

Bradshaw's Lomatium
(Lomatium bradshawii)

5-Year Review
Summary and Evaluation



U.S. Fish and Wildlife Service
Oregon Fish and Wildlife Office
Portland, OR

5-YEAR REVIEW

Species reviewed: Bradshaw's lomatium (*Lomatium bradshawii*)

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5-YEAR REVIEW

Bradshaw's lomatium (*Lomatium bradshawii*)

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Regional Office:

Region 1 Endangered Species Division, Sarah Hall (503) 231-2071

Lead Field Office:

Oregon Fish and Wildlife Office (503)231-6179
Paul Henson, Project Leader
Miel Corbett, Assistant Project Leader
Rollie White, Endangered Species Division Manager
Kim Garner, Fish and Wildlife Biologist

1.2 Methodology used to complete the review:

The U.S. Fish and Wildlife Service (Service) initiated a 5-year review of *Lomatium bradshawii* (Bradshaw's lomatium) on July 6, 2005 (70 FR 38972-38975). This 5-year review was conducted by the Oregon Fish and Wildlife Office and summarizes current scientific research and surveys related to Bradshaw's lomatium. All pertinent literature and documents used in this review are on file at the Oregon Fish and Wildlife Office. The primary sources of information used in this analysis were recent survey information in our files and the September 2008 Draft Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington (Service 2008a) (Draft Recovery Plan).

1.3 Background:

1.3.1 FR Notice citation announcing initiation of this review:

U.S. Fish and Wildlife Service. July 6, 2005. Endangered and Threatened Wildlife and Plants; Initiation of 5-year Reviews (of 33 species in Region 1). Federal Register 70:38972-38975.

1.3.2 Listing history

Original Listing

FR notice: U.S. Fish and Wildlife Service. 1988. Endangered and Threatened Wildlife and Plants; Final Endangered Status for *Lomatium bradshawii* (Bradshaw's lomatium). Federal Register 53(190): 38448-38975.

Date listed: October 31, 1988

Entity listed: Species

Classification: Endangered

1.3.3 Associated rulemakings: N/A

1.3.4 Review History:

This is the first 5-year status review for Bradshaw’s lomatium. Information that has become available since it was listed in 1988 has been used to determine the current status of the species.

1.3.5 Species’ Recovery Priority Number at start of this 5-year review:

5. This denotes a full species with a high degree of threat and a low potential for recovery.

1.3.6 Current Recovery Plan or Outline

Name of plan or outline:

Draft 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), and *Sidalcea nelsoniana* (Nelson’s checker-mallow)

Once finalized, this plan will update and replace the December, 1999, Amendment to the Bradshaw’s Lomatium Recovery Plan.

Date issued: September 22, 2008

Previous plans:

Bradshaw’s lomatium (*Lomatium bradshawii*) Recovery Plan, August 1993
Amendment to the Recovery Plan for Bradshaw’s lomatium (*Lomatium bradshawii*), December 1999

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

This policy does not apply to plant species.

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria?

Yes
 No

2.2.2 Adequacy of recovery criteria.

2.2.2.1 Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat?

Yes
 No

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery plan?

 X *Yes*
 No

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information:

The first Recovery Plan for Bradshaw’s lomatium was published in 1993 and amended in 1999. However, the most recent recovery plan for Bradshaw’s lomatium is the Draft Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington completed in 2008 (Service 2008a). This plan includes three other listed plant species and one listed butterfly species. Once finalized, this recovery plan will replace the 1999 amended Bradshaw’s lomatium recovery plan. For the listed plants, ten recovery zones were delineated that cover the geographic range of the species, Bradshaw’s lomatium occurs in six of these zones. Recovery criteria specify the number and size of populations in each recovery zone and the distribution of subpopulations that make up the populations. The criteria require 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.

The specific recovery criteria for Bradshaw’s lomatium as described in the Draft Recovery Plan and a discussion of how each of these criteria have, or have not, been met follows:

Downlisting/Delisting Criterion 1.

Distribution and abundance. 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 km [2 miles]) of each other.

The Recovery Team’s analysis did not establish the minimum size of populations needed to confer a low risk of population extinction. However, the Recovery Team concluded that each occupied recovery zone should have a goal of at least 5,000 plants. In recovery zones with a target of 5,000 plants, the target may be achieved with a single large population or with a combination of smaller populations, at least two of 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 historic 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. See Table 1 for the distribution and abundance goals for this criterion and the current status of Bradshaw's lomatium.

Based on current population data, the minimum number of protected¹ populations and number of target plants per zone for downlisting have been met in three recovery zones, Salem East, Corvallis East, and Eugene West. The minimum protected population levels and targets for delisting have been met in two recovery zones, Salem East and Eugene West.

Recovery Zone	Downlisting Goals		Delisting Goals		Current Status	
	Minimum # of Populations / Zone	Target # of Plants / Zone	Minimum # of Populations / Zone	Target # of Plants / Zone	Current # of protected populations* over 5,000/Zone	Current estimated # of Plants in protected populations / Zone
SW Washington	1	5,000	1	5,000	0	2000
Salem East	1	5,000	1	5,000	1	over 100,000
Corvallis East	1	5,000	2	10,000	1	over 150,000
Corvallis West	1	5,000	2	10,000	0	517
Eugene East	1	5,000	2	10,000	0	228
Eugene West	2	10,000	3	15,000	3	over 300,000
+ additional populations (may occur in any zone within species' range)	1	5,000	4	20,000	0	0
Total	8	40,000	15	75,000	5	over 550,000

* "population" is based on pollinator distance of 3 km (2 miles).

