



Status of Federally Listed Plant Taxa in Washington State, 2017

Prepared for
US Fish and Wildlife Service, Region 1

Prepared by
Walter Fertig
March 28, 2018

Status of Federally Listed Plant Taxa in Washington State, 2017

Washington Natural Heritage Program Report Number: 2018-02

March 28, 2018

Prepared by:

Walter Fertig

Washington Natural Heritage Program
Washington Department of Natural Resources
Olympia, Washington 98504-7014

ON THE COVER: *Eriogonum codium* (Umtanum buckwheat)

Photograph by: Keith Abel/US Fish and Wildlife Service. Reprinted with permission from Newsome (2017)

Table of Contents

	Page
Table of Contents.....	ii
Tables.....	v
Figures.....	v
Acknowledgements.....	vi
Introduction.....	1
Results.....	3
Literature Cited.....	4
<i>Arenaria paludicola</i> – Swamp sandwort (Caryophyllaceae).....	5
Current Status Summary.....	5
2017 Research, Monitoring, and Updates.....	6
References.....	6
<i>Castilleja levisecta</i> – Golden paintbrush (Orobanchaceae).....	7
Current Status Summary.....	7
2017 Research, Monitoring, and Updates.....	9
References.....	18
<i>Eriogonum codium</i> – Umtanum desert buckwheat (Polygonaceae).....	22
Current Status Summary.....	22
2017 Research, Monitoring, and Updates.....	23
References.....	26
<i>Hackelia venusta</i> – Showy stickseed (Boraginaceae).....	29
Current Status Summary.....	29
2017 Research, Monitoring, and Updates.....	30
References.....	30

<i>Howellia aquatilis</i> – Water howellia (Campanulaceae)	33
Current Status Summary.....	33
2017 Research, Monitoring, and Updates.....	37
References	38
<i>Lomatium bradshawii</i> – Bradshaw’s lomatium (Apiaceae).....	40
Current Status Summary.....	40
2017 Research, Monitoring, and Updates.....	41
References	42
<i>Lupinus oregonus</i> – Kincaid’s lupine (Fabaceae).....	45
Current Status Summary.....	45
2017 Research, Monitoring, and Updates.....	46
References	47
<i>Physaria douglasii</i> ssp. <i>tuplashensis</i> – White Bluffs bladderpod (Brassicaceae)	49
Current Status Summary.....	49
2017 Research, Monitoring, and Updates.....	50
References	51
<i>Sidalcea nelsoniana</i> – Nelson’s checker-mallow (Malvaceae)	53
Current Status Summary.....	53
2017 Research, Monitoring, and Updates.....	54
References	56
<i>Sidalcea oregana</i> var. <i>calva</i> – Wenatchee Mountain checker-mallow (Malvaceae).....	58
Current Status Summary.....	58
2017 Research, Monitoring, and Updates.....	59
References	60

<i>Silene spaldingii</i> – Spalding’s catchfly (Caryophyllaceae)	62
Current Status Summary.....	62
2017 Research, Monitoring, and Updates.....	67
References	68
<i>Spiranthes diluvialis</i> – Ute ladies’ tresses (Orchidaceae).....	71
Current Status Summary.....	71
2017 Research, Monitoring, and Updates.....	72
References	74

Tables

	Page
Table 1. Federally listed vascular plant taxa in Washington.	1
Table 2. Key to Natural Heritage ranks and status.	2
Table 3. Location data for <i>Arenaria paludicola</i> in Washington.	5
Table 4. 2017 <i>Castilleja levisecta</i> population counts in Washington.	10
Table 5. 2017 <i>Castilleja levisecta</i> population counts in British Columbia and Oregon.	11
Table 6. Counted and Extrapolated Totals for Extant Native <i>Castilleja levisecta</i> Populations between 2006 and 2017.	13
Table 7. Minimum, Maximum, Long-term Average, and 5-year Average Population Counts for all Extant Native and Out-planted <i>Castilleja levisecta</i> populations.	15
Table 8. <i>Eriogonum codium</i> PVA Monitoring and Census Data from 1995-2017.	23
Table 9. Location data for <i>Howellia aquatilis</i> in Washington.	34
Table 11. Summary of Washington Populations of <i>Lupinus oreganus</i>	46
Table 12. Summary of Percent Cover and Frequency of <i>Sidalcea nelsoniana</i> at Smith Lake, Ridgefield NWR, 2017.	54
Table 13. Summary of Ridgefield NWR <i>Sidalcea nelsoniana</i> Out-Plantings, 2009-2017.	55
Table 14. Summary of Steigerwald Lake NWR <i>Sidalcea nelsoniana</i> Out-Plantings, 2011-2017.	56
Table 15. Location Data for <i>Sidalcea oregana</i> var. <i>calva</i> in Washington.	59
Table 16. Location Data for <i>Silene spaldingii</i> in Washington.	63
Table 17. <i>Silene spaldingii</i> Key Conservation Areas in Washington.	67
Table 18. Summary of <i>Spiranthes diluvialis</i> Monitoring on the Rocky Reach Reservoir, 2000-2017.	73

