assessment of these minimum criteria should be developed to ensure that sites are suitable before actions are taken. The conditions necessary for ensuring the viability of the population should be assessed, and the factors that led to the extirpation of the native population remedied prior to any reintroduction effort. The sites must be evaluated for their potential contribution to recovery within the functioning network structure. Surveys to determine site suitability should focus on areas close to existing or recent observations of Fender's blue butterflies because undocumented occupied habitat patches may exist nearby. New populations should be reintroduced to suitable habitat patches within dispersal distance of other populations to further strengthen the functioning network structure and to provide the potential for future population expansion. In accordance with metapopulation theory, we do not expect all restored habitat patches to be continuously occupied by Fender's blue butterfly, but such patches are nonetheless considered essential to the long-term functioning of the population network by

allowing for future dispersal and colonization events, and by providing alternative resources in response to environmental variation.

1.1.6.3 Manage and monitor reintroduced and augmented populations.

Detailed management and monitoring protocols should be developed for reintroduced populations, designed to provide useful data generated by hypothesis testing to further refine and improve reintroduction and management protocols. Monitoring must be frequent enough to provide timely feedback and allow for adaptive management actions, as appropriate, should any problems be detected.

1.1.7 Monitor population abundance at all functioning network and independent population sites.

Monitor all populations using a standardized protocol (see Recovery Action 1.1.1.1). The goal of population monitoring should be to determine if the minimum population size in the recovery criteria has been met.

1.1.8 Monitor prairie quality at all functioning network and independent population sites.

All population sites for Fender's blue butterfly must be managed to achieve the recovery goals for prairie quality and diversity, as well as to provide the appropriate larval host plants and an adequate nectar base for adult butterflies. Regular monitoring is essential to provide feedback for management. See Appendix D for suggested prairie quality targets.

1.2 Preserve, restore, and manage populations and habitat for *Erigeron decumbens* var. *decumbens, Lomatium bradshawii, Lupinus sulphureus* ssp. *kincaidii* and *Sidalcea nelsoniana*.

1.2.1 Evaluate the status of extant populations.

The current status of many of the populations of *Erigeron decumbens* var. *decumbens, Lomatium bradshawii, Lupinus sulphureus* ssp. *kincaidii,* and *Sidalcea nelsoniana* are not well documented. The data recorded are varied in terms of collection methods and frequency (*e.g.*, some records provide the total number of plants, some the number of flowering plants, and some merely the

presence or absence of the species), and offer little in the way of standardized counts by which to evaluate the overall status of the species or their constituent populations. Furthermore, we have scant knowledge of the status of populations that occur on private lands where we do not have permission to access the property for monitoring. An accurate assessment of population size and structure is required to provide the current baseline information and to determine when the populations have achieved the size and structure stipulated by the recovery criteria, thereby allowing for consideration of downlisting or delisting. This information is also necessary to evaluate the efficacy of the management program and allow for adaptive management, as necessary, of individual populations to guide the species toward their recovery goals. A standardized monitoring protocol, or at least a standard set of plant features to be monitored, should be developed for each of the four species (see Recovery Action 1.2.5.1). This will allow for comparability of data among sites and years and evaluation of population trends. If populations are known to occur on private lands, landowners should be approached for permission to conduct surveys (see Recovery Action 3).

1.2.2 Survey extirpated sites and suitable habitat near these sites to determine if any of these populations may still persist.

Areas of potential habitat or areas that formerly supported populations of *Erigeron decumbens* var. *decumbens, Lomatium bradshawii, Lupinus sulphureus* ssp. *kincaidii,* or *Sidalcea nelsoniana* that have not been surveyed recently should be revisited (with appropriate landowner permission) to determine whether additional populations of the species may exist. If the populations no longer exist, the sites should be assessed for potential suitability for reintroduction of the species (see Recovery Action 1.2.4).

1.2.3 Select, protect, and manage population sites.

1.2.3.1 Select populations on which to focus recovery actions.

The populations with the greatest potential for achieving the recovery goals should be targeted for protection and active management to make the best use of limited resources. These populations will serve as the core of the population framework for recovery across the recovery zones. Populations will be selected based on factors including, but not limited to, land ownership, current population size, evidence of reproduction, habitat

quality, presence of nonlisted species of conservation concern, surrounding land uses, site management needs, feasibility of providing needed management treatments, security of sites from vandalism and disturbance, and availability of adequate contiguous habitat to provide for population expansion, natural recruitment, and possible augmentation of the population.

1.2.3.2 Evaluate protected status of populations.

In order to provide for the recovery and long-term viability of *Erigeron decumbens* var. *decumbens, Lomatium bradshawii, Lupinus sulphureus* ssp. *kincaidii,* and *Sidalcea nelsoniana*, populations must have long-term protection to the extent possible. Some populations are currently protected to some degree. See the conservation measures section under each species in section II of this Recovery Plan and Appendix C for information on extant populations and status.

1.2.3.3 Secure conservation or management agreements for populations that are not yet protected.

Many of the extant populations of *Erigeron decumbens* var. *decumbens, Lomatium bradshawii, Lupinus sulphureus* ssp. *kincaidii,* and *Sidalcea nelsoniana* occur on private lands and are without any formal protection. Populations may be protected through a variety of means, including conservation agreements or easements, habitat conservation plans, acquisition from willing sellers, or other legally binding agreements. The success of this recovery plan will depend upon the participation of landowners where populations occur, whether public or private. Landowners of population sites that are not yet protected should be contacted and invited to participate in the recovery program, informed as to the various conservation tools available to them (see Recovery Action 3.2), and offered assistance with management, restoration, and monitoring of the prairie habitat on their property.

1.2.3.4 Develop site-specific management plans.

Restoration of prairie ecosystem function and recovery of the associated listed species and nonlisted species addressed in this recovery plan will require active management. Physical and biological characteristics,

current management activities, and threats will vary from site-to-site, necessitating management plans tailored to the individual areas and land managers. Management plans should include provisions for the protection of the sites with the best potential for providing long-term stable habitat conditions and maintenance of currently unoccupied potential habitat in suitable condition, since such areas represent sites for future colonization and population growth. Site-specific management plans must explicitly address the threats discussed in section III (Threats Assessment) above. Private landowners should be provided with assistance in developing such management plans (see Recovery Action 3.2). Public agencies or land trust organizations managing prairie lands within the subject area should be encouraged to develop and implement site-specific management plans aimed at achieving recovery of the listed species as well, in coordination with the Service and other organizations (see Recovery Action 4).

1.2.3.5 Manage populations to address threats and increase populations.

Prairie habitats require ongoing management to approximate natural disturbance regimes and set back succession. The greatest threats to *Erigeron decumbens* var. *decumbens, Lomatium bradshawii, Lupinus sulphureus* ssp. *kincaidii,* and *Sidalcea nelsoniana* are habitat degradation due to the invasion of non-native plant species or woody plant encroachment, fragmentation and isolation, and small population sizes (which increase susceptibility to inbreeding depression and extinction). These threats must be eliminated or sufficiently controlled to achieve the recovery of the species.

1.2.3.5.1 Manage population sites to set back woody plant invasion and reduce competition from non-native plants.

Active management is required to maintain suitable habitat for *Erigeron decumbens* var. *decumbens, Lomatium bradshawii, Lupinus sulphureus* ssp. *kincaidii,* and *Sidalcea nelsoniana*. Management strategies to maintain grassland habitat and reduce the threat of competition from non-native plants include periodic prescribed burning, mowing, manual removal of woody vegetation, and application of herbicides under carefully controlled conditions. Optimal intensity, timing, and frequency

of these treatments may vary on a site-by-site basis, and will need to be refined through future research and management experience.

1.2.3.5.1.1 Prescribed fire.

Prescribed burning is a common method for maintaining prairie habitats. Burning should be conducted in the late summer and early fall (September or October), after native plants have set seed and senesced. Due to air quality concerns and other social issues, controlled burns are not an option in all areas. Prescribed burning requires careful site preparation, permitting, and post-burn weed monitoring and control, and should be performed only by qualified personnel with careful consideration to public safety in mind.

1.2.3.5.1.2 Mowing.

Mowing can be used to set back the succession of woody plants in prairie habitats. As with other management techniques, the use of mowing for the benefit of *Erigeron decumbens* var. *decumbens, Lomatium bradshawii, Lupinus sulphureus* ssp. *kincaidii,* and *Sidalcea nelsoniana* will need to be evaluated on a site-by-site basis. Land managers will need to assess the quantity and identity of non-native plants at the site that may respond positively to this technique. Mowing should generally be done in late summer (August or September), after the listed plants have become dormant. The most appropriate timing and methods of mowing, however, should be determined on a site-by-site basis.

1.2.3.5.1.3 Remove woody plants.

Erigeron decumbens var. *decumbens, Lomatium bradshawii, Lupinus sulphureus* ssp. *kincaidii,* and *Sidalcea nelsoniana* generally require open, unshaded

habitat; therefore trees and shrubs that are not eliminated by burning or mowing should be manually removed. The exception is *Lupinus sulphureus* ssp. *kincaidii* where it occurs in dry forested habitats, particularly in Douglas County. If feasible, following cutting, burning, or mowing, stumps should be treated with herbicide to prevent resprouting the following year.

1.2.3.5.1.4 Eliminate non-native plants to extent practicable and restore native prairie species.

Although the total elimination of invasive non-native plants is unlikely, these alien species can be controlled through the careful and appropriate application of herbicides or mechanical control methods (*e.g.*, rotary line trimmers, pruners, or hand-pulling). Some useful resources are available for guidance on the elimination of non-native plants and restoration of native prairie species in the Willamette Valley (see Appendix E). Herbicides should be applied when native plants are dormant, although research into carefully controlled application of herbicides (*e.g.*, hand-wicking) during the growing season should be conducted. Each site must first be carefully assessed so that the appropriate mode of herbicide application can be determined, depending on the relative number of native plant species versus non-natives. Ground disturbing activities encourage the growth of non-native weedy species from a persistent seed bank and, if applied, should be judiciously used (*e.g.*, no tilling unless followed by herbicide application). Sites should be replanted with common native prairie species.

1.2.3.5.1.5 Work to discourage introduction of transgenic herbicide-resistant grasses in the region.

Glyphosate-resistant strains of *Agrostis stolonifera* have a high potential for invading prairie habitats, and would be very difficult to control effectively if they became established. Moreover, pollen of transgenic *Agrostis* has the potential to move tens of kilometers and can transfer herbicide resistance to wild populations of *Agrostis*. Use of such strains in golf courses or grass seed farms in the Willamette and Umpqua Valleys and southwestern Washington should be discouraged.

1.2.3.5.2 Restore connectivity among populations.

Within each of the identified recovery zones for the species, subpopulations making up larger, connected populations should be within pollinator flight distance of another subpopulation. The interim recommendation is 3 kilometers (2 miles) between subpopulations. Restoring connectivity may be achieved by increasing the geographic extent of existing populations through appropriate habitat management and population augmentation, or may require the reintroduction of intervening populations between two more remote existing populations (see Recovery Action 1.2.4).

1.2.3.5.3 Augment populations, as necessary.

Augmentation (*i.e.*, increasing the size of existing populations by planting seeds or propagules) may be required to achieve population targets.

1.2.3.5.3.1 Develop outplanting protocols for cultivated seedlings.

An outplanting protocol for each of the four species should be developed that defines parameters such as the site conditions required before outplanting commences, number of plants needed to establish a new population, time of year for outplanting, the spacing between

individuals, and when or if repeated plantings will be completed.

1.2.3.5.3.2 Develop protocols for site preparation and planting from seeds *in situ*.

Evaluate site conditions and preparation requirements that could favor augmenting populations from seed. A seed planting protocol should be developed that defines parameters such as the site conditions required before seeding commences, number of seeds needed to establish a new population, time of year for seeding, and when or if repeated seedings will be needed.

1.2.3.5.3.3 Implement population augmentation.

Each site must be individually evaluated to determine whether augmentation is needed, the appropriate method to be used, and the source of seeds or propagules. In general, seed or propagules should come from within the same recovery zone, unless none are available, in which case the source should be the next nearest recovery zone with a similar habitat type. The exception would be when concerns regarding inbreeding lead project planners to select plant materials from a more distant population. Follow-up monitoring will indicate whether repeated augmentation is needed.

1.2.4 Reintroduce populations and restore habitat, as necessary, to meet recovery goals.

Achieving recovery goals for *Erigeron decumbens* var. *decumbens, Lomatium bradshawii, Lupinus sulphureus* ssp. *kincaidii,* and *Sidalcea nelsoniana* will likely require reestablishing populations in suitable prairie habitats. Although some additional populations may potentially become established through appropriate habitat management and natural recruitment from nearby populations, the restoration of populations through reintroduction within the historical range of the species may be necessary. The establishment of additional populations will

require the identification and preparation of appropriate reintroduction sites within each of the recovery zones, as necessary, and the successful reintroduction of the plant through either outplanting or seeding followed by monitoring and management.

1.2.4.1 Identify reintroduction sites.

The status of extant populations of each of the four listed plant species within each recovery zone must be evaluated and the gap between current and desired conditions assessed to determine where reintroduction of the species may be both feasible and desirable to achieve recovery goals. Consideration of sites within the historical range of the species should include factors such as the extent and quality of any remaining prairie habitat or the potential for restoration to high quality prairie; landownership and potential for long-term protection; proximity to other populations of the species for potential gene flow and connectivity within a population structure; environmental buffering, size of the property, and potential for population expansion; and cost and ease of managing the site for maintenance of the appropriate ecological conditions.

1.2.4.2 Conduct reintroductions.

Using the protocols discussed above (Recovery Actions 1.2.3.5.3.1 and 1.2.3.5.3.2), conduct reintroductions at suitable sites.

1.2.5 Monitor populations.

1.2.5.1 Develop a standardized monitoring protocol to monitor population abundance and evaluate population trends at all population sites.

Past inventory and monitoring methods for *Erigeron decumbens* var. *decumbens, Lomatium bradshawii, Lupinus sulphureus* ssp. *kincaidii,* and *Sidalcea nelsoniana* have varied widely, hampering our ability to understand the current status of the species and rendering it impossible to accurately interpret and compare population data between sites. A standardized monitoring protocol designed to count individuals and that is consistently applied throughout the range of the species is a high priority need to assess population trends. All populations should be monitored on

a consistent basis to allow for the adjustment of management strategies, as necessary, and to assess progress toward recovery goals.

1.2.5.2 Monitor populations and trends, evaluate effectiveness of management actions and apply adaptive management practices, as appropriate.

Monitor all populations as needed to track progress towards recovery goals and to evaluate the effect of habitat management actions. Until a final monitoring protocol is available for each species (see Recovery Action 1.2.5.1), sites should be monitored at least one year prior to management action, each year after treatment for at least 2 years, and then every 3-5 years. Monitoring reports should be provided to the U.S. Fish and Wildlife Service and include GIS coordinates or other precise location data.

1.2.6 Monitor prairie quality at all population sites.

In addition to monitoring the status of the listed species at each population site, the sites must be managed to achieve the recovery goals for prairie quality. The attainment of high quality prairie habitats will serve as an indicator that management actions are successfully restoring and maintaining the ecological functions of the prairie ecosystem, will provide the appropriate environmental conditions for the continued expansion of the listed species, and will support populations of associated nonlisted prairie species of conservation concern. See Appendix D for guidance on assessment of prairie quality.

1.2.7 Collect and bank seeds.

Seed banks should be established to assist in augmentation and reintroduction efforts, and to serve as insurance against the possibility of extinction of *Erigeron decumbens* var. *decumbens, Lomatium bradshawii, Lupinus sulphureus* ssp. *kincaidii,* and *Sidalcea nelsoniana*. Collection of seeds should be distributed evenly among as many individuals within populations as possible to maximize the genetic representation of the source population and the resulting genetic diversity in the population undergoing augmentation or reintroduction. In addition, priority should be given to seed collection from sites that are currently unprotected and therefore more vulnerable to extirpation. Seed should be stored at a Center for Plant Conservation member institution, such as the Berry Botanic Garden in

Portland, Oregon. Use the collection protocol and schedule suggested by the target bank. A permit under section 10(a)(1)(A) of the Endangered Species Act is required for seed collection on Federal lands.

1.3 Further research needed for the conservation of the species.

Although much important research has been completed on Fender's blue butterfly, *Erigeron decumbens* var. *decumbens, Lomatium bradshawii, Lupinus sulphureus* ssp. *kincaidii,* and *Sidalcea nelsoniana,* further studies are essential to achieving more focused and cost-effective conservation efforts.

1.3.1 Determine the effect of herbicides on different life stages of Fender's blue butterfly.

Restoration of prairie habitat often requires the use of herbicides to control non-native species. Little is known about the effect of these herbicides on Fender's blue butterfly. The effects of commonly used herbicides on Fender's blue butterflies may be assessed using a surrogate species if appropriate. This is a high priority action; a better understanding of the effect of common herbicides on different life stages of Fender's blue butterfly could allow more liberal use of herbicides, often a very cost-effective option, in the management of prairie habitats.

1.3.2 Develop guidelines for protection of Fender's blue butterfly and its habitat from pesticides.

Populations of Fender's blue butterfly are often found in or near areas that are subject to treatment by insecticides or herbicides, with potentially detrimental or even lethal effects on the butterfly. Such areas include roadsides, agricultural fields, urban areas sprayed for mosquito control, or forest edges where spraying for control of gypsy moths may occur. In addition, Fender's blue butterfly habitat may be intentionally targeted for herbicide treatment to reduce or eliminate undesirable invasive plants. Guidelines should be developed to protect the butterfly and the essential components of its habitat (*e.g.*, lupine and nectar plants) from incompatible usage of pesticides. Pesticide protection guidelines should be incorporated into permits, management plans, habitat conservation plans, and safe harbor agreements.

1.3.3 Evaluate the dispersal ability of Fender's blue butterfly in various habitat types across the species' range.

Conservation of Fender's blue butterfly will require restoration and management of networks of habitat that maintain functioning metapopulations. Previous investigations of the butterfly's behavior and population dynamics (Schultz 1998, Crone and Schultz 2003, Schultz and Crone 2005) have suggested that understanding the butterfly's dispersal behavior across different habitat types and habitat boundaries is essential for predicting how the butterflies move across the landscape, and that maintenance of a functioning metapopulation requires a network of patches of sufficient size and connectivity to promote population growth within the patches and exchange of butterflies among the patches. To date, investigations of butterfly dispersal behavior have focused on Fender's blue populations around Eugene, Oregon, an area that is generally flat and open. In contrast, several areas that are critical to recovery of the species are within relatively hilly and wooded landscapes. Thus, a key need is to conduct dispersal studies within appropriate habitat to determine to what degree findings from earlier studies are valid in hilly, wooded landscapes and to understand how woodlands influence the dispersal behavior of the butterfly. Data from these studies can then be used to adapt models developed for the West Eugene area to develop conservation strategies in other parts of the species' range.

1.3.4 Evaluate other models to predict the viability and persistence of Fender's blue butterfly populations based on new population locations and monitoring data.

All of the current viability models for Fender's blue butterfly are based on data gathered from small populations, since only small populations remain. Because small populations behave differently than larger populations, new data gathered as populations are restored to larger sizes will enable us to more accurately model the probability of persistence of these populations in the face of various uncertainties. As models are refined, the recovery criteria should be revised to reflect any new information, if necessary.

1.3.5 Investigate the role of pollinators in supporting forb species needed for nectar species diversity

The health of prairie habitats depends on preserving the native community of plants and animals, as well as the natural processes that maintain the system. We need a better understanding of the native pollinators and their habitat requirements to guide management of prairie habitats.

1.3.6 Evaluate the effectiveness of different prairie management techniques.

Controlled experiments should be done to compare the response of Fender's blue butterfly, *Erigeron decumbens* var. *decumbens, Lomatium bradshawii, Lupinus sulphureus* ssp. *kincaidii,* and *Sidalcea nelsoniana* to different vegetation management techniques (*e.g.*, burning, mowing, and manual removal of woody vegetation) and to determine which methods most benefit the species. These studies should also evaluate the optimal frequencies, intensities, timing, and possible combinations of these methods.

1.3.7 Identify pollinators and determine habitat needs of pollinators.

Little is known about the specific pollinators of *Erigeron decumbens* var. *decumbens, Lomatium bradshawii, Lupinus sulphureus* ssp. *kincaidii,* and *Sidalcea nelsoniana,* or of the important nectar species for Fender's blue butterfly. Identification of the most frequent pollinators and their habitat requirements (including important nectar plants and nesting substrate) is essential to managing prairie habitats to sustain populations of the listed species in this recovery plan.

1.3.8 Evaluate genetic variability within and among populations of the listed plant species.

Many of the existing populations of *Erigeron decumbens* var. *decumbens, Lomatium bradshawii, Lupinus sulphureus* ssp. *kincaidii,* and *Sidalcea nelsoniana* occur in small, fragmented patches of habitat that are isolated from one another. *Lupinus sulphureus* ssp. *kincaidii,* in particular, is exhibiting symptoms of inbreeding depression, such as reduced seed set and fitness (Severns 2003, Wilson *et al.* 2003). The levels of genetic distinctiveness within and among populations of the listed plant should be evaluated to direct the transfer of genetic material between populations in

augmentation efforts and identify the appropriate source populations for reintroductions. If preliminary research indicates there is little genetic variability between populations of a species (*i.e.*, few or no unique alleles), managers may consider bypassing further costly and time-consuming genetic studies and capturing most of the existing genetic variation within the population by collecting seed from a large sample of the remaining individuals (Schemske *et al.* 1994). Under these circumstances, the vigor of the plants may be improved by the reintroduction of genetic variability that had been lost through population fragmentation and the interruption of gene flow.

1.3.8.1 Elucidate genetic differences between populations of *Erigeron decumbens* var. *decumbens* in wet prairie habitats and drier prairie habitats.

The few existing populations of *Erigeron decumbens* var. *decumbens* occur in small, fragmented patches of habitat that are isolated from one another; the limited reproductive capacity of the plants may be a sign that the species is exhibiting the effects of inbreeding depression (Jackson 1996, Clark 2000). The levels of genetic distinctiveness within and between populations should be evaluated in order to direct the transfer of genetic material among populations in augmentation efforts and identify the appropriate source populations for reintroductions. Particular attention is needed to determine if *Erigeron decumbens* var. *decumbens* populations at wetter sites differ genetically from populations at drier sites.

1.3.8.2 Evaluate incidence of hybridization and develop strategies to minimize potential hybridization.

Hybridization with closely related species has been identified as a potential threat to *Lupinus sulphureus* ssp. *kincaidii* and *Sidalcea nelsoniana.* The current data should be reviewed and studies conducted as necessary to evaluate the current incidence of hybridization in these two species. If hybridization is found to be occurring, management strategies should be developed to minimize the potential for further hybridization.

1.3.9 Research the role of vegetative versus sexual reproduction in *Erigeron decumbens* var. *decumbens*.

Erigeron decumbens var. *decumbens* is capable of vegetative reproduction, forming clumps of genetically identical individuals or ramets. However, sexual reproduction, as facilitated by insect pollination, is important in the long-term survival of the species (Jackson 1996). Further studies are needed to elucidate the relative roles of vegetative and sexual reproduction in this species. If sexual reproduction is most important for population recruitment, then management should focus on strategies that promote flowering and seed production, as well as connectivity and gene flow among local populations (Clark 2000). If vegetative reproduction is important, then management would focus on activities that promote ramet production.