Downlisting/Delisting Criterion 2.

Population trend and evidence of reproduction. The number of individuals in the population shall have been stable or increasing over a period of at least 10 years for downlisting or 15 years for delisting. Populations must show evidence of reproduction by flowering, seed set, or presence of seedlings.

Differences in monitoring protocol, counting methods and inconsistent reporting make it difficult to determine whether this criterion has been met. Population trend information is available for a few sites and is discussed in section 2.3.1.2. In 2008, the Service provided funding under Section 6 of the Endangered Species Act to the Oregon Department of Agriculture (ODA) to develop and evaluate standardized survey, monitoring and demographic study protocols for four rare, threatened and endangered Willamette Valley prairie plant species including Bradshaw's lomatium. A final report is expected in 2012. The implementation of these protocols and consistent reporting will

¹ As defined by criterion 3b.

improve data quality, interpretation and comparison from year to year. The survey protocols currently used by the Service include: counting plants by doing a complete census, sampling a portion of the population, or making visual estimates of the number of plants at a site. This includes all forms of the plant with an estimate of the percentage of flowering plants versus vegetative plants.

Downlisting/Delisting Criterion 3.

Habitat quality and management.

- 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.*
- b. Security of habitat. For each listed species, 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. 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.*

Over seventy-five percent of the known sites are owned or managed by government agencies or private conservation organizations. These sites include over 400 acres of habitat currently being monitored or managed for Bradshaw's lomatium. The quality of habitat varies with over one-third of these sites considered high quality habitat. Over half of these protected sites are federally-owned and actively managed and monitored for prairie ecosystem restoration. Two of the sites are managed by The Nature Conservancy (TNC) and several sites are managed by local city and county governments. Ownership, quality and management activities for specific sites are discussed in section 2.3.1.2 and summarized in Table 2.

Delisting Criterion 4.

Genetic material is stored in a facility approved by the Center for Plant Conservation. 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.

Since 1984 over 27,000 seeds from 536 maternal lines have been collected and stored at Berry Botanical Garden (Guerrant 2008, pers. comm.). Seed was collected from 11 different sites located in 4 out of the 6 recovery zones. The University of Washington Botanic Garden also has banked seeds of this species. See Table 2 for specific site information regarding seed collection.

Delisting Criterion 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 and provide a means of assessing the continuing effectiveness of management actions.

This criterion has not been met.

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology and life history:

Bradshaw's lomatium is a member of the Apiaceae (Umbelliferae) family. It is a low, erect perennial arising from a long slender taproot and has small light yellow flowers that occur in umbels. Bradshaw's lomatium 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 (Kaye and Kirkland 1994). 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 Bradshaw's lomatium from the population swings of any one pollinator (Kaye 1992).

Bradshaw's lomatium does not spread vegetatively and depends exclusively on seeds for reproduction (Kaye 1992). It does not maintain a persistent soil seed bank, and most seeds either germinate or die within one year. Average fruit production of 10.8 fruits per plant was observed by Kaye and Kirkland (1994) and varies from 0.3-18.0 fruits per plant in response to site, year, and burning regime (Pendergrass et al. 1999). 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).

Extensive research has been conducted on the ecology and population biology of Bradshaw's lomatium, 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 2001, Kaye *et al.* 2003). The results of these studies have been used to direct the management of the species at sites managed for wet prairies.

The species generally responds positively to disturbance. Low intensity fire appears to stimulate population growth of Bradshaw's lomatium. The density and abundance of reproductive plants increased following fires (Kaye and Pendergrass 1998, 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).

Studies of the effects of cattle grazing on Bradshaw's lomatium populations show mixed results. Livestock 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.

Propagation studies have found that long-term (8 weeks) cold stratification was necessary to fully break dormancy in this species (Kaye *et al.* 2003). Bradshaw's lomatium plants can be grown from seed in a greenhouse environment (Kaye *et al.* 2003). Plants may be successfully established at existing populations or new locations throughout-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 2001, Kaye *et al.* 2003). Seeds of this species have been banked at the Berry Botanic Garden in Portland, Oregon and the University of Washington Botanic Garden.

2.3.1.2 Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:

Bradshaw's lomatium is much more abundant today than at the time of listing; however, populations can change significantly over a short period of time. Some populations that were large when discovered have since declined substantially in size. A large population at Buford Park near Eugene, Oregon, dropped from about 23,000 plants in 1993 to just over 3,000 plants in 1994 (Greenlee and Kaye 1995), and continued to decline to less than 1,000 plants in 1999, due to suspected herbivory by a booming vole population. A population at Finley NWR declined from over 2000 flowers in 1992 to less than 200 in 2002; the cause has not been determined. Changes in hydrology and rainfall are suspected in the annual variation of some populations. Other populations have greatly increased since the time of listing; for instance, the population at Kingston Prairie Preserve increased from 1,000 plants concentrated in a 3 to 4 acre patch at the time of

listing to an estimated 103,221 in a 3.46 acre patch with 60 percent of the plants flowering in 2007 (USFWS 2007).