Figures

	Page
Figure 1. Distribution of historical, extant native, and out-planted populations of <i>Castilleja levisecta</i> in the Pacific Northwest.	8
Figure 2. Global population counts (wild, planted, and total) for <i>Castilleja levisecta</i> between 2004 and 2017. This graph includes extrapolated estimates of wild populations for years in which census.	14
Figure 3. View of <i>Eriogonum codium</i> habitat on Umtanum Ridge burned by the July 2017 Silver Dollar fire.	25
Figure 4. <i>Eriogonum codium</i> plant considered partially burned from 2017 Silver Dollar fire. It remains to be determined if such plants will be able to survive.	25
Figure 5. Lacamas Prairie Natural Area Preserve and Natural Resources Conservation Area. ...	42
Figure 6. <i>Silene spaldingii</i> occurrences and Key Conservation Areas in Washington.	66
Figure 7. Distribution of <i>Spiranthes diluvialis</i> (red dots) in Washington.	71

Acknowledgements

Thanks to the following individuals for sharing data, providing reviews, or otherwise helping with this project: Keith Abel, Brianna Abrahms, Joe Arnett, Molly Boyter, Paula Brooks, Tom Brumbelow, Jeff Chan, Alex Chmielewski, Karen Colson, Julie Conley, Kelly Cordell, Peter Dunwiddie, Heather Fuller, Kim Frymire, John Gamon, Mike Gregg, Wendy Gibble, Rod Gilbert, Amanda Hendrix, Jasa Holt, Tom Kaye, Judy Lantor, Adam Martin, Tim McCracken, Carolyn Menke, Heidi Newsome, Rebecca Niggeman, Von Pope, Karen Reagan, Nathan Reynolds, James Riser, Mike Rule, Andrea Thorpe, and Dave Wilderman. My apologies (and thanks!) to anyone I may have omitted.

Introduction

The Washington Natural Heritage Program (WNHP) was established in 1977 to provide an objective and scientific approach to setting conservation priorities in the state. In 1981, the state legislature amended the 1972 Natural Area Preserve Act to make WNHP part of the Department of Natural Resources with a goal of providing a scientific basis for identifying potential natural areas for protection. As part of the nationwide network of natural heritage programs (under the umbrella of NatureServe, formerly the Natural Heritage network of The Nature Conservancy), WNHP uses a standardized ranking system and database to provide detailed information on the conservation status and distribution of 190 animal, 336 vascular plant, and 59 non-vascular plant species in Washington, as well as 319 representative plant community types.

Since 1979, WNHP has collaborated with the US Fish and Wildlife Service (USFWS) to provide detailed information on the distribution, abundance, and management needs of listed Endangered, Threatened, or Candidate species under the US Endangered Species Act. For the past decade, WNHP has produced an annual report for USFWS summarizing research and monitoring of listed and candidate plant species (Arnett 2014, 2015, 2016, Arnett and Goldner 2017). The following report contains a review of new information from 2017 for the twelve vascular plant species currently listed as Endangered or Threatened in Washington (Tables 1, 2). Each species account also includes a summary of its current range, number of occurrences, abundance, habitat, threats, trends, and management/ownership status, as well as a list of pertinent references.

Table 1. Federally listed vascular plant taxa in Washington.