1.3.10 Evaluate the importance of mycorrhizae and other below-ground micro-organisms on plant performance.

Mycorrhizae and other organisms in the soil can have substantial impacts on plant growth, competitive ability and overall fitness. The role of these soil organisms should be evaluated to improve restoration, reintroduction and augmentation practices.

1.3.11 Assess the use of mowing as a tool to control vole populations.

Prairie management practices that reduce thatch are generally effective for controlling vole populations. The effectiveness of mowing as a tool to reduce thatch build-up and control vole numbers should be evaluated. Studies to assess the effect of vole control on plant success and prairie quality should also be conducted.

1.3.12 Evaluate interactions between listed species and non-native plants.

Studies should be identified and conducted to determine the mechanisms by which non-native and invasive organisms affect the listed species.

1.3.13 Evaluate the use of livestock grazing as a tool to manage prairie habitat.

Studies should be conducted to determine the efficacy of using controlled livestock grazing to manage prairie structure and quality, evaluating the effect of time of year and different livestock species (cattle, sheep, goats, etc.).

1.3.14 Investigate innovative weeding and vegetation sampling techniques.
Current methods of prairie management and monitoring are time-intensive and costly. New weeding and monitoring methods that could reduce the costs associated with carrying out essential tasks for species recovery should be identified and evaluated.

1.3.15 Evaluate the threat of seed predation by weevils, and develop management strategies to control weevil damage, if needed.
Seed predation by weevils has been identified as a significant threat to *Sidalcea nelsoniana.* Better information is needed on the effect of weevils on the reproductive success of *S. nelsoniana*, with the goal of reducing the adverse effects, if warranted. Further studies on weevil control strategies should be initiated if seed predation by weevils is found to reduce the reproductive success of *S. nelsoniana*, and control is considered to be essential to restoring populations of the species. If pesticide application is evaluated, the studies should also consider the effects of any such applications on the insect pollinators of *S. nelsoniana*. Biological control methods should also be investigated as an alternative method of controlling levels of seed predation by weevils.

1.3.16 Identify factors that limit the expansion of populations of listed prairie plants.
Determine whether seed set is insufficient or if seed availability is limiting the recovery of listed plant species.

1.3.17 Investigate the impacts of global climate change on habitats and species in the area covered by this recovery plan. Adapt management strategies as necessary.
The threat of climate change casts substantial uncertainty over the fate of the prairies of western Oregon and southwestern Washington. Studies of the effects of climate change in the Pacific Northwest should be

considered when determining habitat restoration and management goals and actions, to develop adaptive management strategies in preparation for changes in the distribution and viability of prairie habitats.

1.3.17.1 Convene an expert panel to advise the recovery program on measures needed to respond or adapt to impending climate change effects to the listed species addressed in this recovery plan.

Convene an expert panel to review the most current scientific information for climate change projections to the prairie regions covered by this recovery plan. Seek consensus on likely changes to be expected and identify potential adaptations to climate-related stressors. Develop a monitoring approach and adaptive management responses.

1.3.17.2 Evaluate the role of habitat heterogeneity in buffering populations from the effects of changing climate patterns in the region.

Management for high habitat heterogeneity (*e.g.*, a variety of habitat types, slopes, aspects and elevational gradients) may be an important step in buffering the effects of changing climate conditions on listed prairie species. Conduct research to assess the value of habitat heterogeneity across a range of sites and weather years.

1.4 Reintroduce *Castilleja levisecta* to the Willamette Valley.

Castilleja levisecta occurred historically within the area covered by this recovery plan in the SW Washington, Portland, Salem East and Corvallis East recovery zones. The species has its own current recovery plan, which states that reintroductions of populations throughout the species' historic range will be necessary to achieve recovery (U.S. Fish and Wildlife Service 2000b). The Western Washington Fish and Wildlife Office of the U.S. Fish and Wildlife Service is the lead for recovery of *Castilleja levisecta*; the Oregon Fish and Wildlife Office, which has the lead for the other listed species addressed by this draft recovery plan, will coordinate with the Western Washington Fish and Wildlife Office on the recovery efforts for *Castilleja levisecta* within the geographic range of this plan.

1.4.1 Evaluate protected sites established for other listed prairie species in this plan as potential reintroduction sites for *Castilleja levisecta*.

Potential reintroduction sites for *Castilleja levisecta* should be considered in the SW Washington, Portland, Salem East, Salem West, Corvallis East, Corvallis West, Eugene East, and Eugene West recovery zones; priority should be given to reestablishing populations in zones for which there are historical records (Southwest Washington, Portland, Salem East, Corvallis East). Reintroductions should be guided by the recovery plan for the species (U.S. Fish and Wildlife Service 2000b), the reintroduction plan (Caplow 2004), and the specific recommendations for Willamette Valley reintroductions (Lawrence 2005). An essential part of site evaluation prior to reintroduction is an intensive survey (or reference to a recently completed survey) of the immediate area for possible remnant native populations of *Castilleja levisecta*; this step should ensure that any unique genetic stock native to the Willamette Valley is found and preserved if any still persists. Experimental reintroductions have shown that *Castilleja levisecta* does best at sites that are dominated by native perennial species and are managed to control high levels of herbivory by deer or voles.

1.4.2 Reintroduce *Castilleja levisecta* to restored prairie sites.

Reintroductions should follow the detailed protocol described in Caplow (2004). Recent research has shown that the most successful experimental populations used seed from Whidbey Island populations (Lawrence 2005).

1.4.3 Manage and monitor reintroduced populations of *Castilleja levisecta*.

Active site management should be implemented to restore prairie structure, quality, and native species composition, with an emphasis on limiting the abundance of non-native species, reducing the accumulation of thatch and litter, and managing herbivores. Management actions will likely include prescribed burning, mowing, herbicide use, and seeding with native species. Monitoring should follow the fate of reintroduced populations and determine trends over time.

1.4.4 Monitor effectiveness of management actions for *Castilleja levisecta* and apply adaptive management practices, as appropriate.

This task can be accomplished in concert with management monitoring and adaptive management for the other listed prairie species addressed by this recovery plan.

1.4.5 Evaluate the use of livestock grazing as a tool to manage populations of *Castilleja levisecta*.

One of the largest populations of *C. levisecta* in Washington occurs in a pasture that is grazed by horses, which suggests that grazing may create favorable conditions for the species. Conduct research to determine if some level of livestock grazing is beneficial to the species.

2. Coordinate recovery actions to benefit other listed species and nonlisted prairie species of conservation concern.

The extensive loss of both wet and upland prairie habitats throughout the geographic region addressed by this draft recovery plan has resulted in the concurrent declines of many of the native plants and animals associated with these ecosystems. In this plan we have attempted to focus not only on the recovery of the listed prairie species, but to extend these recovery efforts to the ecosystems upon which they depend. The recommended actions for restoring and reconnecting prairie habitats in western Oregon and southwestern Washington are intended to extend benefits beyond the threatened or endangered species addressed in the plan to all of the native prairie species in these regions, including nonlisted prairie species that are recognized as in decline. Proactive efforts to restore prairie systems should contribute to the arrest or reversal of these declines, thereby preventing the need to list these species in the future. Particularly on sites where listed species co-occur with nonlisted species of conservation concern, landowners or managers should be made aware so as to tailor management actions to avoid inadvertent negative impacts on any such species. Coordination with other agencies, private landowners, or other interested parties will help ensure that the recovery actions outlined in this plan benefit the habitat and populations of other native prairie species.

2.1 Determine current status of Taylor's checkerspot butterfly, *Delphinium leucophaeum, Delphinium oreganum, Delphinium pavonaceum, Horkelia congesta* ssp. *congesta, Sericocarpus rigidus,* and *Sisyrinchium hitchcockii* in the area covered by the recovery plan.

2.2 Protect and manage populations and habitats to ensure long-term survival, with an emphasis on sites managed for other listed prairie species addressed in this recovery plan.

To the extent possible, recovery actions for listed species should be combined with actions designed to protect and enhance the nonlisted prairie species addressed in this recovery plan.

2.2.1 Protect private lands through conservation easements, land acquisition, or other means.

See Recovery Action 3 below for recommended approaches to working with private landowners to protect species and habitats on private lands.

2.3 Collect and bank seeds of *Delphinium leucophaeum, Delphinium oreganum, Delphinium pavonaceum, Horkelia congesta* ssp. *congesta, Sericocarpus rigidus,* and *Sisyrinchium hitchcockii.*

Seed banks should be established to assist in augmentation and reintroduction efforts. Collection of seeds should be distributed evenly among as many individuals within populations as possible to maximize the genetic representation of the source population and the resulting genetic diversity in the population undergoing augmentation or reintroduction. In addition, priority should be given to seed collection from sites that are currently unprotected and therefore more vulnerable to extirpation. Seed should be stored at a Center for Plant Conservation member institution, such as the Berry Botanic Garden in Portland, Oregon. Use the collection protocol and schedule suggested by the target bank.

3. Promote protection of listed species and prairie restoration on private lands.

More than 90 percent of the land in the Willamette Valley is in private ownership. The restoration of prairie systems and their native plant and animal communities can therefore only be successful with the participation of private landowners. Without active management, populations of both listed and nonlisted species endemic to prairie habitats are almost certain to experience further declines. Working with private landowners and providing incentives to participate in the recovery effort for these species are critical elements of the recovery strategy.

3.1 Develop an active program to engage private landowners in the conservation of listed and nonlisted prairie species and prairie habitat restoration.

The species addressed by this recovery plan are insects and plants – groups that do not typically attract high levels of public interest. A critical first step in working with the region's private landowners is to increase their awareness of the rare species in the area and their understanding of the vital role private lands can play in restoring native prairies. Better information on the species, their conservation needs, and the range of programs available to help private landowners coexist with listed species is needed. Informational materials should be developed that assist members of the public in recognizing the species of interest and the features of native prairie habitats. Permission should be sought from interested landowners to conduct surveys for species of interest. Landowners with only listed plant species on their properties may be less hesitant to come forward with location information if they understand that listed plants carry minimal regulatory burdens with regard to the Endangered Species Act, and that conservation efforts on their part are purely voluntary.

3.2 Provide information about the species of interest, incentive programs for voluntary conservation efforts, and restoration and monitoring resources available to landowners.

Private landowners should be invited to participate in recovery efforts for the species covered in this plan. Landowners with remnants of native prairie on their properties or with lands that have good restoration potential have many resources available to help them. There are many Federal and State programs that offer financial assistance and technical expertise to private landowners, including the Service's Partners for Fish and Wildlife program and several other grant programs that support conservation of endangered species; the U.S. Department of Agriculture Natural Resources Conservation Service's Wildlife Habitat Incentive Program and Wetland Reserve Program; the Farm Service Agency's Conservation Reserve Enhancement Program; and the State of Oregon's Wildlife Habitat Conservation and Management Program. There are awards available from private organizations as well, such as Sustainable Agriculture Research and Education (SARE). Numerous additional sources of prairie restoration expertise are available, such as the Willamette Valley Prairie Research Group at Oregon State University and many other organizations identified in Appendix E. Interested private landowners who wish to restore native prairie habitats on their lands should be assisted in the development of site-specific management plans to achieve results consistent with the recovery goals in this plan.

3.3 Develop Safe Harbor Agreements for landowners interested in restoring prairie habitats for the Fender's blue butterfly or *Lupinus sulphureus* ssp. *kincaidii*.
A Safe Harbor Agreement provides assurances against restrictions for the landowner, should the Fender's blue butterfly colonize their property in the future as a result of conservation efforts. Landowners with *Lupinus sulphureus* ssp. *kincaidii* or other species of *Lupinus* may be particularly interested in developing such an agreement with the Service, as may private parties who own parcels adjacent to lands where prairie restoration work is planned. Although there are no take prohibitions for listed plants on private lands, inclusion of listed plants in a Safe Harbor Agreement will ensure an ecosystem approach to management. The U.S. Fish and Wildlife Service's Oregon Fish and Wildlife Office has developed a streamlined approach to Safe Harbor Agreements that can provide coverage for restoration activities on private lands throughout the Willamette Valley; this program encourages restoration of prairie habitats by providing regulatory assurances to private landowners that managing for habitat values that could attract listed species will not foreclose future options for the use of those lands.

4. Cultivate partnerships with both public and private agencies and organizations to promote the conservation of prairie ecosystems and listed prairie species.
A diverse group of agencies and organizations are involved in recovery activities for the native prairies in western Oregon and southwestern Washington, including, but not limited to, the U.S. Fish and Wildlife Service, the Willamette Valley National Wildlife Refuge Complex, the U.S. Bureau of Land Management, U.S. Army Corps of Engineers, Confederated Tribes of Grand Ronde, Oregon Department of Transportation, City of Eugene, The Nature Conservancy, Oregon State University, Institute for Applied Ecology, Greenbelt Land Trust, McKenzie River Land Trust, Oregon Oak Communities Working Group, Washington Native Plant Society, Oregon Native Plant Society, Heritage Seedlings, and Berry Botanic Garden. Information regarding the recovery efforts for the prairie species should be shared with city and county planning, parks, and natural resource departments throughout the region covered by this recovery plan. City and county governments are the primary agencies that determine future land uses, and their participation is important for the recovery and restoration of the prairies and their associated listed species. Some local agencies are already making significant contributions toward prairie restoration; the West Eugene Wetlands are an excellent example of a significant conservation accomplishment achieved through a partnership of federal and local governments and private landowners/organizations. Plans, data, and information pertinent to the recovery of the

prairie species must be synthesized and shared effectively between all agencies, groups, and individuals to leverage collective conservation efforts and achieve recovery.

4.1 Establish technical working groups to review the effectiveness of management plans and recovery actions, monitor the status of the species, and coordinate conservation efforts.

A group of representatives from the agencies and organizations involved in recovery efforts for each species should be formed and meet periodically to review the status and effectiveness of recovery actions, coordinate efforts to maximize efficiency where possible, and recommend changes in recovery strategies or management actions, when necessary.

4.2 Educate the public about native prairies and the rare species that depend on them.

A public education campaign using a variety of media should be developed to inform residents of the region about the value and rarity of native prairie species. Engage the public in conservation efforts, and encourage responsible recreation in and appreciation of these rare habitats.

5. Revise and update recovery plan as needed.

Based on the results of the recommended research and monitoring efforts and the evaluation of the relative success or failure of different management techniques, the recovery plan should be revised periodically as needed to reflect this increased knowledge and improve the efficacy of future recovery actions. The scientific validity of the recovery criteria should also be reviewed and refined, if necessary, as more accurate species-specific data become available to assist with refining recovery criteria.

6. Develop post-delisting monitoring plans for each listed species prior to delisting.

To ensure the continuing recovery of the listed species and adequacy of management actions to maintain the species at viable levels into the foreseeable future, a post-delisting monitoring plan must be developed and ready for implementation prior to delisting of any threatened or endangered species. Such a monitoring plan must be designed to be continued for a minimum of 5 years following the delisting action.

V. IMPLEMENTATION SCHEDULE

The Implementation Schedule that follows outlines the recommended recovery actions and estimated time and costs of the recovery program for Fender's blue butterfly, *Erigeron decumbens* var. *decumbens, Lomatium bradshawii, Lupinus sulphureus* ssp. *kincaidii, Sidalcea nelsoniana* and *Castilleja levisecta* as set forth in this recovery plan. It is a guide for meeting the recovery goals outlined in this plan. The Implementation Schedule includes the following elements:

A. ACTION PRIORITIES

The actions identified in the Implementation Schedule are those that, in our opinion, are necessary to bring about the recovery of these species. However, the actions are subject to modification as dictated by new findings, changes in species status, and the completion of recovery actions. The priority for each action is given in the first column of the Implementation Schedule, and is assigned as follows:

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

Priority 2 — An action that must be taken to prevent a significant decline in the 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.

B. ACTION NUMBER AND DESCRIPTION

The action number and action description are extracted from the stepdown narrative of recovery actions found in Section IV.C of this plan. Please refer back to this narrative for a more detailed description of each action.

C. RESPONSIBLE PARTIES

In this table, we have identified agencies and other parties that we believe are primary stakeholders in the recovery process for these prairie species. Stakeholders are those agencies, organizations, or private individuals who may voluntarily participate in any aspect of implementation of particular actions listed within this recovery plan. Stakeholders may willingly participate in project planning, funding, provide technical assistance, staff time, or any other means of implementation. The list of potential stakeholders is not limited to the list below; other stakeholders are invited to participate.

The listing of an entity in the Implementation Schedule does not require, nor imply an agreement, that the identified agency implement that action or secure funding for implementing the action. However, agencies willing to participate may benefit by being able to show in their own budgets that their funding request is for a recovery action identified in an approved recovery plan and is therefore considered a necessary action for the overall coordinated effort to recover these listed species. Also, section 7(a)(1) of the Endangered Species Act (Act) directs all Federal agencies to utilize their authorities in furtherance of the purposes of the Act by carrying out programs for the conservation of threatened and endangered species.

We, the U.S. Fish and Wildlife Service, have the statutory responsibility for implementing this recovery plan. Only Federal agencies are mandated to take part in the effort. Recovery actions identified in this plan imply no legal obligations of the State and local government agencies or private landowners. However, the recovery of these listed prairie species will require the involvement and cooperation of Federal, State, local, and private interests.

D. ACTION DURATION

The action duration column indicates the number of years estimated to complete the action if it is a discrete action, or whether it is a continual, ongoing, or intermittent action. Occasionally it is not possible to provide a reasonable estimate of either the time or cost to complete an action; these cases are denoted as To Be Determined (TBD). Continual and ongoing actions are defined as follows:

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.

Intermittent — An action that will be implemented on a routine basis once begun, but on an intermittent (*e.g.*, every 3 years, or every 5 years) rather than annual basis.

E. COST ESTIMATES

The Implementation Schedule provides the estimated costs of implementing recovery actions for the first 5 years after the release of the recovery plan, the years 2010 through 2014. Continual and ongoing costs, as well as the estimated total cost, are based on the projected timeframes to recovery and delisting of each species. Recovery of the Fender's blue butterfly is projected to take 25 years, with delisting estimated to occur in the year 2035. Recovery of the listed plants (*Erigeron decumbens* var. *decumbens*, *Lomatium bradshawi*, *Lupinus sulphureus* ssp. *kincaidii* and *Sidalcea nelsoniana*) is projected to take about 20 years, with delisting estimated to occur in 2030, although recovery and delisting of *Sidalcea nelsoniana* could occur sooner.

Annual cost estimates are as follows:

2010 = $2,285,000
2011 = $1,602,000
2012 = $1,252,000
2013 = $1,029,000
2014 = $660,000

The total estimated cost to implement this plan for years 2010 through 2014 is $6,828,000. The total estimated cost to implement this plan through the year 2035, the estimated recovery date of Fender's blue butterfly, is $16,590,000.

It should be noted that because many of the recovery actions identified for particular species will also benefit other listed species, the total cost of recovery may be overestimated.

Key to Responsible Parties:

ACOE	U.S. Army Corps of Engineers
Berry	Berry Botanic Garden
BLM	Bureau of Land Management
FWS	U.S. Fish and Wildlife Service
NGO	Non-governmental agency
ODA	Oregon Department of Agriculture
ODFW	Oregon Department of Fish and Wildlife
ODOT	Oregon Department of Transportation
RT	Recovery Team
TNC	The Nature Conservancy
Tribe	Grand Ronde Tribe
University	Higher education institutions
USGS	U.S. Geological Survey, Biological Resources Discipline
WDNR	Washington Department of Natural Resources

Priority Number	Action Number	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $1,000 units)						Comments / Notes
					Total Costs	FY10	FY11	FY12	FY13	FY14	
	1	Preserve, restore, and manage populations and habitat for the listed prairie species covered by this plan									
	1.1	Preserve, restore, and manage populations and habitat for Fender's blue butterfly									
	1.1.1	Evaluate the status of extant populations									
1	1.1.1.1	Develop a standardized population monitoring protocol	Ongoing	FWS, NGO, University	3	3					
1	1.1.1.2	Survey existing populations and surrounding suitable habitats to determine geographic extent of populations	5	FWS, ACOE, BLM, ODOT, TNC, NGO	100	20	20	20	20	20	
1	1.1.1.3	Attempt to locate additional populations of Fender's blue butterfly by surveying suitable habitats in areas not currently known to support populations	Intermittent	FWS, ACOE, BLM, ODOT, TNC, NGO	65	5	5		5		5k every other yr after
	1.1.2	Identify and protect sites within potential functioning networks and at independent populations									
1	1.1.2.1	Identify and evaluate sites and populations for inclusion in the development of potential functioning networks and independent populations	Continuous	FWS, ACOE, BLM, ODOT, TNC, NGO	77	5	3	3	3	3	3K ea yr

Priority Number	Action Number	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $1,000 units)						Comments / Notes
					Total Costs	FY10	FY11	FY12	FY13	FY14	
2	1.1.2.2	Evaluate protected status of populations and sites identified for inclusion in all functioning networks and independent populations and ensure long-term protection of those not yet secured	Continuous	FWS	53	5	2	2	2	2	2K ea yr
2	1.1.3	Develop and implement management plans for each functioning network and independent population	Continuous	FWS, ACOE, BLM, ODOT, TNC, NGO	520	80	80	80	20	20	20K ea yr next 5 20K every other yr after
	1.1.4	Manage all functioning networks and independent populations to reduce threats and expand and increase populations									
	1.1.4.1	Set back succession and reduce competition from non-native plants.									
2	1.1.4.1.1	Prescribed fire	Intermittent	FWS, ACOE, BLM, ODOT, TNC, NGO	900	100			100		100K every 3rd yr
2	1.1.4.1.2	Mowing	Intermittent	FWS, ACOE, BLM, ODOT, TNC, NGO	780	60	60		60		60K every other yr after
2	1.1.4.1.3	Manual removal of woody plants	Intermittent	FWS, ACOE, BLM, ODOT, TNC, NGO	350	50	50	20		20	20K every other yr after

Priority Number	Action Number	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $1,000 units)						Comments / Notes
					Total Costs	FY10	FY11	FY12	FY13	FY14	
3	1.1.4.1.4	Habitat management using other methods as appropriate, pending results of ongoing and planned research	Intermittent	FWS, ACOE, BLM, ODOT, TNC, NGO	260	20		20		20	20K every other yr after
	1.1.4.2	Restore native prairie species, with an emphasis on larval host plants and adult nectaring sources.									
1	1.1.4.2.1	Restore and enhance populations of larval host plants	Intermittent	FWS, ACOE, BLM, ODOT, TNC, NGO	210	40	40	20		10	10K every other yr after
1	1.1.4.2.2	Restore and enhance populations of nectar sources	Intermittent	FWS, ACOE, BLM, ODOT, TNC, NGO	360	50	50	40		20	20K every other yr after
3	1.1.4.3	Evaluate and reduce grazing impacts from domestic stock, and assess the use of livestock grazing as a habitat management tool	5	FWS, USGS, University, NGO	65	20	20	10	10	5	
3	1.1.4.4	Evaluate and reduce impacts of wild herbivores, especially deer and voles	3	FWS, USGS, University, NGO	40	20	10	10			
3	1.1.4.5	Address threat from collection	Continuous	FWS	17	5		1		1	1K every other yr after
2	1.1.5	Coordinate with recovery efforts *for Lupinus sulphureus* ssp. *kincaidi*.	Continuous	FWS, ACOE, BLM, ODOT, TNC, NGO	61	10	5	2	2	2	2K ea yr
	1.1.6	Reintroduce and augment populations and restore habitat, as necessary, to meet recovery goals									