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):

In a genetic study that included six populations of Bradshaw's lomatium, 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 consistent with a recent genetic bottleneck. However, they are consistent with historical gene flow among all populations and do not appear to be genetically differentiated from the other populations of the species.

2.3.1.4 Taxonomic classification or changes in nomenclature:

No change in taxonomic classification or changes in nomenclature have been suggested since the time of listing.

2.3.1.5 Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g. corrections to the historical range, change in distribution of the species' within its historic range, etc.):

At the time of listing, the geographic range of Bradshaw's lomatium was thought to be from Stayton, Oregon to just south of Eugene, Oregon, with 11 known sites. In 1994, two additional sites were discovered in Clark County in southwestern Washington. The current geographic range extends from southwestern Washington to Cresswell, Oregon with 47 occurrences listed in the Oregon Natural Heritage Information Center database as of August 2008. Most of these populations are small, ranging from about 10 to 1,000 individuals, although the four largest sites each have over 100,000 plants. Figure 1 shows the distribution of Bradshaws' lomatium within each recovery zone. Detailed information on 42 of the sites where Bradshaw's lomatium is currently known to occur is summarized in Table 2.

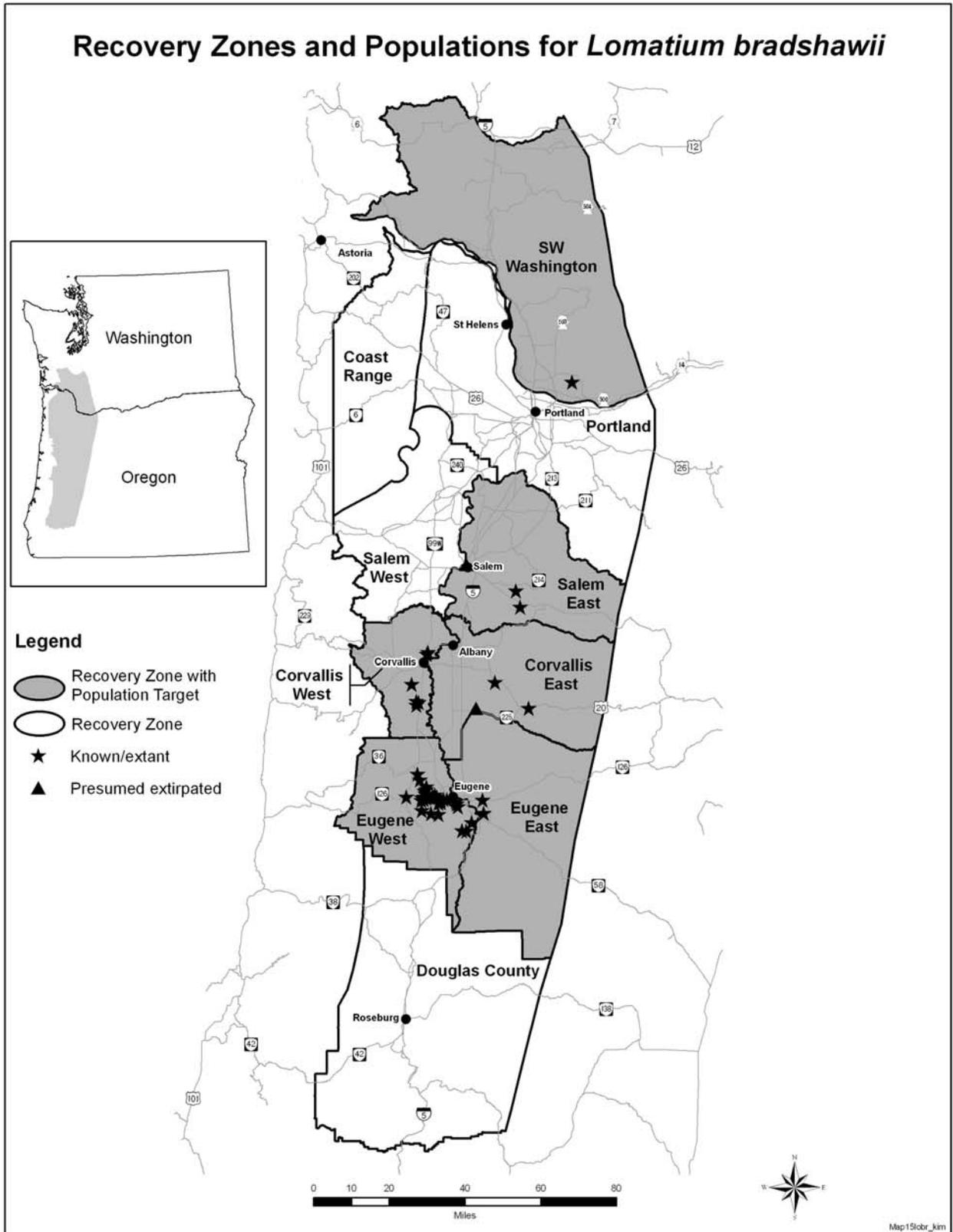


Figure 1. *Lomatium bradshawii* recovery zones and populations.