Species	Common Name	Family Name	Natural Heritage Rank	Washington Status	USFWS Status
<i>Arenaria paludicola</i>	Swamp sandwort	Caryophyllaceae	G1/SX	X	E
<i>Castilleja levisecta</i>	Golden paintbrush	Orobanchaceae	G2/S2	T	T
<i>Eriogonum codium</i>	Umtanum desert buckwheat	Polygonaceae	G1/S1	E	T
<i>Hackelia venusta</i>	Showy stickseed	Boraginaceae	G1/S1	E	E
<i>Howellia aquatilis</i>	Water howellia	Campanulaceae	G3/S2	T	T
<i>Lomatium bradshawii</i>	Bradshaw's lomatium	Apiaceae	G2/S1	E	E
<i>Lupinus oreganus</i>	Kincaid's lupine	Fabaceae	G4T2/S1S2	E	T
<i>Physaria douglasii</i> ssp. <i>tuplashensis</i>	White Bluffs bladderpod	Brassicaceae	G4?T2/S1S2	T	T
<i>Sidalcea nelsoniana</i>	Nelson's checker-mallow	Malvaceae	G2G3/S1	E	T
<i>Sidalcea oregana</i> var. <i>calva</i>	Wenatchee Mountain checker-mallow	Malvaceae	G5T1/S1?	E	E
<i>Silene spaldingii</i>	Spalding's catchfly	Caryophyllaceae	G2/S2	T	T
<i>Spiranthes diluvialis</i>	Ute ladies' tresses	Orchidaceae	G2G3/S1	E	T

Table 2. Key to Natural Heritage ranks and status.

Global Rank characterizes the relative rarity or endangerment of the element world-wide.	
G1 = Critically Imperiled	At very high risk of extinction or elimination due to very restricted range, very few populations or occurrences, very steep declines, very severe threats, or other factors.
G2 = Imperiled	At high risk of extinction or elimination due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors.
G3 = Vulnerable	At moderate risk of extinction or elimination due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors.
G4 = Apparently Secure	At fairly low risk of extinction or elimination due to an extensive range or many populations or occurrences, but with possible cause for some concern as a result of local recent declines, threats, or other factors.
G5 = Secure	At very low risk of extinction or elimination due to a very extensive range, abundant populations or occurrences, and little to no concern from declines or threats.
? = Inexact Numeric Rank	Denotes inexact numeric rank.
Other Comments	A numeric range rank (e.g., G2G3, G1G3) is used to indicate uncertainty about the exact status of a taxon or ecosystem type. The status of infraspecific taxa (subspecies or varieties) are indicated by a "T-rank" following the species' global rank. Rules for assigning T-ranks follow the same principles outlined above.
State Rank characterizes relative rarity or endangerment within the state of Washington.	
S1 = Critically Imperiled	At very high risk of extirpation in the state due to very restricted range, very few populations or occurrences, very steep declines, severe threats, or other factors
S2 = Imperiled	At high risk of extirpation in the state due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors.
S3 = Vulnerable	At moderate risk of extirpation in the state due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors.
SX = Presumed Extirpated	Species is believed to be extirpated from the state. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.
Other Comments	A numeric range rank (e.g., S2S3 or S1S3) is used to indicate any range of uncertainty about the status of the species.
Washington Status of plant species is determined by the Washington Natural Heritage Program. Factors considered include abundance, occurrence patterns, vulnerability, threats, existing protection, and taxonomic distinctness.	
E = Endangered	In danger of becoming extinct or extirpated from Washington.
T = Threatened	Likely to become endangered within the near future in Washington if the factors contributing to population decline or habitat loss continue.
X = Possibly Extinct or Extirpated	Documented to have previously occurred within Washington, but no longer thought to be present here.
USFWS Status under the U.S. Endangered Species Act as published in the Federal Register.	
E = Endangered	The plant is in danger of extinction throughout all or a significant portion of its range.
T = Threatened	The plant is likely to become Endangered within the foreseeable future throughout all or a significant portion of its range.
C = Candidate	A plant for which FWS or NOAA Fisheries has on file sufficient information on biological vulnerability and threats to support a proposal to list as Endangered or Threatened.