Priority Number	Action Number	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $1,000 units)						Comments / Notes
					Total Costs	FY10	FY11	FY12	FY13	FY14	
	1.1.6.1	Develop reintroduction protocol									
1	1.1.6.1.1	Develop a translocation protocol for establishing new populations using individuals from existing populations	1	FWS, RT	3	3					
2	1.1.6.1.2	Design a captive propagation and release program	1	FWS, NGO, Oregon Zoo	25	25					
2	1.1.6.2	Identify reintroduction and augmentation sites and establish connectivity between populations to create functioning networks and meet viability goals	Continuous	FWS, RT	38	10	10	2	2	2	2K every 3rd yr after
3	1.1.6.3	Manage and monitor reintroduced and augmented populations	Continuous	FWS, ACOE, BLM, ODOT, TNC, NGO	500	20	20	20	20	20	20K ea yr
3	1.1.7	Monitor population abundance and trend at all functioning network and independent population sites	Continuous	FWS, ACOE, BLM, ODOT, TNC, NGO	750	30	30	30	30	30	30K ea yr
3	1.1.8	Monitor prairie quality at all functioning network and independent population sites	Intermittent	FWS, ACOE, BLM, ODOT, TNC, NGO	190	40	40		10		10 K every other yr after
	1.2	Preserve, restore, and manage populations and habitat for *Erigeron decumbens* var. *decumbens*, *Lomatium bradshawii*, *Lupinus sulphureus* ssp. *kincaidii* and *Sidalcea nelsoniana*									

Priority Number	Action Number	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $1,000 units)						Comments / Notes
					Total Costs	FY10	FY11	FY12	FY13	FY14	
1	1.2.1	Evaluate the status of extant populations	5	FWS, ACOE, USFS, BLM, ODA, ODOT, WDNR, Tribe, TNC, NGO	1,200	100	100	100			25K/spp/yr/1st 3 yrs 1st 3 yrs/5-yr period
3	1.2.2	Survey extirpated sites and suitable habitat near these sites to determine if any of these populations may still persist	1	FWS, ACOE, BLM, ODA, WDNR, TNC, NGO	60	60					
	1.2.3	Select, protect, and manage population sites									
1	1.2.3.1	Select populations on which to focus recovery actions	1	FWS, ODA, WDNR	5	5					
2	1.2.3.2	Evaluate protected status of populations	1	FWS	20	20					
2	1.2.3.3	Secure conservation or management agreements for populations that are not yet protected	Continuous	FWS	600	80	80	80	80	80	40K every 3rd yr after
2	1.2.3.4	Develop site-specific management plans	Continuous	FWS, ACOE, BLM, ODA, WDNR, ODOT, Tribe, TNC, NGO	925	100	100	100	100	100	50K every yr 5-10; 25K every yr 11-15; 25K yr 17 & 19
	1.2.3.5	Manage populations to address threats and increase populations									
	1.2.3.5.1	Manage population sites to set back woody plant invasion and reduce competition from non-native plants									

Priority Number	Action Number	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $1,000 units)						Comments / Notes
					Total Costs	FY10	FY11	FY12	FY13	FY14	
2	1.2.3.5.1.1	Prescribed fire	Intermittent	FWS, ACOE, BLM, ODA, WDNR, ODOT, Tribe, TNC, NGO	1,470	210			210		40K/yr/ERDEDE 40K/yr/LUSUKI 60K/yr/LOBR 70K/yr/SINE every 3rd yr
2	1.2.3.5.1.2	Mowing	Intermittent	FWS, ACOE, BLM, ODA, WDNR, ODOT, Tribe, TNC, NGO	825	75		75		75	15K/yr/ERDEDE 15K/yr/LUSUKI 20K/yr/LOBR 25K/yr/SINE every other yr
2	1.2.3.5.1.3	Remove woody plants	Intermittent	FWS, ACOE, BLM, ODA, WDNR, ODOT, Tribe, TNC, NGO	180	40	40	40		10	10K every 3rd yr after
2	1.2.3.5.1.4	Eliminate non-native plants to extent practicable and restore native prairie species	Intermittent	FWS, ACOE, BLM, ODA, WDNR, ODOT, Tribe, TNC, NGO	225	35	35	35		20	20K every 3rd yr after
1	1.2.3.5.1.5	Work to discourage introduction of transgenic herbicide-resistant grasses in the region.		FWS	TBD						
2	1.2.3.5.2	Restore connectivity among populations	Continuous	FWS, ACOE, BLM, ODA, WDNR, ODOT, TNC, NGO	230	20	20	20	10	10	10K ea yr after
	1.2.3.5.3	Augment populations, as necessary									

Priority Number	Action Number	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $1,000 units)						Comments / Notes
					Total Costs	FY10	FY11	FY12	FY13	FY14	
1	1.2.3.5.3.1	Develop outplanting protocols for cultivated seedlings	1	FWS, ODA, WDNR, NGO	4	4					1K/plant spp
1	1.2.3.5.3.2	Develop protocols for site preparation and planting from seeds *in situ*	1	FWS, ODA, WDNR, NGO	8	8					2K/plant spp
2	1.2.3.5.3.3	Implement population augmentation	Intermittent	FWS, ODA, WDNR, NGO	TBD						
	1.2.4	Reintroduce populations and restore habitat, as necessary, to meet recovery goals									
1	1.2.4.1	Identify reintroduction sites	Intermittent	FWS, RT	40	10					10K every 5th yr
2	1.2.4.2	Conduct reintroductions.	Continuous	FWS, ACOE, BLM, ODA, WDNR, ODOT, TNC, NGO	825	80	80	80	80	80	50K every yr 5-10; 25K every yr 11-15; 10K every yr 16-20
	1.2.5	Monitor populations									
1	1.2.5.1	Develop a standardized monitoring protocol to monitor population abundance and evaluate population trends at all population sites	1	FWS, ODA, WDNR, NGO	12	12					3K/plant spp
2	1.2.5.2	Monitor populations and trends, evaluate effectiveness of management actions and apply adaptive management practices, as appropriate	Continuous	FWS, ACOE, BLM, ODA, WDNR, ODOT, Tribe, TNC, NGO	800	40	40	40	40	40	40K ea yr

Priority Number	Action Number	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $1,000 units)						Comments / Notes
					Total Costs	FY10	FY11	FY12	FY13	FY14	
3	1.2.6	Monitor prairie quality at all population sites	Intermittent	FWS, ACOE, BLM, ODA, WDNR, ODOT, Tribe, TNC, NGO	480	60	60		40		40K every other yr after
3	1.2.7	Collect and bank seeds	3	FWS, ODA, WDNR, ACOE, BLM, NGO, Berry Botanical	60	20	20	20			5K/plant spp
	1.3	Further research needed for the conservation of the species									
1	1.3.1	Determine the effect of herbicides on different lifestages of Fender's blue butterfly	Ongoing	FWS, University	30	20	10				
2	1.3.2	Develop guidelines for protection of Fender's blue butterfly and its habitat from pesticides	1	FWS, University	10	10					
1	1.3.3	Evaluate the dispersal ability of Fender's blue butterfly in various habitat types across the species' range	Ongoing	FWS, University	200						Fully funded; 2009 Completion date
3	1.3.4	Evaluate other models to predict the viability and persistence of Fender's blue butterfly populations based on new population locations and monitoring data	Once every 5 years	FWS, University, NGO	20	20					

Priority Number	Action Number	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $1,000 units)						Comments / Notes
					Total Costs	FY10	FY11	FY12	FY13	FY14	
3	1.3.5	Investigate the role of pollinators in supporting forb species needed for nectar species diversity	3	FWS, University, NGO	80	30	30	20			
2	1.3.6	Evaluate the effectiveness of different prairie management techniques	5	FWS, ODA, WDNR, ACOE, BLM, NGO, University	100	30	30	20	10	10	
3	1.3.7	Identify pollinators and determine habitat needs of pollinators	3	FWS, ODA, WDNR, NGO, University	90	40	40	10			
	1.3.8	Evaluate genetic variability within and among populations of the listed plant species									
3	1.3.8.1	Elucidate genetic differences between populations of *Erigeron decumbens* var. *decumbens* in wet prairie habitats and drier prairie habitats	3	FWS, ODA, NGO, University	70	30	20	20			
3	1.3.8.2	Evaluate incidence of hybridization and develop strategies to minimize potential hybridization	3	FWS, ODA, WDNR, NGO, University	130	50	50	30			2 spp - 0.5/spp
3	1.3.9	Research the role of vegetative versus sexual reproduction in *Erigeron decumbens* var. *decumbens*	3	FWS, ODA, NGO, University	50	20	20	10			

Priority Number	Action Number	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $1,000 units)						Comments / Notes
					Total Costs	FY10	FY11	FY12	FY13	FY14	
3	1.3.10	Evaluate the importance of mycorrhizae and other below-ground micro-organisms on plant performance	4	FWS, ODA, WDNR, NGO, University	180	50	50	40	40		
3	1.3.11	Assess the use of mowing as a tool to control vole populations	3	FWS, ODA, WDNR, NGO, University	50	20	20	10			
3	1.3.12	Evaluate interactions between listed species and non-native plants	5	FWS, ODA, WDNR, NGO, University	TBD						
2	1.3.13	Evaluate the use of livestock grazing as a tool to manage prairie habitat	3	FWS, ODA, WDNR, NGO, University	50	20	20	10			
2	1.3.14	Investigate innovative weeding and vegetation sampling techniques	4	FWS, ODA, WDNR, NGO, University	100	25	25	25	25		
3	1.3.15	Evaluate the threat of seed predation by weevils, and develop management strategies to control weevil damage, if needed	2	FWS, ODA, WDNR, NGO, University	20	10	10				
2	1.3.16	Identify factors that limit the expansion of populations of listed prairie plants	3	FWS, ODA, WDNR, NGO, University	45	15	15	15			
	1.3.17	Investigate the impacts of global climate change on habitats and species in the area covered by this recovery plan. Adapt management strategies as necessary									

Priority Number	Action Number	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $1,000 units)						Comments / Notes
					Total Costs	FY10	FY11	FY12	FY13	FY14	
2	1.3.17.1	Convene an expert panel to advise the recovery program on measures needed to respond or adapt to impending climate change effects to the listed species addressed in this recovery plan	5	FWS, USGS, ODA, WDNR, NGO, University	15	15					
2	1.3.17.2	Evaluate the role of habitat heterogeneity in buffering populations from the effects of changing climate patterns in the region	5	FWS, USGS, ODA, WDNR, NGO, University	TBD						
	1.4	Reintroduce *Castilleja levisecta* to the Willamette Valley									
2	1.4.1	Evaluate protected sites established for other listed prairie species in this plan as potential reintroduction sites for *Castilleja levisecta*	2	FWS, ODA, WDNR	20	10	10				
2	1.4.2	Reintroduce *Castilleja levisecta* to restored prairie sites	5	FWS, ODA, WDNR, BLM, NGO	100	20	20	20	20	20	
2	1.4.3	Manage and monitor reintroduced populations	Intermittent	FWS, ODA, WDNR, BLM, NGO	220	20	20		20		20K every other yr after
3	1.4.4	Monitor effectiveness of management actions and apply adaptive management practices, as appropriate	Intermittent	FWS, ODA, WDNR, BLM, NGO	180	30	30		20		20K every 3rd yr after

Priority Number	Action Number	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $1,000 units)						Comments / Notes
					Total Costs	FY10	FY11	FY12	FY13	FY14	
3	1.4.5	Evaluate the use of livestock grazing as a tool to manage populations of *Castilleja levisecta*	3	FWS, ODA, WDNR, BLM, NGO	40	20	10	10			
	2	Coordinate recovery actions to benefit other listed species and nonlisted prairie species of conservation concern									
	2.1	Determine current status of Taylor's checkerspot butterfly, *Delphinium leucophaeum, Delphinium oreganum, Delphinium pavonaceum, Horkelia congesta ssp. congesta, Sericocarpus rigidus* and *Sisyrinchium hitchcockii* in the area covered by the recovery plan									
	2.2	Protect and manage populations and habitats to ensure long-term survival, with an emphasis on sites managed for other listed prairie species addressed in this recovery plan									
	2.2.1	Protect private lands through conservation easements, land acquisition, or other means									

Priority Number	Action Number	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $1,000 units)						Comments / Notes
					Total Costs	FY10	FY11	FY12	FY13	FY14	
	2.3	Collect and bank seeds of *Delphinium leucophaeum, Delphinium oreganum, Delphinium pavonaceum, Horkelia congesta ssp. congesta, Sericocarpus rigidus* and *Sisyrinchium hitchcockii*									
	3	Promote protection of listed species and prairie restoration on private lands									
1	3.1	Develop an active program to engage private landowners in the conservation of listed and nonlisted prairie species and prairie habitat restoration	Continuous	FWS	220	20	20	10	10	10	10K ea yr after
2	3.2	Provide information about the species of interest, incentive programs for voluntary conservation efforts, and restoration and monitoring resources available to landowners	Continuous	FWS, ACOE, ODA, WDNR, BLM, NGO	400	60	60	60	10	10	10K ea yr after
2	3.3	Develop Safe Harbor Agreements for landowners interested in restoring prairie habitats for the Fender's blue butterfly and *Lupinus sulphureus* ssp. *kincaidii*	Continuous	FWS	630	60	60	60	30	20	20K ea yr after

Priority Number	Action Number	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $1,000 units)						Comments / Notes
					Total Costs	FY10	FY11	FY12	FY13	FY14	
	4	Cultivate partnerships with both public and private agencies and organizations to promote the conservation of prairie ecosystems and listed prairie species									
3	4.1	Establish a technical working group to review the effectiveness of management plans and recovery actions, monitor the status of the species, and coordinate conservation efforts	Intermittent	FWS, RT	50	10					10K every 5th yr
2	4.2	Educate the public about native prairies and the rare species that depend on them	3	FWS, ACOE, ODA, WDNR, BLM, NGO	54	30	12	12			
3	5	Revise and update recovery plan as needed	TBD	FWS, RT	TBD						
3	6	Develop post-delisting monitoring plans for each listed species prior to delisting	5	FWS	100						
				Total	**16,590**	**2,285**	**1,602**	**1,252**	**1,029**	**660**	

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Appendix A. Glossary of Scientific and Botanical Terms

Achene	A dry fruit that remains closed at maturity.
Acute	Sharply pointed.
Allele	Any of the different forms of a gene occupying the same locus on a chromosome.
Allopatric	Occupying different geographical regions.
Alluvial	Consisting of sediments deposited by flowing water.
Annual	A plant that germinates, flowers and seeds in a single season.
Anther	The pollen bearing portion of the stamen.
Anthropogenic	Caused by human activities.
Banner	An enlarged upper petal.
Basal	Forming the bottom.
Bidentate	Having two teeth.
Bract	A specialized leaf from the axil of which a flower arises.
Calyx	All the sepals of a flower, collectively.
Capillary	With the form of a hair.
Capitate	Headlike.
Capsule	A dry fruit, which opens at maturity, consisting of more than one carpel.

Carpel	The female reproductive part of a flower, which encloses the fertilized ovules.
Caudex	The persistent and often woody base of a herbaceous perennial.
Cauline	Pertaining to the stem.
Cespitose	Growing in tufts.
Chartaceous	Papery in texture.
Clone	A group of plants derived by vegetative propagation from a single parent individual, to which it is genetically identical.
Congener	An organism that belongs to the same genus as another.
Congested	Crowded together.
Cyme	An inflorescence in which the terminal flower blooms first.
Demographic	Relating to populations, especially age structure and growth rates.
Diapause	A period during which the metabolism of an animal slows down, temporarily suspending development and growth.
Disk flower	The tubular flowers in central part of a flower in the family Asteraceae.
Endemic	Native to, and restricted to, a particular geographical region.
Exogenous	Originating from outside the system.
Facultative	Not obligatory, but capable of adapting to different conditions.
Filiform	Slender, threadlike.

Follicle	A dry fruit, composed of one carpel, which at maturity opens along the seed bearing suture.
Forb	A broad-leaved, non-grassy herb.
Geitonogamy	Fertilization between different flowers on the same plant.
Genotypic	Related to the genetic or hereditary constitution of an individual.
Germination	Growing from a seed into a new individual.
Glabrous	Smooth, without hairs or glands.
Glandular	Producing a sticky substance.
Glacio-lacustrine	Pertaining to a lake formed by a glacier.
Globose	Spherical.
Graminoid	Grass-like.
Hemi-parasitic	Used of a plant species that can photosynthesize and survive without a host plant, but which may derive some part of its nutrition by parasitizing other plants.
Herbaceous	Not woody, dying back to the ground at the end of the season.
Hermaphroditic	Of a plant that has both male and female reproductive organs.
Herpetofauna	Reptiles and amphibians.
Heterogeneous	Having a non-uniform structure or composition.
Hirsute	Hairy.
Hybridization	Combination of the genes of two different species or subspecies.
Imbricate	Arranged in a tight spiral.

Inbreeding depression	Reduction of fitness and vigor caused by the crossing of closely related individuals.
Indeterminate	Blooming from the bottom or outside towards the top or center.
Inflorescence	The arrangement of flowers on the axil.
Instar	In the life cycle of an insect, the stage between two successive molts.
Involucre	A set of bracts subtending a flower or flower cluster.
Keel	The two partly united lower petals of many legumes.
Larva	An immature, wingless form of an insect.
Leaflet	The ultimate unit of a compound leaf.
Lepidopteran	Of butterflies and moths.
Microhabitat	An environment that has a unique set of conditions within a larger habitat.
Oblanceolate	Lance-shaped, with the broadest part towards the apex.
Outcross	Mating between individuals that are less closely related than average pairs in the population.
Oviposition	The act of laying eggs.
Palmate	Lobed from a common point, like the fingers of a hand.
Pappus	The modified calyx crowning the ovary of Asteraceae flowers.
Parapatric	Used of populations whose geographic ranges are contiguous but not overlapping, so that gene flow between them is possible.
Perennial	A plant that lives more than two years.

Perfect	Having both male and female reproductive parts on the same flower.
Petiole	A leaf stalk.
Phenology	The relationship between a recurring biological phenomenon and the environmental factors that influence it.
Phytophagous	Feeding on plants; herbivorous.
Pinnate	Having two rows of appendages on either side of an axil, similar to a feather.
Polyploidy	Having more than two sets of homologous chromosomes.
Population	A group of individuals of one species, occupying a defined area, and usually isolated to some degree from other similar groups.
Population growth rate	The finite rate of increase of the population in one time step (usually 1 year), denoted as λ (lambda). When $\lambda = 1$, the population is stable; if $\lambda < 1$, the population is declining and if $\lambda > 1$, the population is growing.
Prairie	Open native grasslands or the grassland understories of savanna habitats.
Prostrate	Flat on the ground.
Protandry	Maturation of male flowers before female flowers on a single plant.
Protogyny	Maturation of female flowers before male flowers on a single plant.
Pubescent	Hairy.
Pupal	Pertaining to an insect at the stage between a larva and an adult.
Raceme	An inflorescence in which the flowers are borne on short stalks along a long main stem.

Ramet	A member of a clone.
Ray flower	The ligulate (strap-shaped) flower at the edge of a flowering head in the family Asteraceae.
Reticulate	In the form of a network.
Rhizome	A creeping underground stem.
Ruderal	Barren or weedy early-successional habitat.
Savanna	A biological community that is dominated by scattered trees and large areas of grasses and other forbs.
Scarification	Breaking the outer cover of hard seeds; often assists germination.
Senesce	To decline with age.
Selfing	Self fertilizing or self-pollinating.
Self-incompatible	Not capable of self-pollination.
Sepal	A modified leaf that encloses the petals and other parts of a flower.
Sessile	Permanently attached at the base.
Stamen	The male reproductive organ of a flower, consisting of an anther and filament.
Stochastic	Random.
Style	The usually narrowed portion of the pistil connecting the stigma to the ovary.
Succession	The gradual and predictable process of progressive community

	change (*e.g.*, gradual replacement of prairie habitat by trees and shrubs).
Sympatric	Populations, species or taxa occurring in the same geographical area; literally growing near each other.
Taproot	A large main root.
Taxon	Any taxonomic entity of whatever rank.
Tepal	A member or segment of a flower perianth in which the parts are not differentiated into distinct sepals and petals.
Type specimen	The designated individual that is the type of a species or subspecies.
Umbel	A flat-topped or convex inflorescence with the pedicels arising from a common point.
Umbellet	An ultimate umbellate cluster of a compound umbel.
Vagility	The tendency of an organism or population to change its location or distribution with time.
Variance	A statistical term which provides a measure of dispersion of values around the mean.
Vegetative	Pertaining to somatic, rather than reproductive, plant material.
Vesicular-arbuscular mycorrhizae	Structures formed by mutualistic associations between plant roots and fungi which assist in inorganic nutrient uptake by the plant.
Viable, Viability	Maintaining the ability to persist into the future.

Appendix B. Plant Population Sites and Area Summaries

Given the very large number of plant locations across the range of this recovery plan, we have, at best, inconsistent data on plant population sizes. Lacking this information, we present cover area as a surrogate for number of plants at a site. Note that "sites" are determined by landownership, and are not necessarily equivalent to a plant population (*i.e.*, a single population may extend across several different ownerships).

Table B-1. Plant population sites and cover area. (Source: U.S. Fish and Wildlife Service, unpublished data).

Recovery Zone	Site Name	Species Code*	Acres Class	Acres	Hectares
Coast Range	Brown's Camp East	SINE	1 to 5	1.55	0.63
Coast Range	Brown's Camp West	SINE	1 to 5	1.33	0.54
Coast Range	Meadow Lake	SINE	>100	111.98	45.32
Coast Range	Nestucca River	SINE	1 to 5	3.56	1.44
Coast Range	North Fork - Tillamook Burn	SINE	< 1	0.18	0.07
Coast Range	Second Growth - Barney Reservoir	SINE	< 1	0.64	0.26
Coast Range	Tillamook Burn 1	SINE	>5 to 20	5.60	2.27
Coast Range	Tillamook Burn 2	SINE	< 1	0.83	0.33
Coast Range	Walker Flat	SINE	>5 to 20	10.98	4.44
Coast Range	Wood Point Quad	SINE	< 1	0.93	0.38
Corvallis East	(Private landowner name suppressed)	ERDED	< 1	0.02	0.01
Corvallis East	Oak Creek (NWR)	LOBR	>5 to 20	12.48	5.05
Corvallis East	Sweet Home quad	LOBR	>20 to 100	52.66	21.31
Corvallis West	(Private landowner name suppressed)	ERDED	1 to 5	1.88	0.76
Corvallis West	Bald Hill	ERDED	>5 to 20	7.70	3.12
Corvallis West	Finley NWR, North	ERDED	< 1	0.01	<0.01
Corvallis West	(Private landowner name suppressed)	LOBR	>5 to 20	16.95	6.86
Corvallis West	Corvallis/Conifer Blvd	LOBR	1 to 5	1.46	0.59
Corvallis West	E4	LOBR	< 1	0.05	0.02
Corvallis West	Finley NWR	LOBR	1 to 5	4.85	1.96
Corvallis West	Finley NWR, North	LOBR	>5 to 20	12.53	5.07
Corvallis West	(Private landowner name suppressed)	LOBR	< 1	0.08	0.03
Corvallis West	Jackson Frazier Wetland	LOBR	>20 to 100	22.39	9.06
Corvallis West	(Private landowner name suppressed)	LOBR	< 1	< 0.01	< 0.01
Corvallis West	Beazell Memorial Forest	LUSU	< 1	0.15	0.06
Corvallis West	Benton Bowmen	LUSU	< 1	0.03	0.01
Corvallis West	Blakesley Creek	LUSU	< 1	0.01	<0.01

Table B-1. Plant population sites and cover area. (Source: U.S. Fish and Wildlife Service, unpublished data).