Table 2. Populations of LOBR by Recovery Zone.									
Recovery Zone		Ownership	Acreage (monitored area)	# of plants	Survey Source	Protected	Habitat Quality	Actively Managed	Seed Stored
EO ID	Site Name								
SW Washington									
3570	Green Mountain	Private	14.0	2000	Rush 1999	Yes	Unknown		
5566	Lacamas Meadows	Private	20.0	over 15 million	FWS 2007	No	High Quality	X	X
Salem East									
22909	<i>Kingston Prairie</i>	TNC	3.5	over 100,000	FWS 2007	Yes	High Quality	X	X
1851	<i>Sublimity</i>	Private	0.3	approx. 12,000	Curriu 2008	No	Degraded		
Corvallis East									
2228	Oak Creek	Federal	7.9	over 150,000	FWS 2007	Yes	Low Quality	X	
15971	Sweet Home	Private	Unknown	unknown		No	Unknown		
Corvallis West									
3690/11293	<i>Finley NWR</i>	Federal	3.1	351	FWS 2007	Yes	Low Quality	X	X
15569	<i>Jackson-Frazier Wetlands</i>	County	0.6	166	FWS 2007	Yes	High Quality	X	
21054	Muddy Creek	Private	6.9	7,600	Salix 2004	No	Degraded		
Eugene East									
27558	<i>Buford Park</i>	County	5.7	228	FWS 2007	Yes	High Quality	X	
10283	Jenna Village	Private	0.9	52	FWS 2007	No	Degraded		
none	Private land in WRP	Private	20.0	6	Jebousek 2005	Unknown	High Quality	X	
Eugene West									
<i>* see below</i>	<i>Fern Ridge Lake</i>	ACOE	>265	40,000+ @ 9 sites	ACOE 2009	Yes	High quality	X	X
27557	Balboa (Introduced)	BLM	0.8	73	BLM 2005	Yes	Low Quality	X	
26913/1852	Eugene Speedway	BLM	7.0	384	BLM 2005	Yes	Low Quality	X	
24696	<i>Long Tom ACEC</i>	BLM	1.7	1600	BLM 2005	Yes	High Quality	X	
22183	North Greenhill/Oak Hill	BLM	0.2	12	BLM 2005	Yes	High Quality	X	
22183	North Greenhill (Introduced)	BLM	2.0	206	BLM 2005	Yes	High Quality	X	
none	Rosy (Introduced)	BLM	0.9	373	BLM 2005	Yes	High Quality	X	
21055	Spectra Physics	BLM	0.03	1	BLM 2005	Yes	Low Quality	X	
unknown	Taylor North	BLM	** see below	208	BLM 2005	Yes	High Quality	X	
unknown	Willow Corner Annex	BLM	0.3	11	BLM 2005	Yes	Low Quality	X	
27560	Creswell	City of Creswell	11.0	100-200	FWS 2008b	No	Low Quality		
2113/4872	Acorn Park	City of Eugene	<.01	112	FWS 2008b	Yes	Low Quality	X	
2383	Amazon Creek	City of Eugene	<.01	80-100	FWS 2008b	Yes	Low Quality	X	
2383	<i>Amazon Park</i>	City of Eugene	3.4	over 250,000	FWS 2008b	Yes	Low Quality	X	X
11987	South Eugene High School	City of Eugene	0.1	60	FWS 2007	No	Degraded		
15162	Veneta	City of Veneta	13.0	1273	FWS 2008b	No	Low Quality		
1132	<i>Camas Swale</i>	ODOT	60.0	1522	ODOT 2006	Yes	High Quality	X	
7466	Short Mountain Landfill	Lane County	15.4	2100	FWS 2007	Yes	Low Quality	X	X
none	Private land in WRP	Private	Unknown	374	FWS 2008b	Unknown	Unknown		
23720	<i>Nielson Road</i>	State	Unknown	160	ONHIC 2008	Unknown	Unknown		
17509	<i>Willow Creek</i>	TNC	4.9	8630	Curriu 2008	Yes	High Quality	X	X
22377	Wallis Street	Unknown	Unknown	approx. 3000	FWS 2008b	No	Low Quality		X

Italics indicate sites known at the time of listing.

* includes: 16497, 8981, 1793, 9382, 4970, 16052, 872

** acreage included with Long Tom ACEC

A discussion of populations within each recovery zone follows:

Southwest Washington Recovery Zone

Two sites with large numbers of Bradshaw's lomatium were discovered in this recovery zone in 1994; an amendment to the Recovery Plan to include these sites was subsequently published in 1999. The first site covers approximately 20 acres and is located at Camas Meadows, a privately-owned golf course. The first population estimates in 1995 reported 70,411 plants; later monitoring from 1997 to 1999 estimated a much higher population of between 814,171 and 1,414,216 flowering individuals. Overall the population has continued to flourish, with the most recent population survey estimating over 15 million Bradshaw's lomatium plants present (USFWS 2007). Over 8,000 seeds have been collected from the site and stored at Berry Botanic Garden. A 5-year conservation agreement expired in 2001 and has not been renewed. The site is not currently protected by an agreement, easement, or covenant; however, the current owner is interested in maintaining the population and continues to manage the habitat through annual fall mowing and limiting golfer access (John Trachsel 2009, pers.comm.).

The second site is located within 3 km (2 mi) of Camas Meadows at Green Mountain Resort Conservation Area and covers approximately 14 acres. The conservation area is part of a 74-acre conservation covenant created as part of the development of Green Mountain Resort, which also includes a golf course. The conservation covenant's stated purpose is to require the wetland and stream buffer area to be maintained in its natural state in order to preserve and protect the wetland ecosystem (Clark County, 1996). In 1999, the Bradshaw's lomatium population was estimated at approximately 2,000 individuals. A 5-year conservation agreement expired in 2000 and has not been renewed. The Nature Conservancy managed the conservation area from 1997 until their Vancouver, Washington, field office closed in 2005. Management efforts included tree and shrub removal, control of non-native weeds and shrubs, prescribed burning, and regular monitoring of rare plant populations. The Washington Department of Natural Resources (WDNR) has taken over management of the site. It is included within the boundary of a combined Natural Area Preserve and Natural Resources Conservation Area. This designation allows WDNR to pursue acquisition and conservation easements on land within the boundary but does not have any regulatory authority until acquisition or easements are in effect (Wilderman 2009, pers. comm.). Management actions by WDNR include monitoring of established plots, mowing, and treating roses that have invaded the habitat. Monitoring of fixed quadrats showed a decrease in the population from 1998 to 2001 and an increase from 2002 to 2004. Monitoring was not performed in 2005 and 2006. Monitoring in 2007 showed a significant decrease in the population when compared to the 2004 results (Wilderman 2009, pers.comm.).

Salem East Recovery Zone

Two sites are known in this recovery zone. The first, Kingston Prairie Preserve, is owned by TNC. At the time of listing this site was very small with 1,000 plants concentrated in a 3 to 4 acre patch along a seasonal creek drainage. This population faced possible

extirpation caused by agricultural development. However, due to the shallow soils and underlying basalt bedrock, the property was unsuitable for farming and was later purchased by TNC to manage as a prairie preserve. The site is one of the best examples of remaining native prairie in the central Willamette Valley and hosts a diversity of native wildflowers including Bradshaw's lomatium, Willamette Daisy, Oregon Larkspur, and white-topped aster. Management activities include rare plant monitoring, and invasive species removal. Currently, a 3.46 acre area is being monitored for Bradshaw's lomatium; the most recent survey estimates the population size at 103,221 with 60 percent of the plants flowering (USFWS 2007). Over 8,000 seeds have been collected from this site and stored at the Berry Botanic Garden.

The second site is at a privately-owned farm just outside of Sublimity in Marion County. Although this site is moderately disturbed, a recent population survey estimates the population size at 12,320 (Currin *et al.* 2008). Seed has been collected for growing transplants to introduce at nearby sites. Efforts to engage the landowner in active management have been unsuccessful.

Corvallis East Recovery Zone

Since the time of listing three populations of Bradshaw's lomatium have been discovered in this recovery zone. A large population, estimated in 1999 to be between 14,800 and 233,600 plants, was reported to occur on private property in Sweet Home. Since then, the property owner has denied access and no current population data exists. Another site occurred on private land in Corvallis, with 5 plants reported in 1991, but none were found in 2005.

The only population with current documented occupancy occurs at Oak Creek and was discovered in 1994. A baseline survey that year estimated the population to be 130,986 with 33 percent flowering or fruiting. The 59-acre property was acquired by the Service in 1996 and is now part of the William L. Finley National Wildlife Refuge (NWR). The population at Oak Creek was estimated at 119,624 plants in 1996; the most recent survey estimates the population to be between 153,766 and 184,526 plants with 60 percent flowering (TNC 1997; USFWS 2007). A monitoring plan was written for the site in 2005 and recovery efforts include removal of woody vegetation, population monitoring, mowing, and prescribed fire (Kaye 2005). Threats observed at this site include adverse impact from adjacent land use, habitat isolation and fragmentation, former agricultural use, and non-native species invasion.

Corvallis West Recovery Zone

Three populations are known in this recovery zone, and of these, two are protected. The first is a small population at Jackson-Frazier Wetland on property owned by Benton County. Approximately 144 acres of this 147-acre site are managed by Benton County Natural Areas and Parks Department. A management plan was prepared by the Jackson-Frazier Wetland Management Plan Task Force in 1992 and revised in 2005 by the Jackson-Frazier Wetland Technical Advisory Committee and a private consultant. The site is managed for preservation, restoration, passive recreation such as nature observing, education

and non-destructive research. The population has been surveyed since 1986. From 1986 to 1994 the population dropped slowly from about 475 plants to about 261 plants, and then recovered to about 460 plants in 1997. The population again dropped to 40 plants between 1997 and 2003. (Kaye and Kirkland 1994; Kaye 2003). Kaye (2003) recommended mowing to reduce woody vegetation and grasses, prescribed burning to promote wet prairie species, and seed collection for storage and future outplantings. After the site was mowed in 2003, the population grew to 150 plants in 2004 and the most recent survey estimates the population at 166 plants with 50 percent flowering. Current management includes monitoring, mowing and prescribed burning.

The second site is located at William Finley National Wildlife Refuge. This population has declined from almost 2000 plants in 1992 to less than 200 plants in 2002. This site is monitored annually and management efforts include prescribed burning, mowing, woody species removal, and seed collection. The most recent population estimate is 244 plants (USFWS 2007). Over 900 seeds have been collected from this site and are stored at Berry Botanic Garden.