Recovery Zone	Site Name	Species Code*	Acres Class	Acres	Hectares
Corvallis West	Blakesley Creek	LUSUK	< 1	0.01	<0.01
Corvallis West	Blakesly Creek Road	LUSUK	< 1	< 0.01	< 0.01
Corvallis West	(Private landowner name suppressed)	LUSUK	1 to 5	4.44	1.80
Corvallis West	Bruce Rd. I	LUSUK	< 1	0.02	0.01
Corvallis West	Butterfly Meadows	LUSUK	>20 to 100	52.94	21.42
Corvallis West	Camp Adair	LUSUK	>20 to 100	28.99	11.73
Corvallis West	Cardwell Hill Roadside	LUSUK	< 1	0.01	<0.01
Corvallis West	Champion	LUSUK	< 1	< 0.01	< 0.01
Corvallis West	Cherry Ck Rd	LUSUK	< 1	< 0.01	< 0.01
Corvallis West	Cherry Creek Road	LUSUK	1 to 5	2.42	0.98
Corvallis West	(Private landowner name suppressed)	LUSUK	>5 to 20	11.09	4.49
Corvallis West	Corvallis Elks Club Rifle Range	LUSUK	< 1	0.09	0.03
Corvallis West	Corvallis Elks' Club Rifle Range	LUSUK	< 1	< 0.01	< 0.01
Corvallis West	(Private landowner name suppressed)	LUSUK	>5 to 20	14.77	5.98
Corvallis West	Diamond A Farms LLC	LUSUK	< 1	0.01	<0.01
Corvallis West	E.E. Wilson Wildlife Management Area, North	LUSUK	1 to 5	3.22	1.30
Corvallis West	E.E. Wilson Wildlife Management Area, South	LUSUK	< 1	0.05	0.02
Corvallis West	E4	LUSUK	< 1	< 0.01	<0.01
Corvallis West	Easterling road	LUSUK	< 1	0.02	0.01
Corvallis West	(Private landowner name suppressed)	LUSUK	< 1	0.18	0.07
Corvallis West	Finley NWR	LUSUK	1 to 5	4.90	1.98
Corvallis West	(Private landowner name suppressed)	LUSUK	< 1	0.03	0.01
Corvallis West	(Private landowner name suppressed)	LUSUK	< 1	0.01	< 0.01
Corvallis West	(Private landowner name suppressed)	LUSUK	< 1	< 0.01	< 0.01
Corvallis West	(Private landowner name suppressed)	LUSUK	< 1	< 0.01	< 0.01
Corvallis West	(Private landowner name suppressed)	LUSUK	< 1	0.01	<0.01
Corvallis West	(Private landowner name suppressed)	LUSUK	< 1	0.03	0.01
Corvallis West	Henkle Way Hwy 34	LUSUK	< 1	0.12	0.05
Corvallis West	Herbert	LUSUK	< 1	0.02	0.01
Corvallis West	(Private landowner name suppressed)	LUSUK	< 1	0.23	0.09
Corvallis West	Hwy 34	LUSUK	< 1	< 0.01	< 0.01
Corvallis West	(Private landowner name suppressed)	LUSUK	< 1	0.02	0.01
Corvallis West	(Private landowner name suppressed)	LUSUK	< 1	0.69	0.28

Table B-1. Plant population sites and cover area. (Source: U.S. Fish and Wildlife Service, unpublished data).

Recovery Zone	Site Name	Species Code*	Acres Class	Acres	Hectares
Corvallis West	Jackson Frazier Wetland	LUSUK	< 1	0.07	0.03
Corvallis West	Kings Valley	LUSUK	1 to 5	3.09	1.25
Corvallis West	Kings Valley Labare Road	LUSUK	< 1	< 0.01	< 0.01
Corvallis West	(Private landowner name suppressed)	LUSUK	< 1	0.04	0.02
Corvallis West	LaBare Rd County ROW	LUSUK	< 1	0.05	0.02
Corvallis West	LaBare Road	LUSUK	< 1	0.05	0.02
Corvallis West	(Private landowner name suppressed)	LUSUK	< 1	0.01	<0.01
Corvallis West	(Private landowner name suppressed)	LUSUK	< 1	< 0.01	< 0.01
Corvallis West	(Private landowner name suppressed)	LUSUK	< 1	0.07	0.03
Corvallis West	Lillian Corner	LUSUK	< 1	0.01	<0.01
Corvallis West	Lupine Meadows (West Hills)	LUSUK	>5 to 20	8.35	3.38
Corvallis West	(Private landowner name suppressed)	LUSUK	< 1	0.01	<0.01
Corvallis West	(Private landowner name suppressed)	LUSUK	< 1	0.05	0.02
Corvallis West	(Private landowner name suppressed)	LUSUK	< 1	0.04	0.02
Corvallis West	(Private landowner name suppressed)	LUSUK	< 1	0.32	0.13
Corvallis West	Oak Creek Road	LUSUK	1 to 5	2.13	0.86
Corvallis West	(Private landowner name suppressed)	LUSUK	1 to 5	2.45	0.99
Corvallis West	Picht	LUSUK	< 1	0.24	0.10
Corvallis West	Price Creek	LUSUK	< 1	0.07	0.03
Corvallis West	(Private landowner name suppressed)	LUSUK	< 1	0.04	0.02
Corvallis West	(Private landowner name suppressed)	LUSUK	< 1	0.01	<0.01
Corvallis West	(Private landowner name suppressed)	LUSUK	< 1	< 0.01	< 0.01
Corvallis West	Soap Creek Ranch	LUSUK	1 to 5	1.68	0.68
Corvallis West	Soap Creek Riparian	LUSUK	< 1	< 0.01	< 0.01
Corvallis West	TNC Wren Preserve	LUSUK	>5 to 20	15.05	6.09
Corvallis West	TNC easement-Weyerhaeuser	LUSUK	< 1	0.03	0.01
Corvallis West	Tanager	LUSUK	1 to 5	3.30	1.33
Corvallis West	W & V Phillips LLC	LUSUK	< 1	< 0.01	< 0.01
Corvallis West	Ward Rd.	LUSUK	< 1	0.02	0.01
Corvallis West	(Private landowner name suppressed)	SINE	1 to 5	1.03	0.42
Corvallis West	(Private landowner name suppressed)	SINE	1 to 5	2.52	1.02
Corvallis West	Ashbrook	SINE	< 1	0.03	0.01
Corvallis West	Bellfountain Road	SINE	1 to 5	4.29	1.74
Corvallis West	Bald Hill	SINE	< 1	0.41	0.17
Corvallis West	Bellfountain at junction with Bruce	SINE	< 1	0.32	0.13
Corvallis West	Chapel Rd.	SINE	< 1	< 0.01	< 0.01
Corvallis West	Decker Road	SINE	1 to 5	1.62	0.65

Table B-1. Plant population sites and cover area. (Source: U.S. Fish and Wildlife Service, unpublished data).

Recovery Zone	Site Name	Species Code*	Acres Class	Acres	Hectares
Corvallis West	Dunawi Creek	SINE	>20 to 100	30.55	12.36
Corvallis West	E.E. Wilson Wildlife Management Area, North	SINE	< 1	0.27	0.11
Corvallis West	E4	SINE	< 1	0.16	0.07
Corvallis West	Fern Rd.	SINE	< 1	0.11	0.04
Corvallis West	Finley NWR	SINE	>20 to 100	59.73	24.17
Corvallis West	Finley NWR, North	SINE	>20 to 100	51.39	20.80
Corvallis West	(Private landowner name suppressed)	SINE	< 1	0.43	0.17
Corvallis West	(Private landowner name suppressed)	SINE	< 1	< 0.01	< 0.01
Corvallis West	Holiday Tree Farms	SINE	1 to 5	1.82	0.74
Corvallis West	Jackson Frazier Wetland	SINE	1 to 5	1.91	0.77
Corvallis West	Lewisburg	SINE	1 to 5	3.20	1.30
Corvallis West	Llewellyn Rd. ROW	SINE	< 1	0.01	<0.01
Corvallis West	Lupine Meadows (West Hills)	SINE	< 1	0.34	0.14
Corvallis West	(Private landowner name suppressed)	SINE	< 1	<0.01	<0.01
Corvallis West	Martin Luther King Jr. Park	SINE	< 1	0.09	0.04
Corvallis West	(Private landowner name suppressed)	SINE	< 1	0.01	0.01
Corvallis West	OSU Horse Barn	SINE	>20 to 100	35.35	14.31
Corvallis West	OSU Poultry	SINE	1 to 5	4.58	1.86
Corvallis West	Owens Farm	SINE	1 to 5	4.57	1.85
Corvallis West	Philomath Blvd.	SINE	< 1	<0.01	<0.01
Corvallis West	Philomath Blvd. property	SINE	< 1	0.01	<0.01
Corvallis West	Philomath Blvd. property-SINE	SINE	< 1	0.01	<0.01
Corvallis West	(Private landowner name suppressed)	SINE	< 1	0.01	0.01
Corvallis West	(Private landowner name suppressed)	SINE	< 1	<0.01	<0.01
Corvallis West	Soap Creek Riparian	SINE	< 1	0.04	0.02
Corvallis West	Tampico & Soap Creek Road	SINE	1 to 5	1.35	0.55
Corvallis West	(Private landowner name suppressed)	SINE	< 1	<0.01	<0.01
Corvallis West	Walnut Park	SINE	1 to 5	4.77	1.93
Corvallis West	WBP-1-SINE	SINE	< 1	<0.01	<0.01
Corvallis West	Wren	SINE	>5 to 20	9.24	3.74
Corvallis West	Holiday Tree Farms/Philomath	SINE	< 1	<0.01	<0.01
Douglas County	Callahan Meadows	LUSUK	< 1	0.40	0.16
Douglas County	Callahan Ridge	LUSUK	< 1	0.14	0.06

Table B-1. Plant population sites and cover area. (Source: U.S. Fish and Wildlife Service, unpublished data).

Recovery Zone	Site Name	Species Code*	Acres Class	Acres	Hectares
Douglas County	Callahan Ridge, Forest Service	LUSUK	< 1	0.14	0.06
Douglas County	China Ditch	LUSUK	1 to 5	2.58	1.04
Douglas County	Corner Brass Cap	LUSUK	< 1	0.93	0.37
Douglas County	Dahl population, along Ollala Road.	LUSUK	< 1	0.18	0.07
Douglas County	Dickerson	LUSUK	< 1	0.06	0.03
Douglas County	Dickerson Heights	LUSUK	< 1	0.06	0.03
Douglas County	Doe Creek	LUSUK	< 1	0.77	0.31
Douglas County	Drain Hills	LUSUK	< 1	0.01	<0.01
Douglas County	Letitia Creek	LUSUK	1 to 5	2.16	0.88
Douglas County	Letitia Creek	LUSUK	< 1	0.41	0.16
Douglas County	Letitia Creek	LUSUK	>5 to 20	7.23	2.93
Douglas County	Milo Population	LUSUK	< 1	0.47	0.19
Douglas County	North Catching & Russel Creeks	LUSUK	1 to 5	1.69	0.68
Douglas County	Ollala Creek	LUSUK	< 1	0.59	0.24
Douglas County	Riser	LUSUK	1 to 5	2.92	1.18
Douglas County	Slide Creek (Riser Creek)	LUSUK	< 1	0.38	0.15
Douglas County	South Catching & Russell Creeks	LUSUK	1 to 5	4.58	1.85
Douglas County	Stouts	LUSUK	1 to 5	3.55	1.43
Douglas County	Stouts Creek	LUSUK	1 to 5	2.03	0.82
Douglas County	Tenmile	LUSUK	< 1	0.03	0.01
Douglas County	Tiller Quad	LUSUK	1 to 5	2.04	0.83
Eugene East	Belts Road	ERDED	1 to 5	2.63	1.06
Eugene East	McKenzie View Drive	ERDED	1 to 5	1.46	0.59
Eugene East	Aster Street Prairie	LOBR	< 1	0.02	0.01
Eugene East	Buford Park	LOBR	1 to 5	1.76	0.71
Eugene East	Buford Recreation Area	LOBR	< 1	0.17	0.07
Eugene East	(Private landowner name suppressed)	LOBR	< 1	0.14	0.06
Eugene East	(Private landowner name suppressed)	LOBR	>20 to 100	56.66	22.93
Eugene East	Springfield quad	LOBR	1 to 5	1.64	0.66
Eugene East	Buford Recreation Area	LUSUK	< 1	0.11	0.05
Eugene East	Coburg North	LUSUK	1 to 5	2.47	1.00
Eugene East	Coburg South Slope (Baldy)	LUSUK	< 1	0.23	0.09
Eugene East	Eagle's Rest	LUSUK	< 1	0.76	0.31
Eugene East	Oak Basin	LUSUK	< 1	0.71	0.29
Eugene East	Walterville Canal	LUSUK	1 to 5	1.59	0.64
Eugene West	Balboa	ERDED	>5 to 20	5.51	2.23

Table B-1. Plant population sites and cover area. (Source: U.S. Fish and Wildlife Service, unpublished data).

Recovery Zone	Site Name	Species Code*	Acres Class	Acres	Hectares
Eugene West	East Coyote	ERDED	>5 to 20	6.65	2.69
Eugene West	Fisher Butte	ERDED	>20 to 100	42.26	17.10
Eugene West	Fisher Butte Dike	ERDED	>5 to 20	5.95	2.41
Eugene West	Hazel	ERDED	< 1	<0.01	<0.01
Eugene West	Lanel Substation	ERDED	1 to 5	1.45	0.59
Eugene West	North Greenhill	ERDED	1 to 5	3.04	1.23
Eugene West	Oxbow West	ERDED	>5 to 20	11.83	4.79
Eugene West	Sanford Road	ERDED	1 to 5	1.68	0.68
Eugene West	Speedway	ERDED	>5 to 20	12.84	5.20
Eugene West	Speedway East	ERDED	>5 to 20	7.54	3.05
Eugene West	Spencer Creek	ERDED	1 to 5	1.08	0.44
Eugene West	Spencer Creek Northwest	ERDED	< 1	<0.01	<0.01
Eugene West	Spencer Creek West	ERDED	< 1	<0.01	<0.01
Eugene West	Vinci	ERDED	>20 to 100	33.77	13.66
Eugene West	Wallis Street	ERDED	1 to 5	2.49	1.01
Eugene West	West 11	ERDED	>5 to 20	8.51	3.44
Eugene West	Willow Creek Bailey Hill	ERDED	1 to 5	3.77	1.53
Eugene West	Willow Creek Daisy	ERDED	>5 to 20	13.99	5.66
Eugene West	Willow Creek North	ERDED	< 1	0.48	0.19
Eugene West	Willow Creek Preserve	ERDED	>5 to 20	15.09	6.11
Eugene West	1250 Bertelsen Rd	LOBR	1 to 5	1.93	0.78
Eugene West	Acorn Park	LOBR	< 1	0.02	0.01
Eugene West	Amazon Park Site	LOBR	1 to 5	3.83	1.55
Eugene West	Balboa	LOBR	< 1	0.28	0.12
Eugene West	Camas Swale	LOBR	< 1	0.02	0.01
Eugene West	Cheshire quad	LOBR	< 1	0.48	0.20
Eugene West	Dragon Fly Bend	LOBR	1 to 5	1.93	0.78
Eugene West	East Coyote	LOBR	>5 to 20	5.17	2.09
Eugene West	Eugene East quad	LOBR	1 to 5	1.93	0.78
Eugene West	Eugene West quad	LOBR	1 to 5	3.88	1.57
Eugene West	Fern Ridge Dam	LOBR	1 to 5	1.93	0.78
Eugene West	Fern Ridge Reservoir - Amazon	LOBR	>20 to 100	51.00	20.64
Eugene West	Fern Ridge Reservoir - Amazon Dike #2	LOBR	1 to 5	3.42	1.38
Eugene West	Fern Ridge Reservoir - East Coyote Dikes	LOBR	>5 to 20	8.25	3.34
Eugene West	Fern Ridge Reservoir - Kirk Pond	LOBR	< 1	0.09	0.03

Table B-1. Plant population sites and cover area. (Source: U.S. Fish and Wildlife Service, unpublished data).

Recovery Zone	Site Name	Species Code*	Acres Class	Acres	Hectares
Eugene West	Fern Ridge Reservoir - Wildrose Lane	LOBR	>5 to 20	19.34	7.83
Eugene West	Fisher Butte	LOBR	>20 to 100	30.88	12.50
Eugene West	Fisher Butte West	LOBR	>5 to 20	13.37	5.41
Eugene West	Fox Hollow quad	LOBR	1 to 5	3.86	1.56
Eugene West	Junction City	LOBR	< 1	0.33	0.14
Eugene West	Long Tom River	LOBR	>5 to 20	7.18	2.91
Eugene West	Lanel Substation	LOBR	1 to 5	1.18	0.48
Eugene West	Long Tom ACEC	LOBR	< 1	0.38	0.16
Eugene West	Nielsen Road	LOBR	1 to 5	4.84	1.96
Eugene West	North Fisher Butte	LOBR	>5 to 20	10.13	4.10
Eugene West	North Greenhill	LOBR	< 1	0.75	0.30
Eugene West	North Taylor	LOBR	< 1	0.04	0.02
Eugene West	Oxbow West	LOBR	1 to 5	3.86	1.56
Eugene West	Rosy	LOBR	< 1	0.28	0.11
Eugene West	Royal Amazon	LOBR	>5 to 20	11.66	4.72
Eugene West	Short Mountain Landfill	LOBR	1 to 5	2.51	1.01
Eugene West	South Eugene High School	LOBR	< 1	0.01	<0.01
Eugene West	South Eugene High School	LOBR	< 1	0.11	0.05
Eugene West	South Green Oaks	LOBR	>5 to 20	6.02	2.44
Eugene West	Speedway	LOBR	1 to 5	4.30	1.74
Eugene West	Speedway East	LOBR	1 to 5	2.71	1.10
Eugene West	Veneta	LOBR	1 to 5	2.79	1.13
Eugene West	Veneta	LOBR	>5 to 20	13.46	5.45
Eugene West	Veneta quad	LOBR	1 to 5	1.93	0.78
Eugene West	Vinci	LOBR	1 to 5	1.66	0.67
Eugene West	West Eugene Wetland Site B-3, in part	LOBR	1 to 5	1.93	0.78
Eugene West	Wallis Street	LOBR	< 1	0.28	0.11
Eugene West	Willow Creek Daisy	LOBR	< 1	0.94	0.38
Eugene West	Willow Creek Preserve	LOBR	>20 to 100	32.94	13.33
Eugene West	Big Spires	LUSUK	1 to 5	1.04	0.42
Eugene West	Dragon Fly Bend	LUSUK	1 to 5	2.15	0.87
Eugene West	East Shore	LUSUK	< 1	0.90	0.36
Eugene West	East Spires	LUSUK	< 1	0.04	0.02
Eugene West	Fern Ridge Unit H Site 1	LUSUK	1 to 5	2.00	0.81
Eugene West	Fir Butte	LUSUK	>20 to 100	22.00	8.90

Table B-1. Plant population sites and cover area. (Source: U.S. Fish and Wildlife Service, unpublished data).

Recovery Zone	Site Name	Species Code*	Acres Class	Acres	Hectares
Eugene West	Fir Butte Rd	LUSUK	1 to 5	3.47	1.41
Eugene West	Fir Butte Road Royal Ave	LUSUK	1 to 5	1.68	0.68
Eugene West	Hillaire Road	LUSUK	>5 to 20	17.23	6.97
Eugene West	Horkelia Prairie	LUSUK	< 1	0.01	0.01
Eugene West	Isabelle	LUSUK	< 1	0.44	0.18
Eugene West	Nielsen Road	LUSUK	>5 to 20	13.67	5.53
Eugene West	North Eaton	LUSUK	1 to 5	2.42	0.98
Eugene West	North Fisher Butte	LUSUK	< 1	0.45	0.18
Eugene West	North Green Oaks	LUSUK	>5 to 20	9.09	3.68
Eugene West	North Greenhill	LUSUK	< 1	0.04	0.02
Eugene West	Oxbow West	LUSUK	1 to 5	1.58	0.64
Eugene West	(Private landowner name suppressed)	LUSUK	1 to 5	2.11	0.85
Eugene West	(Private landowner name suppressed)	LUSUK	1 to 5	3.12	1.26
Eugene West	Royal Amazon	LUSUK	< 1	0.06	0.02
Eugene West	Schultz Experimental Site 2	LUSUK	1 to 5	1.19	0.48
Eugene West	Schultz Fitzpatrick Experimental Sites	LUSUK	1 to 5	2.09	0.85
Eugene West	South Eaton	LUSUK	1 to 5	2.45	0.99
Eugene West	South Green Oaks	LUSUK	>5 to 20	5.51	2.23
Eugene West	Turtle Swale	LUSUK	1 to 5	1.50	0.61
Eugene West	West Lawn Cemetery	LUSUK	>5 to 20	8.63	3.49
Eugene West	West Shore	LUSUK	< 1	0.94	0.38
Eugene West	West Spires	LUSUK	1 to 5	1.81	0.73
Eugene West	Willow Creek Bailey Hill	LUSUK	>5 to 20	5.90	2.39
Eugene West	Willow Creek Fir Grove	LUSUK	1 to 5	1.81	0.73
Eugene West	Willow Creek Main	LUSUK	>5 to 20	9.88	4.00
Eugene West	Willow Creek North	LUSUK	1 to 5	2.31	0.94
Salem East	Heritage	ERDED	< 1	0.12	0.05
Salem East	Kingston Meadows Preserve	ERDED	>5 to 20	12.95	5.24
Salem East	Lone Fir Cemetery	ERDED	1 to 5	2.49	1.01
Salem East	Shelburne Drive	ERDED	< 1	0.16	0.07
Salem East	Starlight Road	ERDED	1 to 5	3.91	1.58
Salem East	Sublimity Grasslands	ERDED	1 to 5	2.13	0.86
Salem East	Kingston Meadows Preserve	LOBR	>5 to 20	5.83	2.36
Salem East	Sublimity Grasslands	LOBR	1 to 5	3.90	1.58
Salem East	Aumsville Ponds	SINE	1 to 5	2.08	0.84
Salem East	Burkland Lumber (At Turner)	SINE	>5 to 20	6.35	2.57

Table B-1. Plant population sites and cover area. (Source: U.S. Fish and Wildlife Service, unpublished data).