The third site is on privately-owned land at Muddy Creek. A botanical survey completed at the site in 2004 estimated the population to be 7,600 plants (mainly flowering plants were counted). Severe vole damage to plants and woody species invasion were documented during this survey (Salix 2004). The site has been considered for mitigation banking but to date, no formal agreements have been made.

Eugene East Recovery Zone

Three sites are known in this recovery zone. The first site, Jenna Village (also known as Springfield Drive-Inn) is privately-owned property with very little suitable habitat. Current population survey estimates 52 plants at this location (USFWS 2007). Management activities at this site are unknown.

The second site is a privately-owned property managed in the Wetland Reserve Program with USDA Natural Resource Conservation Service (NRCS) and the Partner's for Fish and Wildlife Program with the Service. Restoration activities implemented in 2005 and 2006 included treatment of invasive species, prescribed burning, and seeding. A 2005 survey found 6 plants.

The third site is at Howard Buford Park Recreation Area and is owned by Lane County Parks. This site is actively managed for low intensity recreation, education, and conservation and enhancement of its natural areas. Census plots were established at the site in 1993 to monitor the Bradshaw's lomatium population; data has been collected from these sub-plots annually since 1993. The estimated population at this site dropped from 27,599 in 1993 to a low of 515 in 2000; grazing by voles is believed to be the cause of the decline. Prescribed burning was implemented in 1999 and is thought to be the cause of the subsequent increase in population to 2,712 in 2005. The most recent population survey estimates 228 plants in 2007. The Friends of Buford Park and Mt. Pisgah are very active in conservation and restoration of the park. They have worked in cooperation with Lane County Parks to implement prescribed burns and invasive species

removal. The Technical Advisory Group for the park has drafted a Habitat Management Plan for the park which includes management for wetland prairie habitat and Bradshaw's lomatium (Friends of Buford Park and Mt. Pisgah 2009).

Eugene West Recovery Zone

Over sixty percent of the known sites are located in the West Eugene Recovery Zone; most of these sites occur with 3 km (2 miles) of each other and are considered subpopulations. Many of the sites are included in the West Eugene Wetland Program. This program is based on the West Eugene Wetland Plan, a multiple-objective wetlands management and land use plan adopted by the City of Eugene that includes wetland protection and establishment of a mitigation bank to restore degraded wetlands. The program is a partnership between several government and non-governmental agencies including the City of Eugene, BLM, the Army Corps of Engineers, TNC, the U.S. Fish and Wildlife Service, the Oregon Youth Conservation Corps, Willamette Resources and Educational Network, the Long Tom Watershed Council and the McKenzie River Trust.

The largest subpopulation in this recovery zone is owned and managed by the City of Eugene at Amazon Park. This 3.5 acre site boasts a population of over 250,000 plants (USFWS 2007). The site has been monitored since 1995. Two other city-owned sites have fewer than 100 plants. Current management includes annual mowing and active monitoring; city staff have recently made site visits to assess hydrology and weed infestations (Emily Steel 2009, pers. comm.).

The Army Corps of Engineers (ACOE) owns and manages several sites in the vicinity of Fern Ridge Reservoir that support Bradshaw's lomatium. There are nine monitored sites with a combined 265 acres of habitat. The most recent monitoring reports estimate the combined population of over 40,000 plants (ACOE 2009). Management includes prescribed burns, manual removal of woody species, mowing, herbicide application, seed collection and outplanting. Current threats include changes in hydrology, potential threat of inundation due to increased lake volume and woody plant encroachment.

Nine sites in the recovery zone are owned and managed by the Bureau of Land Management. Management activities include monitoring, manual removal of woody plants, mowing, prescribed burns, seed collection, and outplanting. Monitoring has occurred at some sites since 1991 and three of the sites are introduced populations. Threats at these sites include vole herbivory, woody vegetation encroachment, thatch buildup and competition from invasive weeds. See Table 2 for population size at each site.

The Nature Conservancy owns and manages a site at Willow Creek Nature Preserve. This high-quality habitat currently supports a subpopulation of over 8,000 plants. TNC management activities include monitoring, prescribed burning, mowing, manual woody plant removal and herbicide application.

Lane County owns the site at Short Mountain Landfill; the population is scattered throughout the site and was estimated at 2,100 plants in 2007. Mowing occurs when needed in some areas, but part of the population is inaccessible by mowing equipment due to the hydrology of the site (D. Strunk 2009, pers. comm.). In 2008, the landfill was expanded and 193 Bradshaw's lomatium plants located within the expansion footprint were translocated to a nearby mitigation site at Quamish Prairie; 144 of these plants were located in 2008. This mitigation site is adjacent to the landfill and is owned and managed by Lane County. Over 1,600 Bradshaw's lomatium seeds were planted at the mitigation site in 2007; however, only 10 seeds germinated. The low germination rates may have been due to poor site conditions or poor seed viability. Ongoing mitigation efforts include hydrology monitoring, vegetation management, seed collection, and plant and site protection (Lane County 2009).

The Camas Swale site is located less than 200 m from the Short Mountain Landfill site and is owned by the Oregon Department of Transportation. The Bradshaw's lomatium population is monitored and managed as a Special Management Area. It is mowed in the fall every other year to control weeds and encroachment by woody species. The population size in 2006 was 1522 plants (ODOT 2006).