Recovery Zone	Site Name	Species Code*	Acres Class	Acres	Hectares
Salem East	Fletcher Road	SINE	1 to 5	1.72	0.69
Salem East	Hess Road	SINE	>20 to 100	22.29	9.02
Salem East	Ridge Drive	SINE	>5 to 20	7.35	2.97
Salem East	Salem Airport; Turner Road	SINE	>100	234.37	94.85
Salem East	Santiam Interchange	SINE	>5 to 20	8.18	3.31
Salem East	Salem Airport	SINE	1 to 5	1.13	0.46
Salem East	Salem Fletcher Road	SINE	< 1	0.11	0.04
Salem East	Salem Santiam Interchange	SINE	1 to 5	2.19	0.89
Salem East	Walker Road	SINE	1 to 5	3.43	1.39
Salem East	Wipper Road (Battle Creek)	SINE	< 1	0.06	0.02
Salem West	Baskett Butte North	ERDED	< 1	0.78	0.31
Salem West	Baskett Butte South	ERDED	1 to 5	4.39	1.77
Salem West	(Private landowner name suppressed)	ERDED	< 1	<0.01	<0.01
Salem West	Grande Ronde	ERDED	>5 to 20	12.97	5.25
Salem West	Grand Ronde	ERDED	1 to 5	1.47	0.59
Salem West	Mill Creek	ERDED	< 1	0.04	0.02
Salem West	(Private landowner name suppressed)	LUSUK	< 1	0.10	0.04
Salem West	ODOT	LUSUK	< 1	0.79	0.32
Salem West	Lee Road	LUSUK	>5 to 20	7.72	3.12
Salem West	Baskett Butte North	LUSUK	>20 to 100	62.26	25.19
Salem West	Baskett Butte South	LUSUK	>100	130.65	52.87
Salem West	(Private landowner name suppressed)	LUSUK	< 1	0.31	0.12
Salem West	Carlton	LUSUK	1 to 5	3.34	1.35
Salem West	Cooper Hollow	LUSUK	< 1	<0.01	<0.01
Salem West	Cove Orchard	LUSUK	< 1	0.57	0.23
Salem West	Dallas	LUSUK	>5 to 20	7.01	2.84
Salem West	Deer Creek Park	LUSUK	< 1	0.17	0.07
Salem West	Elkins Road	LUSUK	< 1	0.45	0.18
Salem West	Fern Creek	LUSUK	< 1	<0.01	<0.01
Salem West	(Private landowner name suppressed)	LUSUK	1 to 5	3.17	1.28
Salem West	Gopher Valley Dupee Road	LUSUK	>5 to 20	10.48	4.24
Salem West	Hacker Road	LUSUK	< 1	0.04	0.02
Salem West	(Private landowner name suppressed)	LUSUK	>5 to 20	5.09	2.06
Salem West	(Private landowner name suppressed)	LUSUK	>5 to 20	5.08	2.06
Salem West	(Private landowner name suppressed)	LUSUK	< 1	0.43	0.17
Salem West	(Private landowner name suppressed)	LUSUK	1 to 5	3.67	1.49
Salem West	McTimmonds Valley Shady Lane	LUSUK	>5 to 20	6.17	2.50

Table B-1. Plant population sites and cover area. (Source: U.S. Fish and Wildlife Service, unpublished data).

Recovery Zone	Site Name	Species Code*	Acres Class	Acres	Hectares
Salem West	Mill Creek	LUSUK	1 to 5	3.53	1.43
Salem West	Muddy Valley	LUSUK	< 1	0.43	0.17
Salem West	ODOT, Hwy 22	LUSUK	< 1	0.02	0.01
Salem West	ODOT, Hwy 99, MP 33	LUSUK	1 to 5	1.59	0.64
Salem West	ODOT, Loop Road	LUSUK	< 1	0.42	0.17
Salem West	ODOT, Sheridan	LUSUK	1 to 5	1.52	0.62
Salem West	Oak Ridge North	LUSUK	>5 to 20	6.01	2.43
Salem West	Oak Ridge South	LUSUK	< 1	<0.01	<0.01
Salem West	Old Moores Valley Road	LUSUK	< 1	0.07	0.03
Salem West	Parker Road	LUSUK	< 1	0.01	0.01
Salem West	Puddy Gulch Road	LUSUK	< 1	0.04	0.01
Salem West	(Private landowner name suppressed)	LUSUK	>5 to 20	9.41	3.81
Salem West	(Private landowner name suppressed)	LUSUK	< 1	0.70	0.29
Salem West	Zena Property	LUSUK	>5 to 20	7.12	2.88
Salem West	Baskett Slough	SINE	1 to 5	3.07	1.24
Salem West	Baskett Slough - Coville Road	SINE	< 1	0.63	0.26
Salem West	Baskett Slough - Livermore Road	SINE	< 1	0.92	0.37
Salem West	Baskett Slough - Morgan Prairie	SINE	1 to 5	1.94	0.79
Salem West	Dallas South	SINE	>5 to 20	9.54	3.86
Salem West	Dyck Road	SINE	1 to 5	1.12	0.45
Salem West	Dyck Road	SINE	< 1	0.10	0.04
Salem West	Fairdale - Flying M	SINE	>100	187.64	75.93
Salem West	Fall City	SINE	>5 to 20	8.50	3.44
Salem West	Fern Creek	SINE	< 1	0.16	0.07
Salem West	(Private landowner name suppressed)	SINE	1 to 5	1.89	0.76
Salem West	Grand Ronde	SINE	>20 to 100	47.46	19.21
Salem West	Garh Farm	SINE	>5 to 20	12.40	5.02
Salem West	Grand Ronde	SINE	>5 to 20	7.64	3.09
Salem West	Greenwood Road	SINE	< 1	0.18	0.07
Salem West	Highway 99W and Baskett Slough	SINE	< 1	0.51	0.21
Salem West	Johansen WRP	SINE	< 1	0.02	0.01
Salem West	(Private landowner name suppressed)	SINE	1 to 5	1.46	0.59
Salem West	McTimmonds Valley	SINE	>20 to 100	48.85	19.77
Salem West	McTimmonds Valley Hwy 223	SINE	>5 to 20	18.34	7.42
Salem West	Meyers Road	SINE	< 1	0.50	0.20
Salem West	Salt Creek	SINE	1 to 5	2.58	1.04
Salem West	SR18 (HWY 18)	SINE	>20 to 100	20.68	8.37

Table B-1. Plant population sites and cover area. (Source: U.S. Fish and Wildlife Service, unpublished data).

Recovery Zone	Site Name	Species Code*	Acres Class	Acres	Hectares
Salem West	SR22 (HWY 22)	SINE	>20 to 100	58.50	23.68
Salem West	SR99W	SINE	1 to 5	1.16	0.47
Salem West	(Private landowner name suppressed)	SINE	< 1	0.49	0.20
Salem West	VanWell Road	SINE	>5 to 20	13.30	5.38
SW Washington	Camas Meadows	LOBR	>100	274.31	111.01
SW Washington	Green Mountain	LOBR	>5 to 20	9.96	4.03
SW Washington	Boistfort	LUSUK	< 1	0.54	0.22
SW Washington	Drew Prairie	LUSUK	< 1	<0.01	<0.01
SW Washington	Lacamas Prairie	LUSUK	< 1	0.02	0.01
SW Washington	Boistfort Park	SINE	>100	146.13	59.14
SW Washington	Coal Creek Road	SINE	>20 to 100	33.75	13.66

* Species Codes:
ERDE = *Erigeron decumbens* var. *decumbens*
LOBR = *Lomatium bradshawii*
LUSU = *Lupinus sulphureus* ssp. *kincaidii*
SINE = *Sidalcea nelsoniana*

Table B-2. Summary of total known acreage for listed plant species (over all recovery zones and within each recovery zone).		
Species and Recovery Zone	**Plant Cover Sum of Acres**	**Number of Sites**
Erigeron decumbens* var. *decumbens	**233.03**	**39**
Corvallis East	0.02	1
Corvallis West	9.58	3
Eugene East	4.09	2
Eugene West	177.93	21
Salem East	21.76	6
Salem West	19.64	6
Lomatium bradshawii	**741.68**	**64**
Corvallis East	65.15	2
Corvallis West	58.31	8
Eugene East	60.39	6
Eugene West	263.84	44
Salem East	9.73	2
SW Washington	284.27	2
Lupinus sulphureus* ssp. *kincaidii	**608.02**	**164**
Corvallis West	161.69	65
Douglas County	34.00	23
Eugene East	5.86	6
Eugene West	127.55	32
Salem West	278.36	35
SW Washington	0.56	3
Sidalcea nelsoniana	**1276.50**	**90**
Coast Range	137.58	10
Corvallis West	220.19	39
Salem East	289.25	12
Salem West	449.59	27
SW Washington	179.88	2
Grand Total	**2859.23**	**357**

Appendix C. Species Occurrence on Protected Sites

Fender's blue butterfly, *Erigeron decumbens* var. *decumbens*, *Lomatium bradshawii*, *Lupinus sulphureus* ssp. *kincaidii* and *Sidalcea nelsoniana* occur at many small, remnant prairie sites across the range of this recovery plan. Table C-1 and Figures C-1 through C-9 show the known locations of these species at sites that have some type of protective management, in 9 of the 10 recovery zones established for the listed plant species. One recovery zone (SW Washington) does not have any populations in protective management. If nonlisted plant species of conservation concern (*Delphinium leucophaeum, Delphinium oreganum, Delphinium pavonaceum, Horkelia congesta* ssp. *congesta, Sericocarpus rigidus* or *Sisyrinchium hitchcockii*) occur at the managed sites, their presence is also noted. The purpose of this appendix is to show where protected populations of the target species occur, as these sites may form the foundations for populations necessary to achieve recovery.

The site numbers shown in Table C-1 refer to the numbers on maps C-1 through C-9. Each species is identified by a 3-4 letter code.

Key to Species Codes in Table C-1:

CALE	*Castilleja levisecta*
DELE	*Delphinium leucophaeum*
DEOR	*Delphinium oreganum*
DEPA	*Delphinium pavonaceum*
ERDE	*Erigeron decumbens* var. *decumbens*
FBB	Fender's blue butterfly
HOCO	*Horkelia congesta* var. *congesta*
LOBR	*Lomatium bradshawii*
LUSU	*Lupinus sulphureus* ssp. *kincaidii*
SERI	*Sericocarpus rigidus*
SINE	*Sidalcea nelsoniana*
SIHI	*Sisyrinchium hitchcockii*
TCB	Taylor's checkerspot butterfly

Table C-1. Known locations of listed and nonlisted prairie species at sites with protective management.				
Recovery Zone	**Site #**	**Site Name**	**Ownership**	**Species**
Coast Range	1	Walker Flat	BLM, Private	SINE
Corvallis East	1	Oak Creek	USFWS	LOBR
	2	Cogswell Foster Preserve	TNC	LUSU
Corvallis West	1	E.E. Wilson Wildlife Management Area	ODFW	LUSU, SINE
	2	Butterfly Meadows	OSU, Private	LUSU, FBB
	3	Jackson Frazier Wetlands	Benton Co.	LOBR, LUSU, SINE
	4	Wren Prairie	BLM, TNC	LUSU, SINE, FBB, TCB
	5	William L. Finley National WIldlife Refuge	USFWS	DEPA, ERDE, LOBR, LUSU, SINE
Douglas County	1	China Ditch	BLM	LUSU
	2	Dickerson	BLM	LUSU
	3	Letitia Creek	BLM	LUSU
	4	Corner Brass Cap	BLM	LUSU
	5	Callahan Meadows	USFS, BLM	LUSU
	6	Catching & Russel Creeks	BLM	LUSU
Eugene East	1	Coburg Ridge South	TNC	LUSU, FBB
	2	Eagle's Rest	BLM	LUSU
	3	Buford Park	City of Eugene	LOBR
Eugene West	1	Long Tom ACEC	BLM	HOCO, LOBR
	2	Fern Ridge Reservoir Kirk Park Unit D	ACOE	LOBR, SERI
	3	Fern Ridge Reservoir - Kirk Pond	ACOE	LOBR, SERI
	4	Fern Ridge Reservoir Shore Lane Unit G	ACOE, Private	LUSU, FBB
	5	East Spires	ACOE	FBB
	6	South Eaton	ACOE	FBB
	7	Fern Ridge Reservoir - Amazon Dike #2	ACOE	LOBR, SERI
	8	Green Oaks	ACOE	FBB
	9	Horkelia Prairie	ACOE	FBB, HOCO, SERI
	10	Fern Ridge Reservoir - Amazon	ACOE	LOBR, HOCO
	11	Fir Butte	BLM	LUSU, FBB, SERI
	12	Fern Ridge Reservoir Royal Amazon	ACOE	LOBR, LUSU, FBB, SERI
	13	Fern Ridge Reservoir Fisher Butte	ACOE	ERDE, LOBR, LUSU, FBB, SERI
	14	Fern Ridge Reservoir Coyote	ACOE	DEOR, ERDE,

Table C-1. Known locations of listed and nonlisted prairie species at sites with protective management.				
Recovery Zone	**Site #**	**Site Name**	**Ownership**	**Species**
		Unit		LOBR
	15	Meadowlark Prairie	BLM, City of Eugene	LOBR, LUSU, FBB, SERI
	16	North Greenhill/Oak Hill	BLM	ERDE, HOCO, LOBR, LUSU, SERI
	17	Vinci	BLM	ERDE, HOCO, SERI
	18	Willamette Daisy Meadow	BLM, City of Eugene, ODOT	ERDE, HOCO, LOBR, LUSU, FBB, SERI
	19	West Lawn Cemetery	Private	ERDE, HOCO, LUSU, SERI
	20	Balboa	BLM	ERDE, LOBR, HOCO, SERI
	21	Rosy	BLM	LOBR, HOCO
	22	Isabelle	BLM	LUSU, FBB, SERI
	23	West Oak Patch	City of Eugene	LOBR
	24	Luk-wah Prairie (Speedway)	BLM	ERDE, LOBR, HOCO, SERI
	25	Willow Creek Natural Area	TNC, City of Eugene	ERDE, HOCO, LOBR, LUSU, FBB, SERI, SIHI
	26	Amazon Park	City of Eugene	LOBR
	27	East Amazon	City of Eugene	LOBR
	28	Camas Swale	Oregon Dept of Fish & Wildlife	LOBR
	29	Amazon Diversion Channel	City of Eugene	LOBR, HOCO, LUSU
	30	East Oak Patch	City of Eugene	LOBR
	31	Coyote Prairie	City of Eugene	LOBR
	32	Dragonfly Bend	City of Eugene	LUSU
	33	Private (Briggs)	Private, TNC easement	LUSU
	34	Taylor North	BLM	LOBR
	35	Willow Corner Annex	BLM	LOBR
Portland	1	Willamette Narrows	Metro	DELE
	2	Cooper Mountain Nature Park	Metro	DELE
	3	Iron Mountain Park	City of Lk Oswego	DELE
	4	Camassia Natural Area	TNC	DELE
Salem East	1	Kingston Meadows Preserve	TNC	ERDE, LOBR, SERI, DEOR

Table C-1. Known locations of listed and nonlisted prairie species at sites with protective management.				
Recovery Zone	**Site #**	**Site Name**	**Ownership**	**Species**
Salem West	1	Grand Ronde	Grand Ronde Tribe	SINE
	2	Baskett Slough National Wildlife Refuge	USFWS	ERDE, LUSU, SINE, FBB

Species Occurrence on Selected Managed Sites in Coast Range Recovery Zone

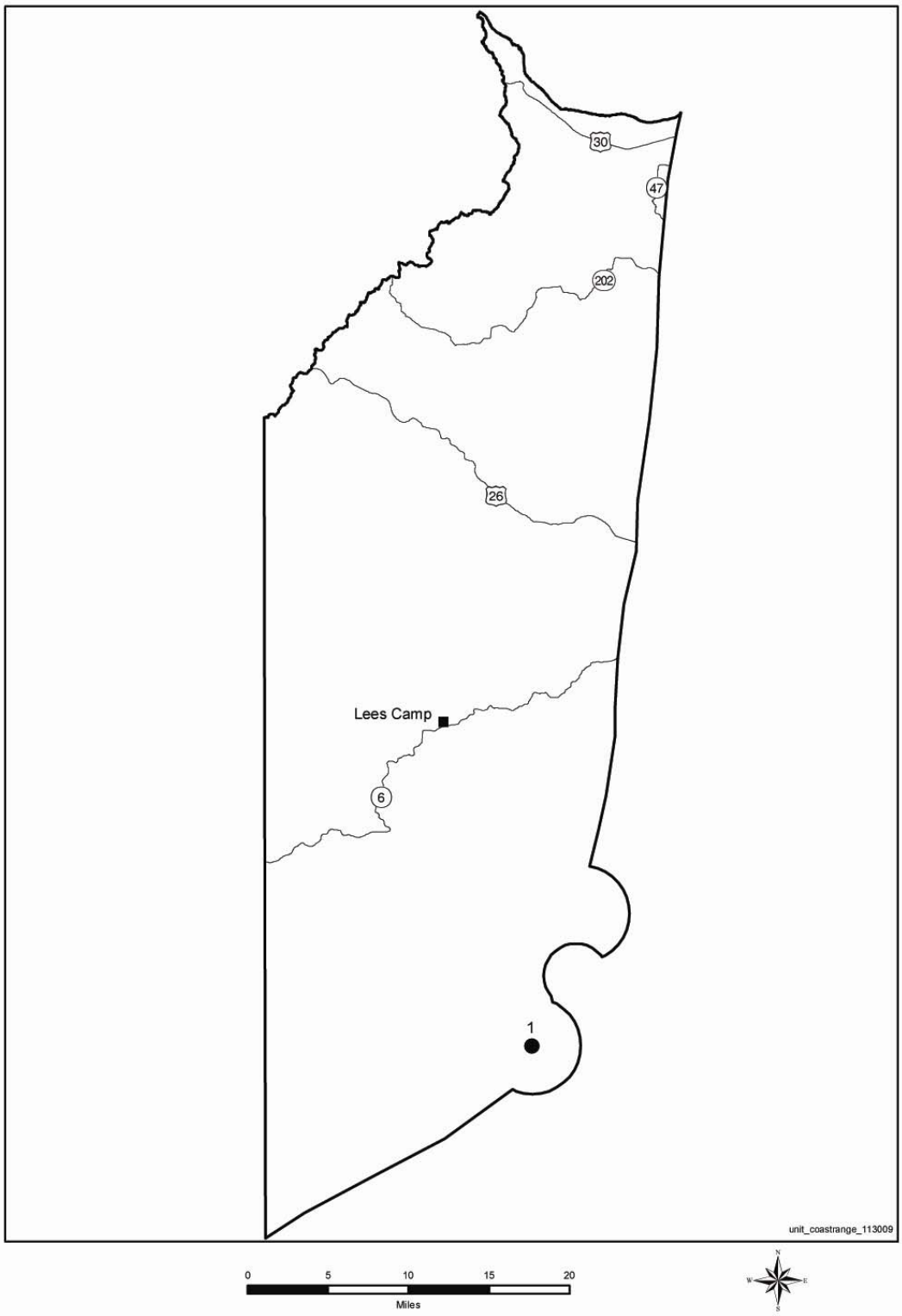

Figure C-1. Protected sites, Coast Range Recovery Zone.

Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington

Species Occurrence on Selected Managed Sites in Corvallis East Recovery Zone

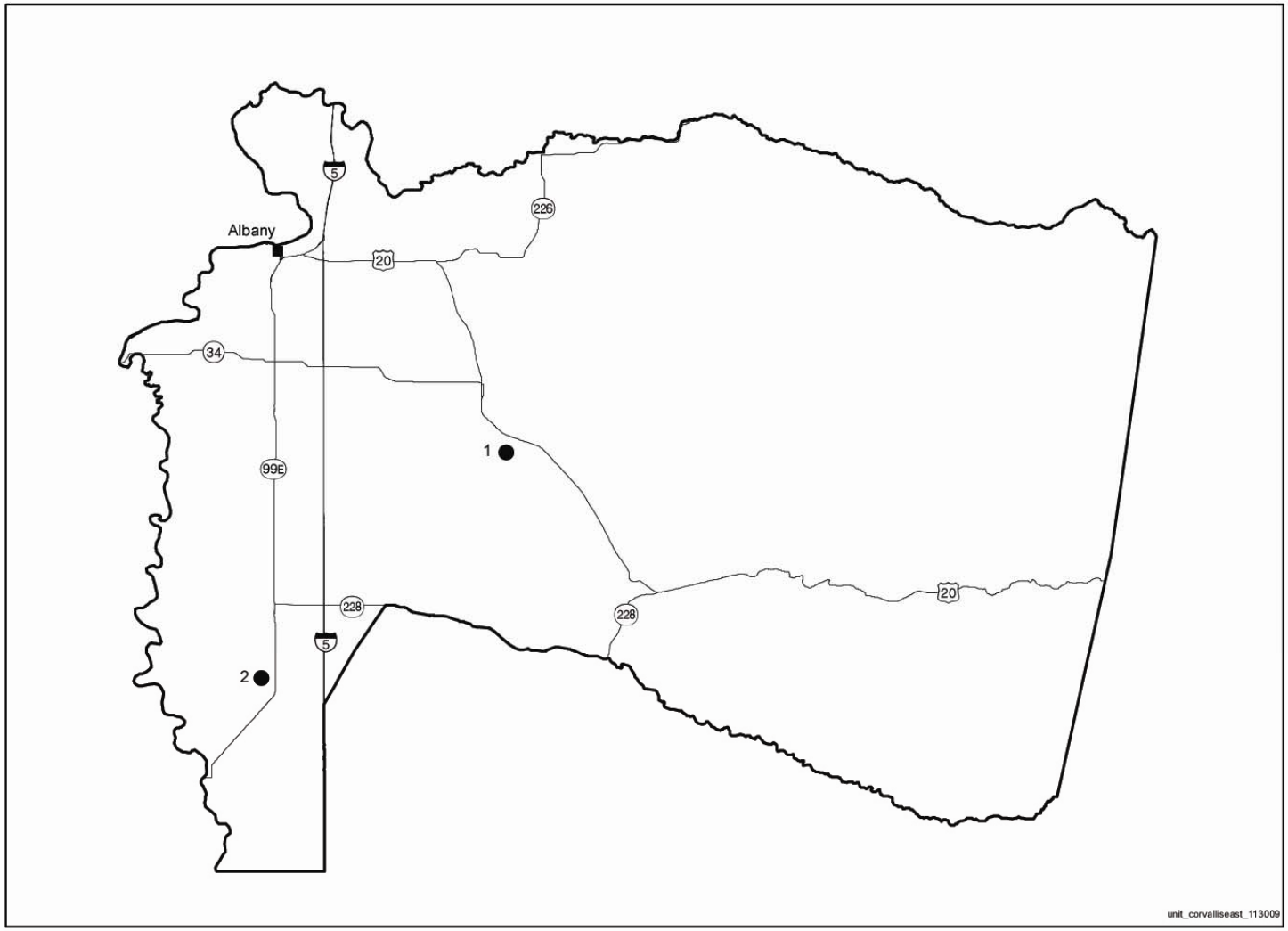

Figure C-2. Protected sites, Corvallis East Recovery Zone

Species Occurrence on Selected Managed Sites in Corvallis West Recovery Zone

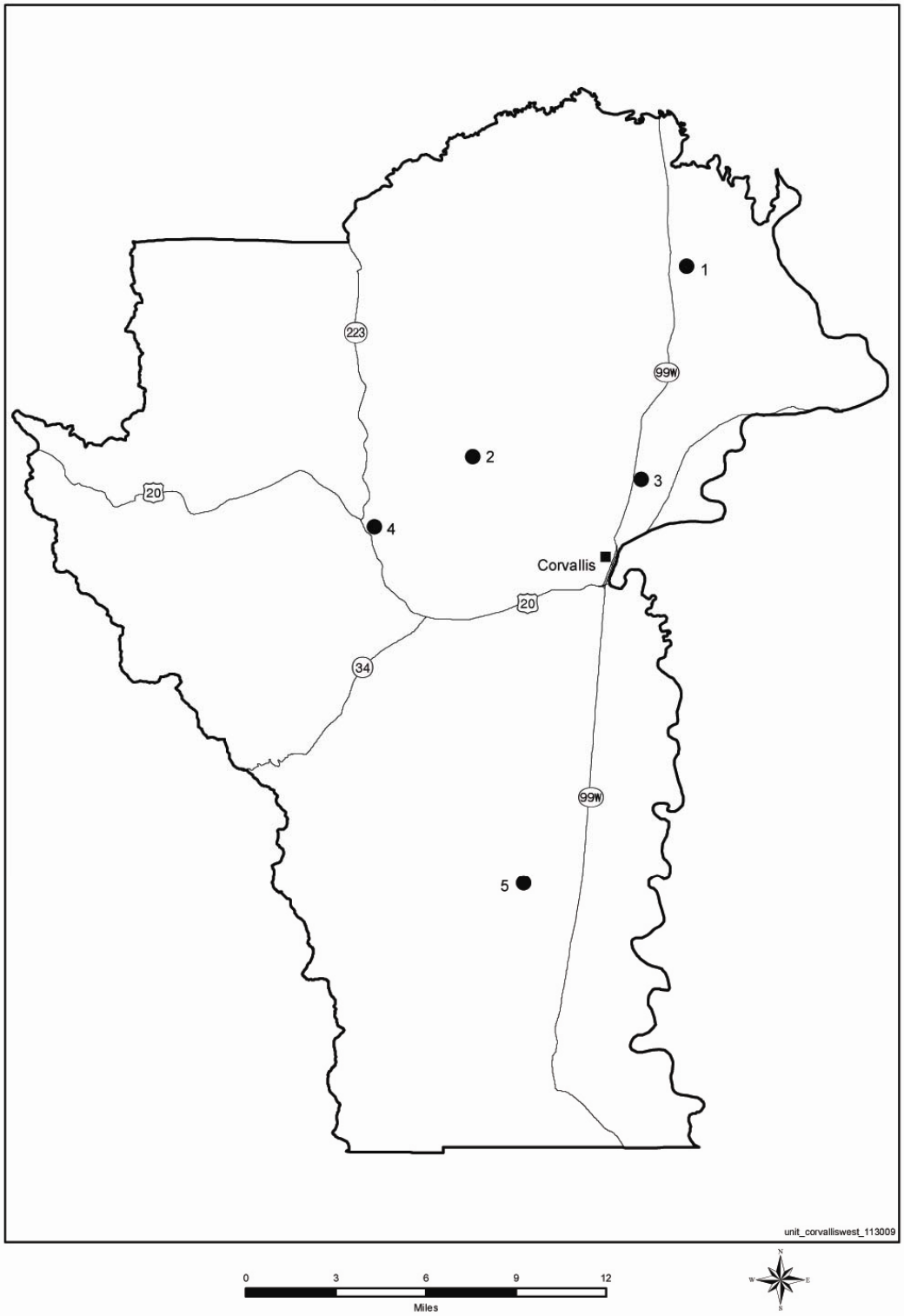

Figure C-3. Protected sites, Corvallis West Recovery Zone.

Species Occurrence on Selected Managed Sites in Douglas County Recovery Zone

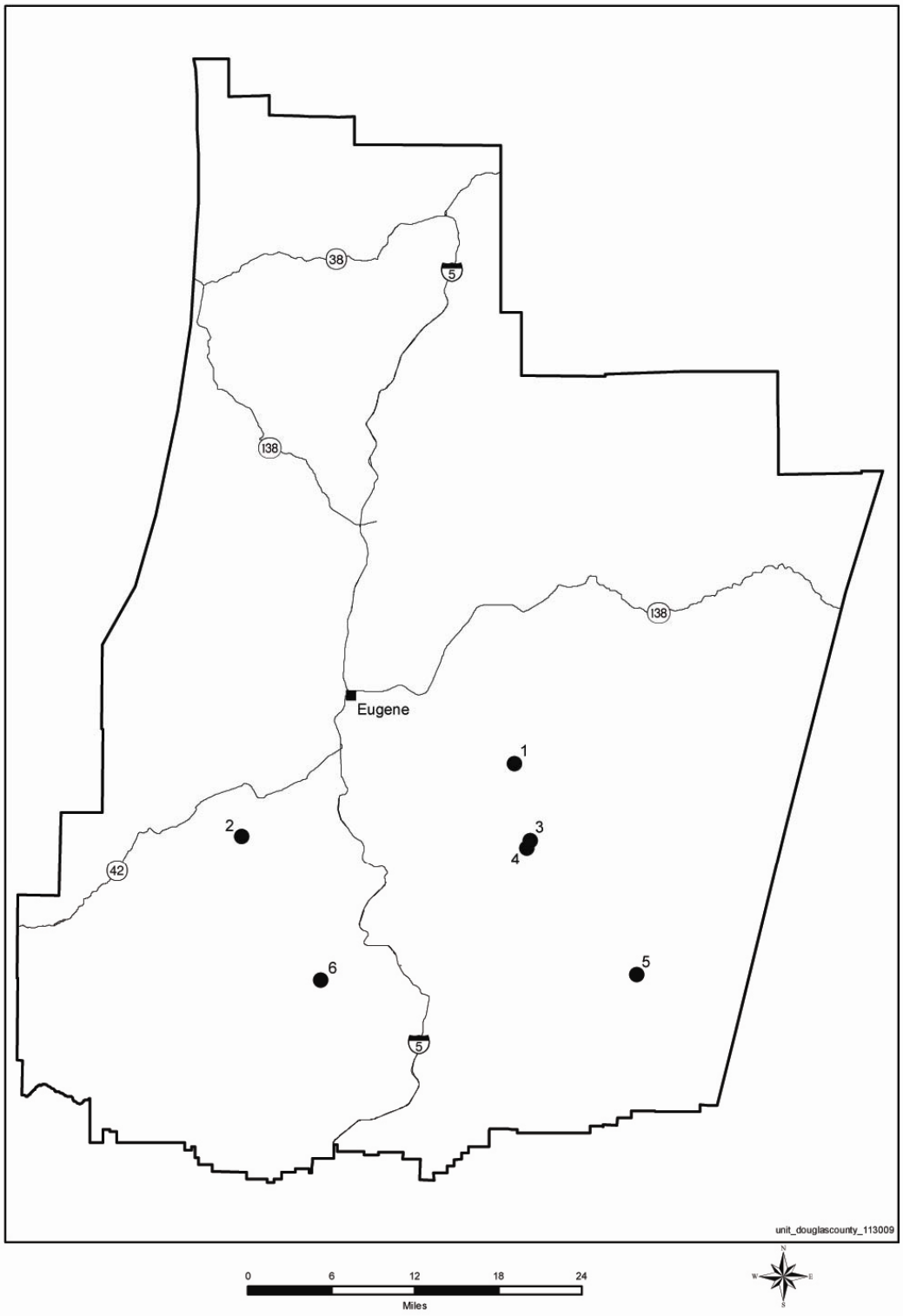

Figure C-4. Protected sites, Douglas County Recovery Zone.

Species Occurrence on Selected Managed Sites in Eugene East Recovery Zone

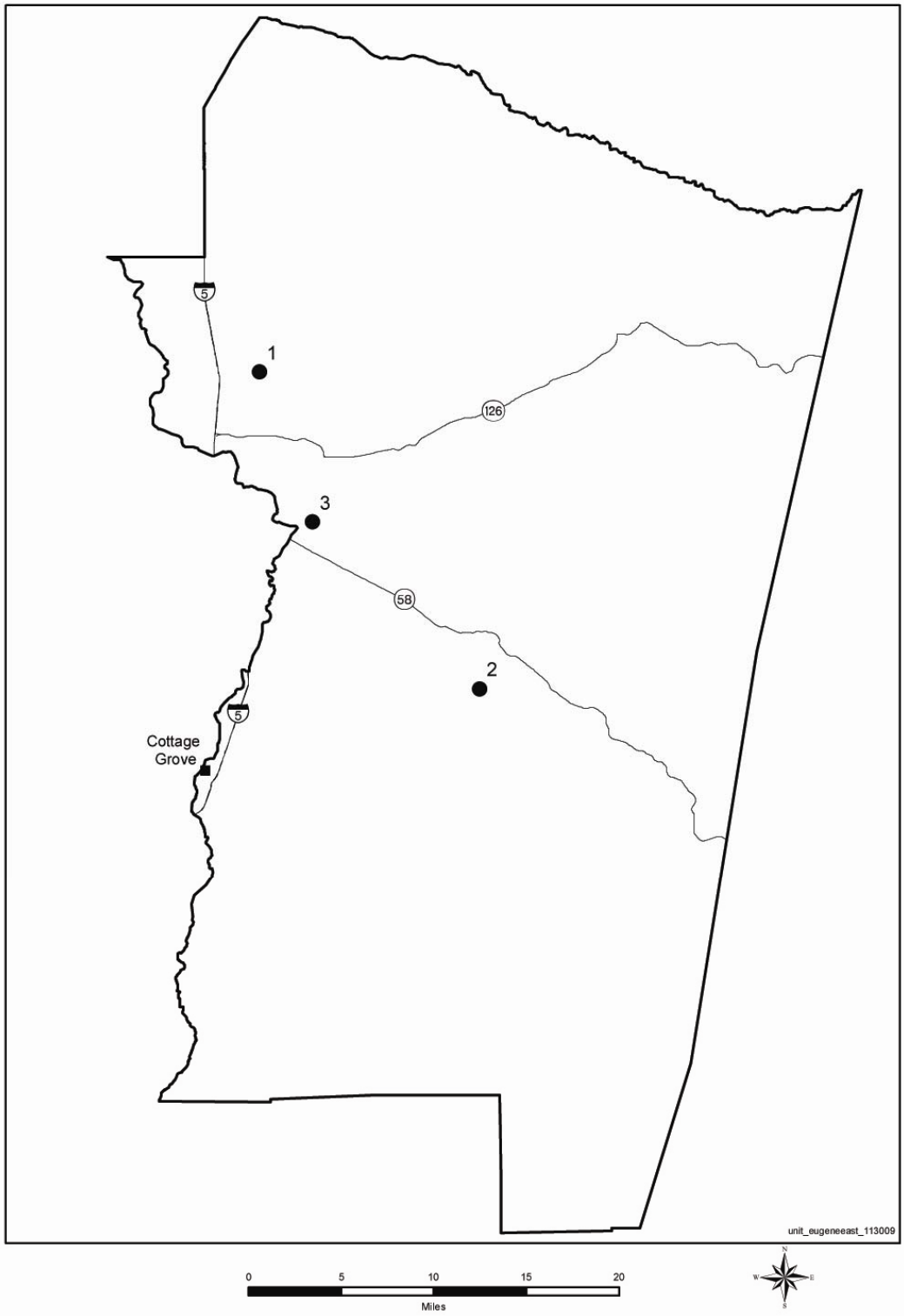

Figure C-5. Protected sites, Eugene East Recovery Zone.

Species Occurrence on Selected Managed Sites in Eugene West Recovery Zone

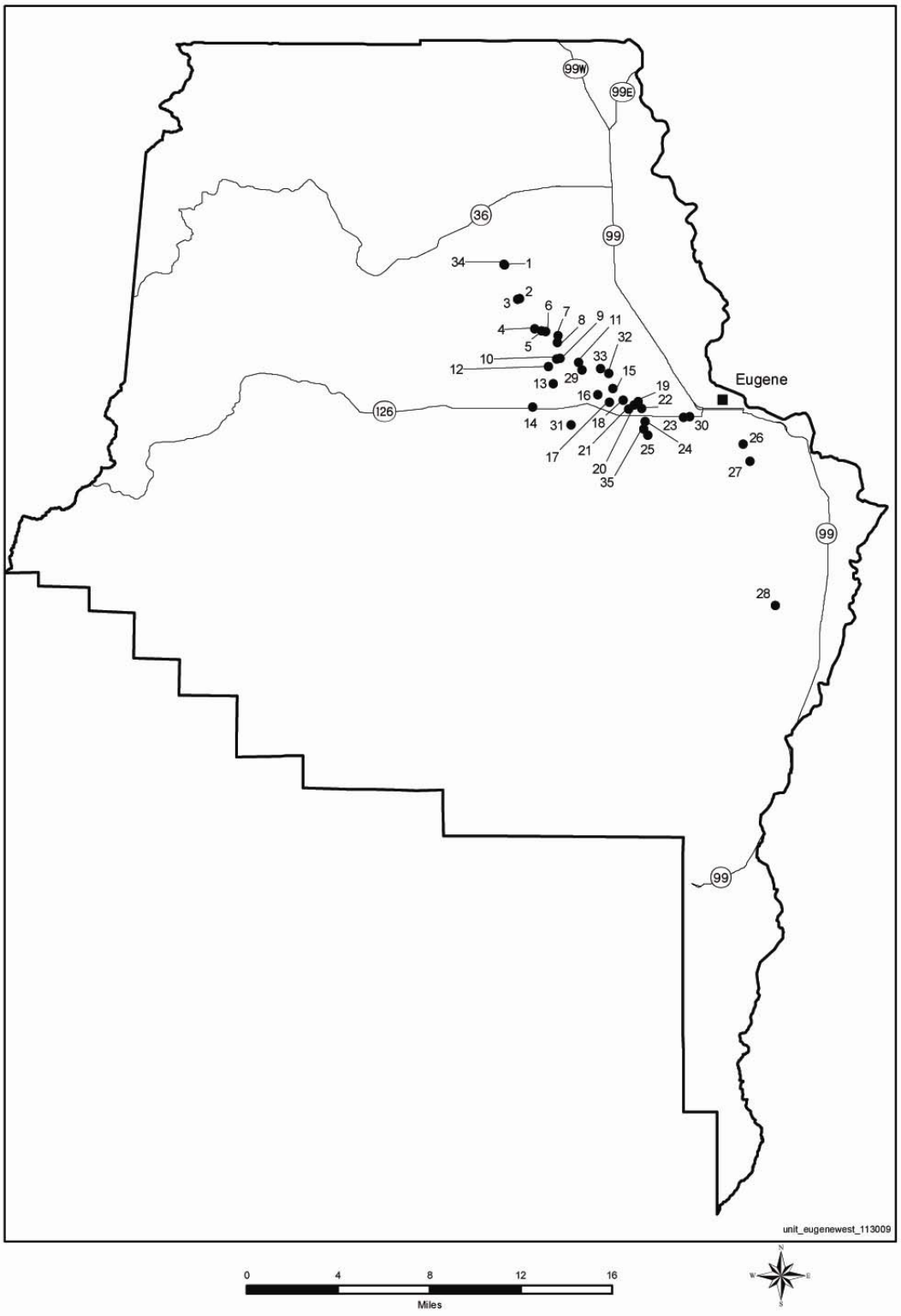

Figure C-6. Protected sites, Eugene West Recovery Zone.

Species Occurrence on Selected Managed Sites in Portland Recovery Zone

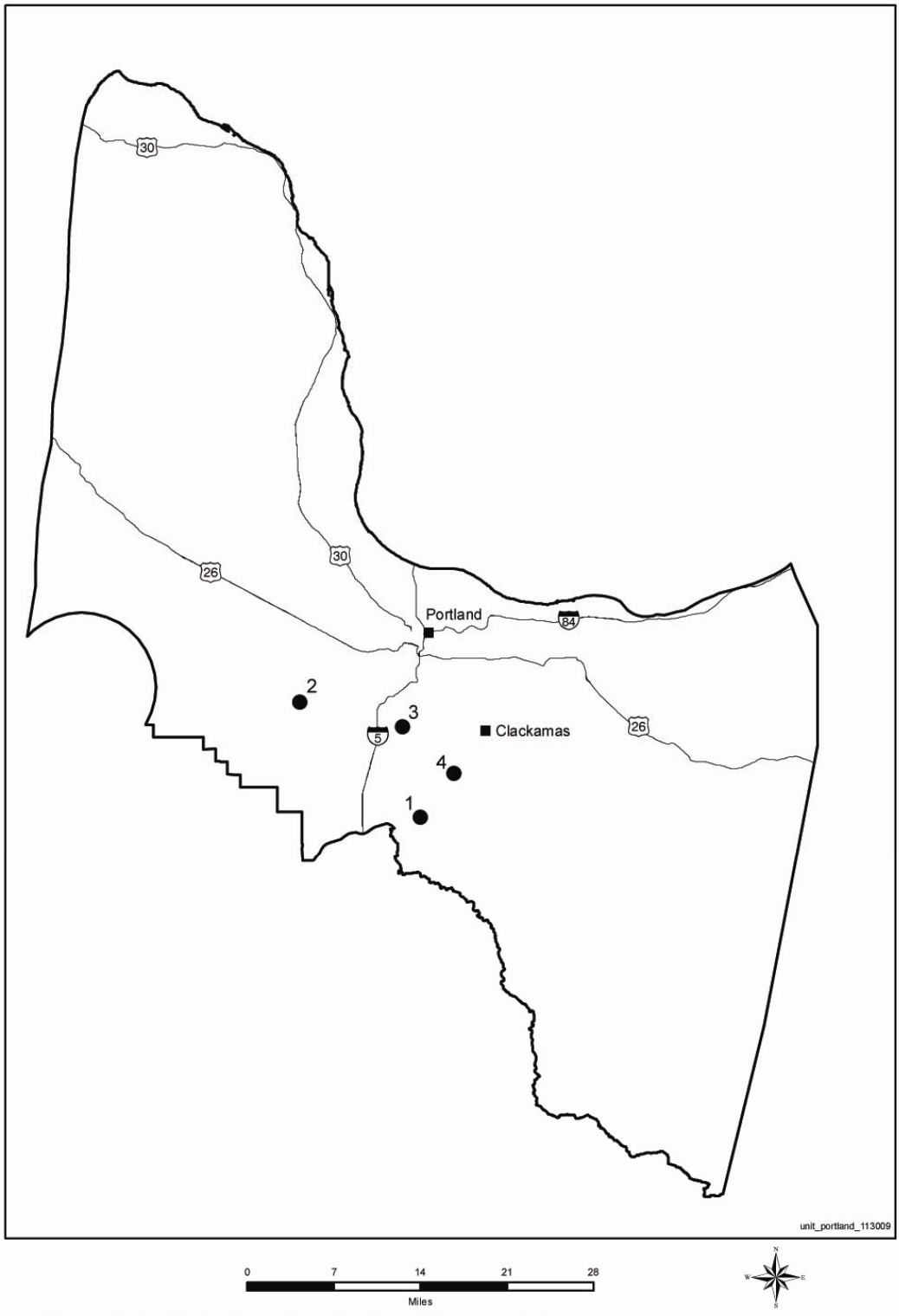

Figure C-7. Protected sites, Portland Recovery Zone.

Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington

Species Occurrence on Selected Managed Sites in Salem East Recovery Zone

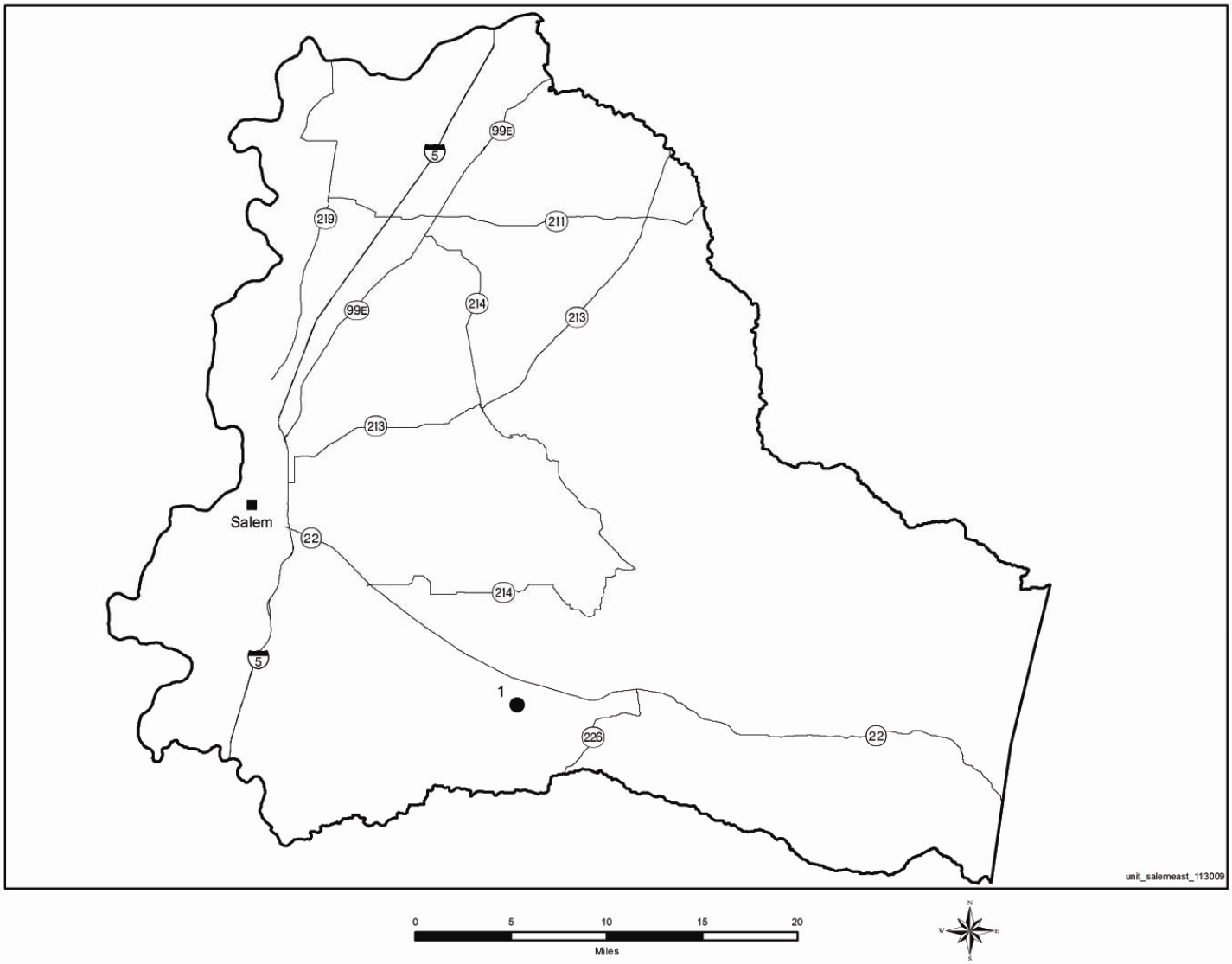

Figure C-8. Protected sites, Salem East Recovery Zone.

Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington

Species Occurrence on Selected Managed Sites in Salem West Recovery Zone

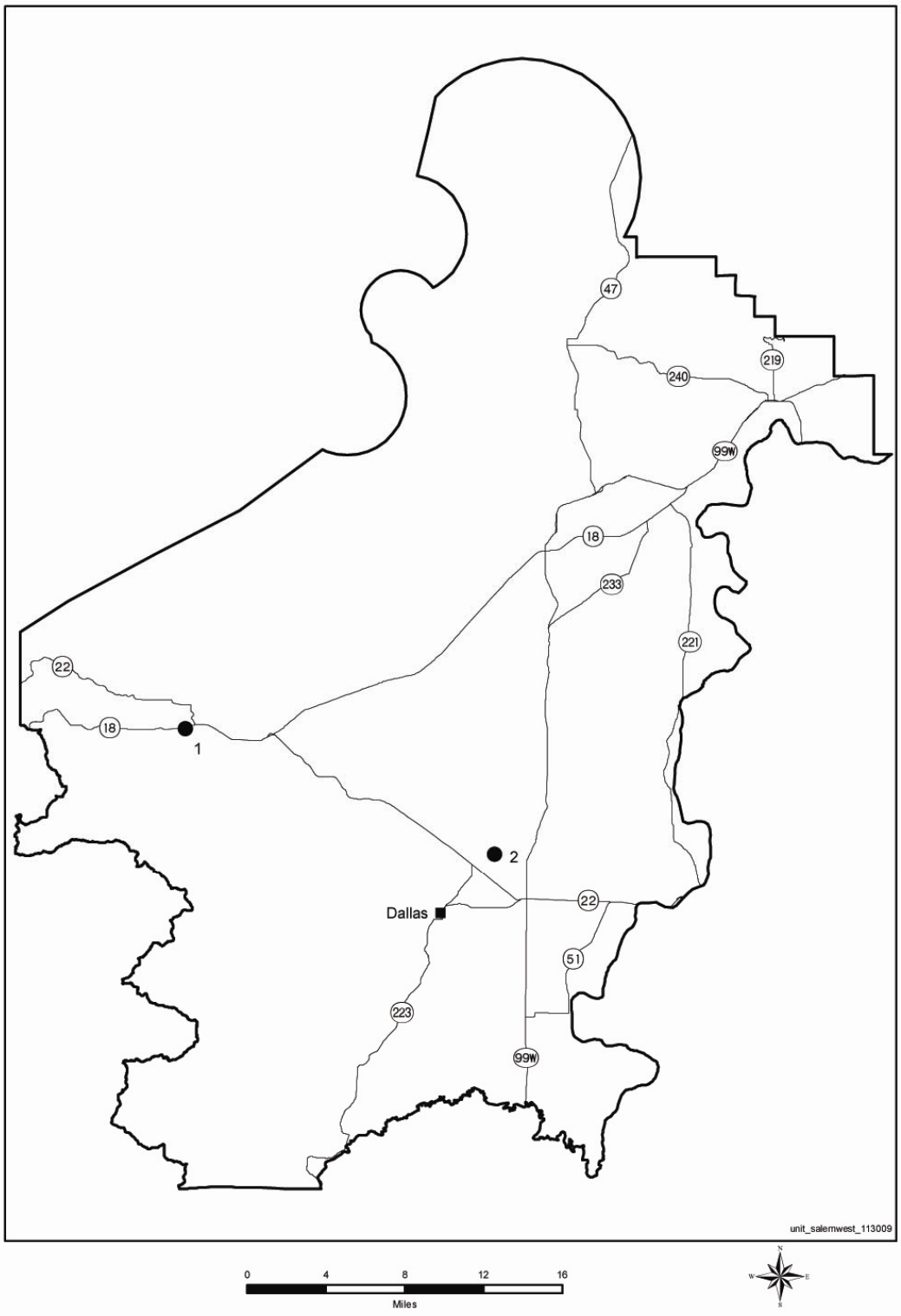

Figure C-9. Protected sites, Salem West Recovery Zones.

Appendix D. Guidelines for Assessment of Prairie Quality and Diversity

1. Prairie Quality and Diversity

Habitat quality is an important factor in the long-term viability of populations of the prairie species addressed in this recovery plan. Absent active management, prairie habitats may be overwhelmed by non-native vegetation and encroaching woody species. Management is therefore necessary to maintain high quality prairie habitats for the target species in this recovery plan. The criteria below may be used to evaluate prairie quality at sites managed for recovery of the listed species in the region. Attainment of these criteria would indicate that the subject site supports a diversity of native plants necessary to attract and maintain pollinator populations, and has a low level of invasion by non-native species. These criteria were developed with the prairies of the Willamette Valley in mind, and may not apply to the more wooded prairie and savanna habitats in Douglas County.

The standards set in this appendix apply to managed degraded native prairies, but would not necessarily be applicable to restoration sites, which would likely have higher standards. Criteria in this appendix would not supersede other criteria established elsewhere for restoration or mitigation sites (often associated with mitigation banks or the ecosystem services market). The standards presented here not absolute criteria – they are suggested targets, but can be modified based on expert opinion and local conditions.

a. **Cover of native vegetation**: Sites with populations of target species should have relative cover of natives of 50 percent or more. Relative cover is calculated by adding up the cover values for each of the individual native prairie species present and dividing by the total cover value for all of the species present added together at the site.

b. **Cover of woody vegetation**: For each site, woody vegetation should make up no more than 15 percent of the absolute vegetative cover, and woody species of management concern will make up no more than five percent (unless the site is savanna habitat, in which case the upper limit would be about 25 percent woody vegetation). Woody species of management concern are identified below in Table D-1.

c. Prairie diversity: For each population site, native prairie species richness must exceed 10 species (measured in 25-m^2 plots), of which seven or more must be forbs and one must be a bunch grass. Native prairie species are defined as vascular plants that occur as a normal component of healthy prairie habitats. Managers should consult with a knowledgeable botanist or plant ecologist for appropriate species lists for the local area.

d. Non-native vegetation: At each reserve, no single non-native plant will have more than 50 percent cover. Non-natives of particular concern, as identified in Table D-2, will have no greater than 5 percent cover. Non-native plants should never be planted or seeded in areas being managed for recovery of listed prairie species.

Table D-1. Woody species of management concern.

Scientific name	**Common name**
Crataegus monogyna	Oneseed hawthorn
Crataegus suksdorfii	Suksdorf's hawthorn
Cytisus spp.	Non-native brooms (*e.g.*, Scotch broom, Spanish broom, and others)
Pyrus communis	Feral common pear
Rosa eglanteria	Sweetbriar rose
Rosa multiflora	Multiflora rose
Rubus armeniacus	Armenian blackberry
Rubus laciniatus	Cutleaf blackberry
Toxicodendron diversilobum	poison oak

Table D-2. Partial list of invasive non-native plant species. The presence of these or other invasive species would disqualify a site from contributing to recovery goals unless they are managed aggressively to maintain less than 5 percent cover.

Scientific name	**Common name**
Arrhenatherum elatius	tall oatgrass
Brachypodium sylvaticum	false-brome
Centaurea X *pratensis*	meadow knapweed
Cytisus scoparius	Scotch broom
Phalaris arundinacea	reed canary grass
Pyrus communis	feral common pear
Rubus armeniacus	Armenian blackberry
Rubus vestitus	European blackberry

2. Additional habitat quality and diversity criteria for Fender's blue butterfly

Additional quality and diversity criteria are needed for habitats that support populations of Fender's blue butterfly. These criteria focus on resources needed for adult and larval stages of the butterfly. High quality butterfly habitat requires not only overall quality and diversity of native species, but also abundance criteria for larval and adult resources, and resources for pollinators which are essential components of viable prairie habitats. Recent studies have shown that the density of Fender's blue butterflies at a habitat patch is strongly correlated with host plant abundance (measured as the number of lupine leaves/m^2 of habitat) and total nectar from native nectar flowers (measured as mg nectar sugar/m^2 of habitat) (Schultz and Dlugosch 1999, Schultz 2001). Based on these studies, we recommend the following preliminary criteria for measuring habitat quality and diversity for Fender's blue butterfly population sites.

a. Nectar flower abundance and diversity:

1. There should be sufficient abundance of flowers that provide nectar for Fender's blue butterfly (Table D-3); the target abundance is a minimum of 20 mg nectar sugar/m^2 of habitat, which may be achieved by planting species identified as abundant nectar producers in Table D-3;

2. Each population site should have a minimum of five native nectar species.

b. Lupine host plant abundance: Sites that provide breeding habitat for Fender's blue butterfly should have a minimum of 30 lupine leaves/m^2 of habitat.

c. Nectar plant availability: Nectar plants should be available at the habitat patch throughout the entire flight season of the pollinator species (March through September of each year) to ensure the continued viability of the pollinators and the species they pollinate.

Table D-3. Partial list of plant species used as nectar sources by Fender's blue butterfly. Plants known to produce high amounts of nectar (defined here as > 3.0 mg sugar per floral unit or > 0.1 mg sugar per individual flower) utilized by the butterflies are indicated as "abundant nectar producers." On average, native plants produce greater quantities of nectar utilized by Fender's blue butterfly than non-natives (Schultz and Dlugosch 1999).

Scientific Name	Common Name	Abundant Nectar Producer?	Native Species?
Allium amplectens	Narrowleaf onion	Yes	Yes
Anthemis arvensis	Corn chamomile	No	No
Bellis perennis	Lawndaisy	No	No
Calochortus tolmiei	Tolmie star-tulip	Yes	Yes
Camassia quamash	Small camas	Yes	Yes
Cryptantha intermedia	Clearwater cryptantha	No	Yes
Eriophyllum lanatum	Common woolly sunflower	Yes	Yes
Hypochaeris radicata	Hairy cat's-ear	Yes	No
Lathyrus sphaericus	Grass pea	No	No
Leucanthemum vulgare (= Chrysanthemum leucanthemum)	Oxeye daisy	Yes	No
Linum angustifolium (= L. bienne)	Pale flax	No	No
*Lupinus arbustus (= L. laxiflorus)**	Longspur lupine*	No	Yes
*Lupinus sulphureus ssp. kincaidii**	Kincaid's lupine*	Yes	Yes
Myosotis discolor	Changing forget-me-not	No	No
Sidalcea malviflora ssp. virgata	Rose checker-mallow	Yes	Yes
Vicia hirsuta	Tiny vetch	No	No
Vicia sativa	Common vetch	Yes	No
Vicia villosa	Winter vetch	Yes	No

* these species also serve as larval host plants.

Appendix E. Prairie Restoration Resources

The following resources are provided to assist landowners and land managers with prairie restoration within the geographic area of this plan. The listing of an agency or organization here does not imply an endorsement by the U.S. Fish and Wildlife Service, nor were any agencies or organizations intentionally omitted from this list.

Section A includes people and organizations with knowledge of prairie restoration techniques, management tools and/or resources for accomplishing prairie restoration, and non-profit organizations that work for the preservation of prairie habitats within the geographic area of this plan.

Section B provides a few of the written references that may serve as useful guidance for prairie restoration. The References section of this draft recovery plan should also be consulted for many highly relevant and more species-specific works.

Section C is a guide to those agencies that may provide financial assistance to landowners for prairie restoration and habitat improvement projects.

A. People and Organizations

Greenbelt Land Trust
P.O. Box 1721
Corvallis, OR 97339
541-752-9609
www.greenbeltlandtrust.org

Heritage Seedlings, Inc.
4194 71st Ave. SE
Salem, OR 97301
503-585-9835
www.heritageseedlings.com

Institute for Applied Ecology
563 SW Jefferson Avenue
Corvallis, Oregon 97333
541-753-3099
www.appliedeco.org

McKenzie River Trust
359 Mill Street, Suite B
Eugene, Oregon 97401
541-345-2799
mrt@mckenzieriver.org
www.mckenzieriver.org

Native Seed Network
Institute for Applied Ecology
563 SW Jefferson Avenue
Corvallis, Oregon 97333
541-753-3099
www.nativeseednetwork.org

The Nature Conservancy
821 SE 14th Avenue
Portland, Oregon 97214
503-802-8100
Oregon@tnc.org

The Nature Conservancy
1917 First Avenue
Seattle, WA 98101
206-343-4344
Washington@tnc.org

Oregon Oak Communities Working Group
www.oregonoaks.org

Partners for Fish and Wildlife Program (Private Lands) Biologist
Willamette Valley National Wildlife Refuge Complex
26208 Finley Refuge Road
Corvallis, Oregon 97333
541-757-7236

Rare Plant Care and Conservation Program
Center for Urban Horticulture
University of Washington
Box 354115
Seattle, WA 98195-4115
http://courses.washington.edu/rarecare/

Oregon State University
Prairie Research Group
Dr. Mark V. Wilson
http://oregonstate.edu/~wilsomar/Index.htm

City of Eugene
West Eugene Wetlands Program
City of Eugene, Public Parks and Open Space Division
1820 Roosevelt Blvd.
Eugene, OR 97402-4159
Phone: 541-682-4888
http://www.eugene-or.gov/ wetlands

Bureau of Land Management
West Eugene Wetlands Project
West Eugene Project Manager
Bureau of Land Management
751 South Danebo
Eugene, OR 97402
541-520-2159

Willamette Resources and Educational Network
751 S. Danebo
Eugene, OR 97402
541-683-6494
www.wewetlands.org

B. Published or Web-based Resources

Alverson, E. Preserving prairies and savannas in a sea of forest; a conservation challenge in the Pacific Northwest. Plant Talk No. 40, Available online at http://www.plant-talk.org/stories/40forest.html

Bonesteele Park Upland Prairie Restoration Plan. Marion County Department of Public Works. Available online at http://publicworks.co.marion.or.us/parks/bonesteele/restore.asp

Boyer, L. Native Willamette Valley Oak Habitat and Prairie Restoration Site-Preparation and Seeding Information. Available online at http://www.heritageseedlings.com/PDF/PrairieRestInfo.pdf

Campbell, B.H. Restoring rare native habitats in the Willamette Valley. Available online at http://www.biodiversitypartners.org/pubs/Campbell/01.shtml

Darris, D.C. Considerations for establishing native grasses from seed for restoration, revegetation, and erosion control in western Washington and western Oregon.

Fitzpatrick, G.S. 2004. Techniques for restoring native plant communities in upland and native prairies in the Midwest and west coast regions of North America. Available online at http://www.lcog.org/wewresearch/PDF/FitzpatrickLiteratureSearch.pdf.

Kaye, T.N., J. Cramer and A. Brandt. 2003. Seeding and transplanting rare Willamette Valley prairie plants for population restoration. Third year (2002) report. Institute for Applied Ecology, Corvallis, Oregon and USDI bureau of Land Management, Eugene District. Available online at http://222.appliedeco.org/reports.html#propagate

Kaye, T.N., and K. Kuykendall. 2001. Germination and propagation techniques for restoring rare Pacific Northwest prairie plants. Pages 213-224 *in* S.H. Reichard, P.W.

Dunwiddie, J.G. Gamon, A.R. Kruckeberg, and D.L.Salstrom (eds.), Conservation of Washington's native plants and ecosystems. Washington Native Plant Society, Seattle, Washington. Available online at http://www.appliedeco.org/reports.html#propagate

C. Potential Grant Sources for Prairie Restoration and Enhancement

Partnership Resource Center
National Forest Foundation and USDA Forest Service
www.partnershipresourcecenter.org

Sustainable Agriculture Research and Education
USDA Cooperative State Research, Education, and Extension Service
Western Region:
Utah State University
Ag Science 305
Logan, UT 84322-4865
435-797-2257
www.sare.org

USDA Farm Service Agency
Conservation Reserve Enhancement Program
http://www.fsa.usda.gov/FSA/webapp?area=home&subject=copr&topic=cep

USDA National Resources Conservation Service
Wetlands Reserve Program
www.nrcs.usda.gov/PROGRAMS/wrp/

USDA National Resources Conservation Service
Wildlife Habitat Incentives Program
www.nrcs.usda.gov/Programs/whip/

USDI Fish and Wildlife Service
Partners for Fish and Wildlife and other grant opportunities for habitat restoration and threatened and endangered species conservation
www.fws.gov/partnerships/partnership_links.html

Appendix F. Taxonomy and Description of Species Addressed in This Recovery Plan

Fender's blue butterfly (*Icaricia icarioides fenderi*)

This species belongs to the group of blue butterflies in the family Lycaenidae. Fender's blue butterfly is one of about a dozen subspecies of Boisduval's blue butterfly (*Icaricia icarioides*), which is found only in western North America. Fender's blue butterfly is **endemic** to the Willamette Valley (Schultz *et al.* 2003), and was originally described by Macy as *Plebejus maricopa fenderi* based on specimens collected in Yamhill County, Oregon, by K.P. Fender (Macy 1931). The species *maricopa* is currently considered to be a synonym of the species *icarioides*, which has been determined to be within the genus *Icaricia* rather than *Plebejus* (Miller and Brown 1981). For a time, the subspecies *fenderi* was considered to be a synonym of the pardalis blue butterfly (*I. icarioides pardalis*), an inhabitant of the central California Coast Range near San Francisco (Downey 1975, Miller and Brown 1981). More recently, however, Fender's blue butterfly has been considered a distinct **taxon** based on adult characteristics and geographic distribution (Dornfeld 1980, Hammond and Wilson 1993).

Fender's blue butterfly is a small butterfly with a wingspan of approximately 2.5 centimeters (1 inch). The upper wings of the males are brilliant iridescent blue and the borders and **basal** areas are black. The upper wings of the females are reddish-brown. The undersides of the wings of both sexes are creamish-tan with black spots surrounded with a fine white border or halo.

***Erigeron decumbens* var. *decumbens* (Willamette Daisy)**

Thomas Nuttall (1840) described *Erigeron decumbens* based on a specimen he collected in the summer of 1835. The autonym *E. decumbens* var. *decumbens* was automatically established by Cronquist (1947) when he described *E. decumbens* var. *robustior*. Recent revisions of the *Erigeron* genus (Strother and Ferlatte 1988, Nesom 1989) treat the plant as a variety, *E. decumbens* var. *decumbens*. According to Strother and Ferlatte (1988), *E. decumbens* var. *decumbens* is geographically limited to the Willamette Valley and the morphologically similar *E. decumbens* var. *robustior* is restricted to Humboldt and western Trinity Counties, California.

Erigeron decumbens var. *decumbens* is a **taproot**ed perennial herb in the sunflower or daisy family (Asteraceae). It grows 15 to 60 centimeters (6 to 28 inches) tall, with erect to

sometimes **prostrate** stems at the base. The basal leaves often wither prior to flowering and are mostly linear, 5 to 12 centimeters (2 to 5 inches) long and 3 to 4 millimeters (0.1 to 0.2 inch) wide. Flowering stems produce two to five heads, each of which is daisy-like, with pinkish to pale blue **ray flowers** and yellow **disk flowers**. Ray flowers often fade to white with age (Siddall and Chambers 1978). The morphologically similar *Erigeron eatonii* (Eaton's fleabane) occurs east of the Cascade Mountains, while the **sympatric** species *Symphotrichum hallii* flowers later in the summer. In its vegetative state, *E. decumbens* var. *decumbens* can be confused with *S. hallii*, but close examination reveals the reddish stems of *S. hallii* in contrast to the green stems of *E. decumbens* var. *decumbens* (Clark *et al.* 1993). As with many species in the family Asteraceae, *E. decumbens* var. *decumbens* produces large quantities of wind-dispersed seed. Flowering typically occurs in June and July with pollination carried out by syrphid flies and solitary bees. Seeds are released in July and August. *Erigeron decumbens* var. *decumbens* is capable of spreading vegetatively (Clark *et al.* 1993).

***Lomatium bradshawii* (Bradshaw's Lomatium)**

Lomatium bradshawii is a member of the Apiaceae (Umbelliferae), the umbel or parsley family. The genus is a North American group with its center of distribution in the western United States. The genus is composed of taprooted or tuberous perennial herbs with large, winged fruits. *Lomatium bradshawii* was first collected by J.C. Nelson near Salem, Oregon in 1916. The type specimen was collected in 1921, in Eugene, by R.V. Bradshaw, for whom the species was named by Mildred Mathias in 1934. It was originally described as *Leptotaenea bradshawii* Mathias, and was renamed *Lomatium bradshawii* (Rose ex. Math.) Math. & Constance in their 1942 revision of the genus.

Lomatium bradshawii is a low, erect perennial arising from a long slender taproot. Overall, the plant is **glabrous** and has leaves 10 to 30 centimeters (4 to 12 inches) long which are dissected into linear or **filiform** segments. *Lomatium bradshawii* has small light yellow flowers that occur in compound **umbels** composed of **umbellets,** which are rarely larger than 1 centimeter (0.4 inch) across. Generally, only 2 to 5 flowers in each umbel are actually fertile. The fruit is oblong, 0.6 to 1.2 centimeters (0.25 to 0.5 inch) long and glabrous with thickened, corky wings and inconspicuous dorsal ribs (Hitchcock *et al.* 1961). The plant's blooming period peaks around the end of April and beginning of May, but flowers may be observed as early as the first week of April through the end of May (Kagan 1980).

***Lupinus sulphureus* ssp. *kincaidii* (Kincaid's Lupine)**

*Lupinus sulphureu*s ssp. *kincaidii* was first described in 1921 by A.A. Heller as *Lupinus oreganus* from a collection made in Eugene, Oregon (Wilson *et al.* 2003). In the intervening decades, Phillips (1955) described the plant as a subspecies, *L. sulphureus* ssp. *kincaidii*. Hitchcock (1961) retained the position noted by Phillips (1955), but preferred the combination as a varietal rank, *L. sulphureus* var. *kincaidii*, although this is not accepted under the rules of botanical nomenclature (Wilson *et al.* 2003). Additional taxonomic work may be needed for this subspecies, and it is possible that the subspecies should be considered a distinct species, *L. oreganus* (Wilson *et al.* 2003).

*Lupinus sulphureu*s ssp. *kincaidii* is an herbaceous perennial in the legume family (Fabaceae) that forms a branched crown, usually with numerous unbranched stems 40 to 100 centimeters (16 to 39 inches) tall, with whitish or brownish stiff to silky **pubescence**. Basal leaves are usually persistent until after flowering, the lowermost **petioles** 3 to 5 times as long as the blades, the upper **cauline** leaves with petioles sometimes shorter than the blades. **Leaflets** usually number from 7 to 12, and are rather narrowly **oblanceolate**, usually **acute**, 2.5 to 5 centimeters (1 to 2 inches) long. The flowers are numerous but not crowded on the stem, and range in color from bluish or purple to yellowish or creamy white, fading to orange-brown. The **banner** is distinctively ruffled and not very reflexed, the upper **calyx** lip short, **bidentate**, and not concealed by the reflexed sides of the long-clawed banner. The fruit pods are not hairy, are 3 to 4 centimeters (1 to 1.5 inches) long, with 1 to 6 pinkish-brown to black seeds. The species is distinguished from other relatives by its ruffled banner on light-colored flowers, its unbranched flowering stems, and its low growing habit (Hitchcock 1961, Kaye and Kuykendall 1993, Gisler 2004).