Two sites with multiple ownerships, Meadowlark Prairie and Willamette Daisy Meadow, were surveyed in recent years but Bradshaw's lomatium was not found. Other smaller sites are located in this recovery zone and have been included in Table 2, but are not discussed here due to a lack of available information.

2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):

Bradshaw's lomatium is generally 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 Bradshaw's lomatium 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 cm (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.

Less frequently, Bradshaw's lomatium 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 cm (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). Bradshaw's lomatium at these sites occurs in areas with very shallow soil, usually in vernal wetlands or along stream channels.

2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range:

Bradshaw's lomatium is threatened by historic and continued habitat loss and modification. Only about one percent of historic bottomland/wet prairie habitat remains in the Willamette Valley. At the time of listing the most significant threat identified was conversion of native prairie habitat to agricultural land. Although this threat still exists, the current most significant threat to Bradshaw's lomatium is habitat loss due to succession to woody plants and competition from invasive species.

Most of the populations are surrounded by residential and industrial development which continues to threaten some of the remaining habitat through urban expansion and changes in hydrology.

The Draft Recovery Plan identified the following threats to current habitat:

On-site agriculture conversion and management practices. Conversion of natural prairie habitats into non-urban uses, including agriculture, tree farms, golf courses, etc., which directly destroys populations of prairie plants.

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

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

Housing / urban development. 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 2000). This is especially a concern where prairie habitat abuts existing urban areas, such as in the West Eugene Wetlands (Lane County, Oregon). Most of the known sites for Bradshaw's lomatium are located in or adjacent to urban areas.

Hydrologic alterations. Changes in landforms may modify the natural hydrology of a site; examples would include ditching or draining a wet prairie, thereby altering the annual duration of soil saturation, which in turn affects the species composition of the site.

Improper prairie management. 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.

Invasive species. 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 *Festuca arundinacea*, *Holcus lanatus*, *Phalaris arundinacea*, *Pyrus communis*, *Rosa eglanteria* and *Rubus armeniacus*. Additionally, bentgrass species (*Agrostis* spp.) are aggressive invaders of wet and upland prairies throughout the Willamette Valley and for many land managers in this region, bentgrass is the single greatest obstacle barring successful restoration (Service 2008c). As woody species are removed, these invasive plant species can quickly become established in the newly opened areas outcompeting native grasses and forbs.

Isolation / fragmentation. A result of the destruction of prairie habitats throughout the region has been the increasing 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. As urban development continues, Bradshaw's lomatium populations may become more isolated. This threat is most imminent in the Eugene area where populations occur in or adjacent to urban areas.

Road development / maintenance. This species occurs in mostly 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.

Utilities installation and maintenance. Similar to roadside maintenance, clearing and maintaining utility corridors can directly remove or fragment populations.

Wildfire / burning. Similar to improper prairie management, wildfires and intentional burning can have negative impacts 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.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:

Due to its rarity, the potential taking of Bradshaw's lomatium by collectors was identified as a vulnerability at the time of listing; however, no evidence of collecting has been reported since listing. The species is not known to be threatened by commercial use. Some of the sites located since the time of listing are in areas of high recreational-use. Additionally, monitoring and research activities have increased in an effort to recover this

species. The following threats for recreational, scientific, or educational purposes are listed in the Draft Recovery Plan:

Field research activities. 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. Increased foot traffic in fragile habitats may result in crushing sensitive plants, collection of specimens may further reduce small population sizes, seeds of invasive plants may be carried in on boots or equipment, etc.

Recreation. As attractive open spaces in a largely forested region, prairies attract human recreation, which can have negative effects. Off-road vehicles, hikers, cyclists and horses may crush or uproot plants, seeds of invasive species may be spread by vehicle tires and horse manure, etc.

Over-collecting / poaching. Rare plants are less likely to be collected, although removal for herbarium specimens may be a concern.

2.3.2.3 Disease or predation:

Land use conversion and introduction of forage plants for the purpose of grazing livestock was identified as a potential threat at the time of listing. A fungus, a spittle bug, two species of aphids, and an unidentified insect predator (of the fruit) were also identified as potential threats to small populations at the time of listing. The Draft Recovery Plan listed the following current threats due to disease or predation:

Herbivores / predators. Herbivory is a part of the natural life cycle of prairie plants. This 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. Predation by voles was determined to be the cause of a significant decline in the population at Buford Park.

Livestock grazing. 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. Grazers also can increase the spread of non-native plant seeds into native habitats.

Parasites. Similar to the herbivore threat, seed parasites and gall-forming insects are part of the natural environment. As populations of this 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.

2.3.2.4 Inadequacy of existing regulatory mechanisms:

As a federally-threatened species, regulatory measures are undertaken to conserve this species. All Federal agencies are required to actively pursue efforts to conserve listed species (section 7(a)(1) of the ESA) and ensure that activities they fund, authorize, or carry out are not likely to jeopardize the continued existence of the species (section 7(a)(2) of the ESA). The Act also regulates interstate and foreign trade of Bradshaw's lomatium, prohibits willful destruction in violation of State trespass laws on all lands, and prohibits removal and reduction to possession on federal lands. The Act does not provide protection to plants on private lands.

As a State of Oregon-endangered species, all state agencies must ensure the activities they authorize, fund, or carry out on state-owned or state-leased land are not likely to adversely affect any state-listed species. The ODA also regulates trade of Bradshaw's lomatium within Oregon. The Oregon Endangered Species Act does not require private landowners to safeguard listed species on their land, but ODA is willing to assist owners and managers of private land in conservation efforts (ORNHIC 2004).

The passage of the Natural Area Preserves Act (NAPA) in 1972 authorized the Washington Department of Natural Resources (WDNR) to establish and manage a statewide system of natural areas in cooperation with private individuals and organizations, and local, state, and federal agencies. Currently, WDNR and its partners manage more than 5 million acres of land in Washington. In 1981, NAPA was amended to establish a Natural Heritage Program (WNHP) within WDNR to develop a scientific approach to the process of identifying candidate sites for the natural areas system; this program also maintains a list of rare, threatened, and endangered plants for Washington. Several county, state and federal agencies have adopted policies, regulations and ordinances that recognize WNHP's list and provide protection for species contained in it (WDNR 2007).

2.3.2.5 Other natural or manmade factors affecting its continued existence:

Other natural or manmade threats identified in the Draft Recovery Plan follow:

Succession to woody plants. Among the most urgent threats to western prairies, succession to shrublands or forest occurs when the historical prairie disturbance regime has been suppressed. Common species that invade and ultimately take over wet prairie habitats in the absence of periodic disturbance include: *Crataegus douglasii*, *Fraxinus latifolia*, and *Rosa eglantheria*.

Impaired ecological functions. Frequently an effect of fragmentation and isolation, impaired ecological function occurs when remnant prairie patches become too small 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.

Small population size / low genetic variability. Also, a frequent effect of fragmentation and isolation, 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, and unseasonal fires.

Pesticide use. Herbicides and insecticides, if not carefully applied, may have direct impacts to sensitive prairie species, or may have indirect impacts through damage to pollinators; in either case, the effects of improperly applied pesticides may further reduce population size.

Vandalism. Habitat vandalism is identified as a potential threat in the Draft Recovery Plan. 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.

2.4 Synthesis

Recovery criteria for downlisting and delisting have not been met; however, the overall population of Bradshaw's lomatium has increased significantly since listing, and over 20 additional sites have been located. This increase is attributed mainly to active management including mowing and prescribed burning to control invasive weeds and the encroachment of woody species. However, several of the larger populations are not actively managed and are not protected under state or federal law because they occur on private land.

At the time of listing, the primary threat to Bradshaw's lomatium was loss of habitat due to agricultural development. The conversion of wetlands to upland agriculture continues to threaten this species. However, loss of habitat due to succession by woody species is the most significant threat facing the current population; without intensive management to prevent succession the overall population would most likely experience a significant decline in a short time.

For the purpose of recovery, there are 13 areas of concentrations that are sufficiently discrete to be considered separate populations. These populations are located within 5 of the 6 recovery zones. The species continues to exhibit fluctuating population numbers but appears to be generally stable with intensive management.

The designation of Bradshaw's lomatium as an endangered species is still appropriate for several reasons. First, there is significant pressure to develop habitat for industrial or residential needs. Second, succession by woody species is certain to continue threatening the availability of suitable habitat and requires active management to control. Third, although recovery efforts have generally been successful and overall population numbers are high, several of the larger sites lack adequate protection to ensure conservation of the species. Successful recovery of

Bradshaw's lomatium will depend on an increased effort to preserve, restore, and manage existing populations and habitat.

3.0 RESULTS

3.1 Recommended Classification:

Downlist to Threatened

Uplist to Endangered

Delist

Extinction

Recovery

Original data for classification in error

No change is needed

3.2 New Recovery Priority Number: 5 (no change)

Brief Rationale:

This recovery priority number reflects a species facing a high degree of threat with a low recovery potential. Although this species is currently stable, it is dependent on intensive management to minimize threats. If ongoing recovery actions were withheld, it would face extinction in the near future because of rapid population decline or habitat destruction.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

- Preserve, restore, and manage existing populations and habitat.
- Monitor prairie quality and diversity at all population sites.
- Focus future introduction and augmentation efforts to recovery zones that lack adequately-sized reserves.
- Promote protection of listed species and prairie restoration on private lands.
- Cultivate partnerships with both public and private agencies and organizations to promote the conservation of prairie ecosystems and listed prairie species.
- Reinitiate or develop conservation plans for sites where plans have expired or do not exist.
- Implement standardized population monitoring protocol. Establish procedures for data collection.
- Collect and bank seeds from several sites in each recovery zone.
- Identify and implement further research needed for the conservation of the species.
- Monitor effectiveness of management actions and apply adaptive management measures, as needed.
- Develop post-delisting monitoring plans prior to delisting.

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Signature Page
U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Lomatium bradshawii*

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

- Downlist to Threatened
- Uplist to Endangered
- Delist
- No change needed

Appropriate Listing/Reclassification Priority Number, if applicable: N/A

Review Conducted By: *Kimberly S. Garner*

Michael R. Corbett Date *9/24/09*
Lead Field Supervisor, Fish and Wildlife Service
Acting