***Sidalcea nelsoniana* (Nelson's checker-mallow)**

Sidalcea nelsoniana was first collected by Elihu Hall in 1871 (Robinson and Parenti 1990). The plant was described by Charles Piper in 1919, based on material collected by J.C. Nelson near Salem, Oregon (Piper 1919).

Sidalcea nelsoniana is an herbaceous perennial plant in the mallow family (Malvaceae). It produces numerous elongate, branched **inflorescences** 50 to 150 centimeters (20 to 60 inches) tall, consisting of a vertical stem with 30 to 100 lavender to deep pink flowers clustered in spike-like **racemes**. Like many of the members of this genus, *Sidalcea nelsoniana* has a breeding system in which mature plants produce either exclusively female

flowers or **perfect** flowers. Although the two types of plants exhibit no perceptible vegetative differences, female flowers are generally smaller than perfect flowers, and bear only vestigial, non-functional **anthers**. As is characteristic of the mallow family, *Sidalcea nelsoniana* **stamens** are fused at the base to form a tube around the **style**. Basal leaves are **palmately** lobed, upper stem leaves are deeply divided, and stems are variably **pubescent** with simple hairs. The ring-shaped fruits separate at maturity into 7 to 9 single-seeded, lightly **reticulate**, beaked **carpels**. Plants produce short, thick, twisted rhizomes, as well as a system of fine roots extending from a stout taproot (Hitchcock 1957, Peck 1961, Hitchcock and Cronquist 1973, Halse *et al.*1989).

Four other native *Sidalcea* species are found within the geographic range of *Sidalcea nelsoniana* (Hitchcock and Cronquist 1973, Gisler 2004). *Sidalcea malviflora* ssp. *virgata* (rose checker-mallow) is typically shorter and begins flowering earlier than the other checker-mallows in the region, tends to occupy somewhat dryer, more upland sites, and has forked or branched stem hairs and distinctively deep pink to rose-colored flowers. *Sidalcea campestris* (meadow checker-mallow) is the tallest checker-mallow in the region, and can be distinguished by its large, pale pink to white flowers. *Sidalcea cusickii* (Cusick's checker-mallow) occurs only within the extreme southern portion of *Sidalcea nelsoniana*'s range, barely extending north of the city of Eugene, Oregon, and is discernable by generally forked stem hairs, broad calyx lobes, and prominently veined petals. *Sidalcea hirtipes* (Bristly-stem checker-mallow) has a longer and fuzzier calyx, longer petals, and longer hair on the stem; its range overlaps that of *Sidalcea nelsoniana* in the Coast Range and Lewis County, Washington. *Sidalcea hirtipes* is itself considered endangered in Washington by the state's Natural Heritage Program (Washington Natural Heritage Program 2008).

***Castilleja levisecta* (Golden Paintbrush)**

Castilleja levisecta was first collected by Macoun in 1875, in Victoria, British Columbia. The specimen was labeled *C. parviflora*, but later annotated by Greenman (1898), who published a description of C. *levisecta* in that year. A collection by Howell in 1880 from Mill Plain (Clark County, Washington) was designated as the type specimen (Piper 1906, Sheehan and Sprague 1984).

Castilleja levisecta is a perennial herb in the figwort or snapdragon family (Scrophulariaceae). *Castilleja levisecta* often has from 5 to 15 unbranched stems. The stems may be erect or spreading, in the latter case giving the appearance of being several

plants, especially when in tall grass. Plants are up to 30 centimeters (12 inches) tall and are covered with soft, somewhat sticky hairs. The lower leaves are broader, with one to three pairs of short lateral lobes near the terminal third. The showy **bracts** are about the same width as the upper leaves, softly hairy and sticky, and are golden yellow. The bracts effectively hide the flowers (U.S. Fish and Wildlife Service 2000b).

Taylor's Checkerspot Butterfly *(Euphydryas editha taylorii)*

Taylor's checkerspots are medium-sized, colorfully checkered butterflies with a set of reduced brushy forelegs. They are orange with black and yellowish spot bands, giving a checkered appearance (Pyle 2002).

Taylor's checkerspot is a subspecies of Edith's checkerspot (*Euphydryas editha*). It is one of a small group of rare Pacific coastal subspecies, including the Bay checkerspot (*E. e. bayensis*) from the San Francisco bay area and the Quino checkerspot (*E. e. quino*) from the San Diego region, both of which are Federally listed as endangered. Three other subspecies are known to occur in Washington: *E. e. beani* in the north Cascades, *E. e. edithana* in the foothills of the Columbia Basin, and *E. e. colonia* in the southern Cascades and northeast Olympic Peninsula.

***Delphinium leucophaeum* (Pale Larkspur)**

Delphinium leucophaeum was first collected on open prairies in the Willamette Valley by Thomas Nuttall in 1834 (Goodrich 1983). At various times, it has been described as a subspecies of *D. nuttallii* (upland larkspur) or a hybrid of *D. menziesii* (Menzies' larkspur) (Meinke 1982).

This slender perennial in the buttercup family (Ranunculaceae) forms clusters of tubers and usually grows from 20 to 60 centimeters (8 to 24 inches) tall. The numerous leaves are evenly distributed on the stem and have long petioles with lobed leaf blades. The inflorescence is a raceme with 6 to 30 flowers. The **sepals** are white to cream, sometimes slightly greenish-blue on the back. Lower petals are white or faintly bluish tinged and the upper petals are bluish to lavender tipped. The fruit is a **follicle** 8 to 12 millimeters (0.3 to 0.5 inch) long. *Delphinium leucophaeum* may be distinguished from *Delphinium pavonaceum* (peacock larkspur), the only other white larkspur west of the Cascades, by the orientation of the sepals (forward cupped for *D. leucophaeum*, reflexed for *D.*

pavonaceum) and the hairiness of the lower petals (more and longer hairs for *D. leucophaeum*) (Chambers 2000).

***Delphinium oreganum* (Willamette Valley Larkspur)**

Delphinium oreganum is a member of the buttercup family (Ranunculaceae). Thomas Howell collected the first specimen of *D. oreganum* in June 1882, in the Willamette Valley (Boyer 1999). The taxonomic status of *D. oreganum* is uncertain. *D. oreganum* is intermediate in its floral and inflorescence traits between *D. nuttallii* (Nuttall's larkspur) and *D. menziesii* (Menzies' larkspur). A recent taxonomic treatment (Warnock 1995) considers *D. oreganum* to be synonymous with *D. menziesii* ssp. *menziesii*. An earlier review ranked *D. oreganum* as synonymous with *D. nuttallii* (Hitchcock and Cronquist 1973). One published key presents *D. oreganum* as a valid species (Peck 1961), and a graduate thesis "suggests it is a separate taxon warranting further study" (Goodrich 1983).

Delphinium oreganum is a slender perennial arising from short, fleshy, tuber-like roots. The plant grows to 80 centimeters (31 inches) tall as a single stem. The few leaves are evenly distributed along the stem below a 6- to 30-flowered raceme. The flowers have inconspicuous petals with showy dark blue sepals. The lower petals are short with hairs distributed evenly over most of blade (broadly obovate) and the upper petals are bluish-tipped.

***Delphinium pavonaceum* (Peacock Larkspur)**

First described by Ewan (1945) from collections by Gilbert in 1916 near Corvallis, *Delphinium pavonaceum* is known to hybridize with the closely related *D. leucophaeum* and *D. menziesii*. Ewan (1945) suggests that *Delphinium pavonaceum* may represent a hybrid derivative of *D. leucophaeum* and *D. menziesii*.

This tall perennial in the buttercup family (Ranunculaceae) has showy cream and purple flowers. It rises from clusters of **globose** tubers, and grows from 30 to 90 centimeters (12 to 35 inches) tall. Flowering stems are erect, with soft to **hirsute** pubescence. The leaves are palmate and deeply cleft. The inflorescence is a raceme with many flowers and has **glandular** hairs. Sepals are white or faintly yellowish tinged, upper petals dark blue distally, the lower only blue toward the base, and otherwise creamy white. The fruit is a follicle 16 to 20 millimeters (0.6 to 0.8 inch) long.

***Horkelia congesta* ssp. *congesta* (Shaggy Horkelia)**

Horkelia congesta ssp. *congesta* was first collected by David Douglas and described by Hooker (1829).

This perennial herb is a member of the rose family (Rosaceae). The plant arises from a multi-capital root **caudex** with 1 to 3 crowns and has erect flowering stems that are 10 to 40 centimeters (4 to 16 inches) tall arising from few-leaved rosettes; the leaves are **pinnately** dissected into 11 to 17 leaflets. The flowering heads are **cymes**, which are **congested** and **capitate**, terminating the mostly simple or sparingly branched stems. Flowers are made up of 5 creamy white petals that are 4 to 5 millimeters (0.16 to 0.2 inch) long. The fruit is an achene.

***Sericocarpus rigidus* (White-topped Aster)**

First collected by Scouler in the early 1800s along the Columbia River, *Sericocarpus rigidus* is known from collections in Washington, Oregon, and British Columbia (Gamon and Salstrom 1992). The species was originally described as *Seriocarpus rigidus* Lindley, and was later placed in the genus *Aster* as *Aster curtus* by Cronquist in 1955 (Hitchcock *et al.* 1955, Gamon and Salstrom 1992). Recent genetic work has shown that the species belongs in the genus *Sericocarpus*, which is more closely related to the genus *Solidago* than to the North American genus *Aster*, and the species has been reassigned as *Sericocarpus rigidus* (Leonard *et al*. 2005).

Sericocarpus rigidus is a perennial herb in the sunflower or daisy family (Asteraceae), with slender creeping rhizomes and generally unbranched stems, topped by terminal clusters of flowering heads. Flowering stems are 10 to 30 centimeters (4 to 12 inches) tall; non-flowering stems are about half as tall. Leaves are alternate and evenly distributed along the stem, oblanceolate and tapering to an essentially **sessile** base, the lowermost leaves reduced and the largest leaves (2.5 to 3.5 centimeters [1 to 1.5 inches] long) occurring along the center third of the stem. Flowers are inconspicuous, occurring in compact clusters of 5 to 20 small heads. Ray flowers are typically two, 1 to 3 millimeters (0.04 to 0.12 inch) long, and shorter than the pappus; disk flowers are pale yellow with purple anthers. **Involucres** are 7 to 9 millimeters (0.3 to 0.4 inch) high, narrow, the bracts **imbricate** in several series, with a strong midrib or slight **keel**, **chartaceous** below and with spreading light green herbaceous tips (Hitchcock *et al.* 1955, Gamon and Salstrom 1992).

***Sisyrinchium hitchcockii* (Hitchcock's Blue-eyed Grass)**

Sisyrinchium hitchcockii is in the iris family (Iridaceae). Henderson (1976) first described *Sisyrinchium hitchcockii* as a separate species during his study of Pacific Northwest blue-eyed grasses. The species had previously been infrequently collected and categorized as either *Sisyrinchium segetum* (Idaho blue-eyed grass) or *S. bellum* (western blue-eyed grass).

Genetically isolated from all other northwestern blue-eyed grasses, *Sisyrinchium hitchcockii* is the most striking and morphologically distinctive member of the genus in the western states. While *S. hitchcockii* has an elongate rhizome and usually with only one or two stems, the other Pacific Northwest blue-eyed grasses have very compact rhizomes producing single to numerous stems. Additionally, *S. hitchcockii* is the only Pacific Northwest blue-eyed grass that is **self-incompatible** (Henderson 1976). This species has the largest flowers (up to 20 millimeters [0.8 inch]) and the widest leaves and stems of the genus. The six **tepals** are approximately 1.2 centimeters (0.5 inch) long, reddish-purple in color with dark purple veins and sometimes yellow at the base. The plant ranges from 35 to 45 centimeters (14 to 18 inches) tall and is usually erect or somewhat recumbent. The basal leaves, approximately 6 millimeters (0.25 inch) wide, are about two-thirds the height of the stem (Eastman 1990).

Appendix G. Summary of Comments on the Draft Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington

1. Background

On September 22, 2008, we released the Draft Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington (Draft Plan) for a 90-day review and comment period ending on December 22, 2008. Availability of the Draft Plan was announced in the Federal Register (73 FR 54603 and 73 FR 58975) and via a news release to stakeholders and media contacts throughout the range of the species. Over 160 people and 16 media contacts were notified of the availability of the Draft Plan for review.

In accordance with Service policy, requests for peer review of the Draft Plan were sent to experts outside the Service. Four experts agreed to provide peer review of the Draft Plan:

Dr. Patricia Muir, Dept. of Botany and Plant Pathology, Oregon State University, Corvallis, Oregon
Dr. Eric Seabloom, Dept. of Zoology, Oregon State University, Corvallis, Oregon
Dr. Gordon Pratt, Department of Entomology, University of California, Riverside, California
Diane Steeck, Parks and Open Space Department, City of Eugene, Oregon

We received 14 comments during the official comment period. Affiliations of these commenters are shown below:

Peer reviewers:	4 comments (affiliations shown above)
Federal agencies:	1 comment (Bureau of Land Management)
State agencies:	1 comment (Washington Natural Heritage Program)
Local governments:	1 comment (City of Eugene)
Universities:	1 comment (Washington State University, Vancouver)
Conservation organizations:	2 comments (The Nature Conservancy, Greenbelt Land Trust)
Private citizens:	4 comments

Each comment letter contained one or more issues, and some letters raised similar issues. Many commenters provided specific advice on wording and clarity or offered suggestions for refining individual recovery tasks. Their comments were incorporated, as appropriate, into the final recovery plan and are not discussed further here. We convened a meeting of the Recovery Team to discuss several of the substantive comments received; those comments and our responses based on the team's recommendations are summarized below. Information and comments not incorporated into the final recovery plan were considered and are also summarized below.

All of the comments received on the Draft Recovery Plan are on file at the U.S. Fish and Wildlife Service, Oregon Fish and Wildlife Office, 2600 SE 98th Avenue, Suite 100, Portland, Oregon, 97266.

2. Issues

Issue: Recovery Criteria for Fender's Blue Butterfly
Comment: The recovery criterion for Fender's blue butterfly abundance should be expressed as a minimum number per network or independent population over a specific period of time; using a minimum number, rather than an average population size, would more closely relate to extinction risk.

Response: We agreed to modify the criterion based on revised modeling done by Drs. Cheryl Schultz and Elizabeth Crone, which focuses on minimum population size needed for acceptable persistence probability. Revised criteria for downlisting and delisting are expressed in terms of persistence probability of 90 and 95 percent, respectively.

This change from average to minimum population counts will also have some benefits for monitoring requirements. Monitoring to detect a minimum number in a population rather than annual complete counts of all populations will require less effort, which is important as the number of populations has grown to the point that it is now very difficult and expensive to attempt to conduct a complete count at all known populations each year.

Comment: How far apart can subpopulations within a functioning network be when they are connected by stepping stones of small patches of lupines and nectar species? The recovery plan should specify a minimum number of Kincaid's lupine plants, minimum patch size, and maximum number of stepping stones that would be acceptable.

Response: We don't have the data to set a limit on the number of stepping stones which could link disjunct subpopulations. The attributes of stepping stones will depend on the landscape context of each individual functioning network. The U.S. Fish and Wildlife Service will be involved in reviewing management plans for functioning networks, and we will have an opportunity to review the reasonableness of the connectivity parameters. Lacking specific data on the subject, we choose to allow flexibility.

Issue: Recovery Criteria for Plants
Comment: Is the term "stable" appropriate or meaningful in the recovery criterion for population trend?

Response: A "stable" population does not mean that the population size is static over time. The wording of the population trend criterion has been clarified to explain that over a period of X years, the number of individuals in the population may exhibit natural year-to-year variability, but the trend must not be declining (average growth rate equal to or greater than 1).

Comment: The target numbers of plant populations for delisting (15 populations) seems low and should be increased.

Response: We agree that a more conservative approach to recovery would be to require 12 populations for downlisting to threatened and 20 populations for delisting. The recovery criteria have been modified accordingly.

Comment: Is a single population per recovery zone adequate for plants?

Response: Generally speaking, no, although the recovery zones are not equal in size, and a single population in a small zone may well be appropriate given historical information and current conservation opportunities. For each of the listed plant species, the Recovery Team agreed that most zones will require a minimum of two populations, to spread the risk of localized stochastic events. However, there are a very few zones that will have a target of just one population; this standard will apply in those cases where there are few historical records of the species and where there are limited opportunities for population creation within that zone.

Comment: The target numbers of populations and individuals per zone are the same for *Erigeron decumbens* var. *decumbens*, *Lomatium bradshawii*, *Lupinus sulphureus* ssp. *kincaidii* and *Sidalcea nelsoniana.* Is this because not much is known about the individual species, or to be protective to the most sensitive species and the capacity to individualize them is limited by lack of knowledge? The plan also establishes a minimum population sizes but isn't explicit about their basis. Where did these numbers come from?

Response: Section IV.3(a) is explicit about the rationale for setting targets for number of populations and population size. The Recovery Team developed a simple model to relate number of populations to extinction risk, and determined that at least 14 populations of each listed plant, distributed across its historical range, would be sufficient to achieve an acceptable extinction risk; the Recovery Team settled on 20 populations of each plant species to build in an extra measure of security. The Recovery Team derived target population sizes for downlisting and delisting by consensus, drawing on their many years of professional experience and expertise with the plant species and prairie habitats in the region.

Comment: Should we establish a minimum separation distance between plant populations?

Response: Populations should be separated enough to be independent of localized stochastic threats. The Service will likely use the decision rules for separate element occurrences used by the state Heritage programs, but will not set an absolute separation distance. We want to maintain flexibility to reflect the variability and heterogeneity of the landscape.

Comment: It would be useful if the recovery plan better described to what extent the recovery strategy for the plant species relies on population augmentation and the establishment of new populations versus protection of existing populations.

Response: Establishing a focus on augmentation or new population establishment is best dealt with on an ad hoc basis by land managers and the appropriate species working group. These decisions will be driven by the current locations of rare species and conservation opportunities in each recovery zone.

Issue: Recovery Zones
Comment: What were the criteria for setting the boundaries of the 10 recovery zones? One commenter suggested that it would make sense to add a central zone along the Willamette River.

Response: The Recovery Team examined many different alternatives for dividing the range of the listed species into ecologically relevant divisions for recovery, and felt that the 10 zones adequately capture the range of landscape diversity across the region covered by the recovery plan.

Issue: Seed Transfer Zones
Comment: The draft recovery plan suggests that recovery zones should be considered as interim seed transfer zones, but this concept is not well supported.

Response: The recovery plan will no longer use the term "seed transfer zones," however, the plan will recommend that seeds should only be moved within recovery zones, unless there is better information to support a different decision. The recovery plan provides guidance to use: a) the closest population with b) the most similar habitat to the recipient population that c) has a sufficient population to support seed collection.

Issue: Assessment of Prairie Quality and Diversity (Appendix C in the draft recovery plan, Appendix D in the final recovery plan)
Comment: Comments from various land managers indicate that our criteria set standards that are *both* too low and too high.

Response: The standards set in the Prairie Quality Appendix apply to managed degraded native prairies, but would not necessarily be applicable to restoration sites, which would likely have higher standards. Criteria in the Prairie Quality Appendix would not supersede other criteria established elsewhere for restoration or mitigation sites (often associated with mitigation banks or the ecosystem services market). The recovery plan includes a recovery task to continue to refine the prairie quality criteria, especially for prairie restoration or creation sites. The plan stresses that the criteria in Appendix D are not absolute criteria – they are suggested targets, but can be modified based on expert opinion and local conditions.

Issue: Recovery Zones for *Castilleja levisecta*
Comment: A few commenters disagreed about which recovery zones should have targets for populations of *Castilleja levisecta*.

Response: The final recovery plan has been modified; the goal for *Castilleja levisecta* will be to establish 5 populations (each at least 1,000 flowering individuals) in at least 3 of the following recovery zones: SW Washington, Portland, Salem East, Salem West, Corvallis East, Corvallis West, Eugene East, Eugene West. Priority will be given to reestablishing populations in zones for which there are historical records (SW Washington, Portland, Salem East, Corvallis East).

Comment: There are introduced populations of *Castilleja levisecta* at Baskett Slough and Finley National Wildlife Refuges. Shouldn't these be acknowledged?

Response: Yes. These two small populations resulted from transplant experiments, and whereas the small groups of plants may not constitute viable populations, the recovery plan will treat them as small, existing populations, although these sites will not necessarily be the foundation of new populations that will contribute towards recovery.

Issue: Climate Change
Comment: The draft recovery plan does not address the uncertain and changing threats posed by climate change.

Response: The final recovery plan acknowledges that climate change is a definite threat, although we are uncertain at this time of the likely effects of changing climate on the species and habitats covered in this recovery plan. Recovery criteria stress planning for climate change by designing monitoring and adaptive management programs for managed populations. The recovery plan also recommends establishing populations of listed species at sites that span the natural elevation range of the species, as well as at sites with northern aspects or moister soils. The recovery plan now includes a recovery task to convene a panel to address potential threats of climate change to the prairies of the region, to identify potential solutions and to develop a monitoring approach and adaptive management responses to climate change in the recovery program for the listed prairie species.

Other Issues
Comment: Was *Lathyrus holochlorus* (thin-leaved peavine) considered during the preparation of the draft recovery plan as a possible species of concern?

Response: Yes, *Lathyrus holochlorus* was originally included among the nonlisted species of conservation concern covered in the recovery plan, but there is so little published information about its ecology and locations that we decided we could not adequately address it in the recovery plan.

Comment: Did the Recovery Team consider designating ecologically significant units? This could provide incentive to work on zones independently.

Response: We assume the commenter may have been thinking of Recovery Units, which may be designated in a recovery plan. A Recovery Unit is a management sub-unit of the listed entity, geographically or otherwise identifiable, that is essential to the recovery of the entire listed entity; conserves genetic or demographic robustness, important life history

stages, or other feature for long-term sustainability of the entire listed entity. Recovery units are optional, but, where used, should collectively encompass the entire listed entity. Recovery criteria for the listed entity should address each identified recovery unit, and every recovery unit must be recovered before the species can be delisted. The range of the species covered in this recovery plan is not very large, and we did not believe that a subset of the range of any species would be appropriate for consideration as a Recovery Unit.

Comment: Several commenters were concerned that the estimated budgets for recovery actions, particularly those involving habitat acquisition or easements, were too low.

Response: We have revised the budgets for many actions in the Implementation Schedule (section V). The purpose of the estimated budget in the recovery plan is to help decision makers understand the potential costs of implementing recovery actions, however, these figures are just estimates, and future implementation of recovery actions will be not be constrained to the figures in the Implementation Schedule.

Comment: One commenter was concerned about the effect of the Endangered Species Act and publication of this recovery plan on private property rights and opined that we have created a disincentive for landowners to manage for listed species.

Response: The prohibitions on take and trade of listed species are found in section 9 of the Endangered Species Act; it is beyond the scope of the recovery plan to change the Act. However, there are numerous programs implemented by the Service to assist private landowners who have listed species or habitat for listed species on their property (*e.g.*, Partners for Wildlife, Safe Harbor Agreements and Habitat Conservation Planning programs). It is also important to note that most of the species addressed in this recovery plan are plants, which have no Federal protection on private lands, unless a Federal agency is involved (*i.e.*, funds, authorizes or carries out an action).

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