The current report does not include a summary of Wormskiold's northern wormwood (*Artemisia campestris* var. *wormskioldii*). This taxon was formerly a candidate for potential listing but was determined as not warranting protection by USFWS in 2016 (US Fish and Wildlife Service 2016). It is still listed as Endangered in Washington by WNHP and tracked as a species of concern. Monitoring was conducted in 2017 at the Beverly population and is summarized by Grant County PUD (2017). The status of *A. campestris* var. *wormskioldii* is summarized by Arnett (2017).

Results

The status of the twelve listed Endangered and Threatened vascular plant species in Washington ranges from possibly extirpated to nearly recovering. *Arenaria paludicola* has not been observed in the state since 1976 and considered potentially extirpated, though no surveys have been undertaken to relocate historical populations since 2006. *Eriogonum codium* numbers declined sharply in 2017 as a result of a large wildfire that burned about 60% of its limited habitat. Long-term monitoring data suggest that native populations of *Castilleja levisecta* and *Spiranthes diluvialis* are declining. Other species, such as *Howellia aquatilis* may be declining in Washington, but more current monitoring information is needed from many populations to determine if these are short term events or a long term pattern. Most of the listed species in Washington show stable trends at present, or are exhibiting a modest upward trend (such as *Hackelia venusta*).

Several listed species have exhibited population increases due to the success of out-plantings to create new occurrences or augment existing ones. The most successful out-planting effort has been for *Castilleja levisecta*, which has exhibited a six-fold increase in numbers since 2012, almost entirely due to newly established populations. Other species, such as *Sidalcea nelsoniana* and *Physaria douglasii* ssp. *tuplashensis* have increased due to out-plantings, but population growth has been more moderate.

Regular monitoring should continue for each of the state's listed Endangered or Threatened plant species. For those species that are considered extirpated, site revisits might be scheduled less frequently (such as once every 8-10 years) in the chance that the species is still present at low numbers or just difficult to detect. Species that are less imminently threatened with extinction might also be monitored less frequently, although ideally selected sites should be revisited every 3-5 years. Annual monitoring should be implemented for species with significant management concerns, like *Eriogonum codium*, to ensure that trends are being adequately detected or the species is responding to management changes. Species close to recovery, such as *Castilleja levisecta* and *Howellia aquatilis*, also should continue to be monitored to ensure that de-listing goals are being met (including post-delisting monitoring when appropriate). WNHP and USFWS should continue to work cooperatively to ensure that monitoring work is taking place and that results are being archived and shared among other partner organizations.

Literature Cited

Arnett, J. 2014. Monitoring federally listed and candidate plant taxa in Washington state 2011-2013. Natural Heritage Report 2014-09. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.

Arnett, J. 2015. Monitoring federally listed and candidate plant taxa in Washington state 2014. Natural Heritage Report 2015-01. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 64 pp.

Arnett, J. 2016. Monitoring federally listed and candidate plant taxa in Washington state 2015. Natural Heritage Report 2016-01. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.

Arnett, J. 2017. Status report and conservation support for *Artemisia campestris* var. *wormskioldii* (Wormskiold's wormwood). Natural Heritage Report 2017-05. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 20 pp. + app.

Arnett, J. and A. Goldner. 2017. Monitoring federally listed and candidate plant taxa in Washington state 2016. Natural Heritage Report 2017-03. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 63 pp. + app.

Grant County PUD. 2017. Visual observations and demographic monitoring results for Northern wormwood (*Artemisia borealis* var. *wormskioldii*) summary report – 2017. Public Utility District No. 2 of Grant County, Washington, Ephrata, WA. 3 pp.

US Fish and Wildlife Service 2016. Endangered and Threatened Wildlife and Plants; 12-month findings on petitions to list nine species as Endangered or Threatened species. Federal Register 81(183):64843-64857.

Arenaria paludicola – Swamp sandwort (Caryophyllaceae)

Current Status Summary

Legal Status

Listed as Endangered under the ESA in August 1993 (US Fish and Wildlife Service 1993).

Natural Heritage Rank

G1/SX; WA Extirpated.

Range

Central Mexico to Guatemala, with disjunct populations along the coast of central California and northwestern Washington (Hartman et al. 2005). In the United States, presently known only from San Luis Obispo County, California. Washington populations were known from Grays Harbor, King, and Pierce counties in the North Cascades, Pacific Northwest Coast, and Puget Trough ecoregions.

Number of Occurrences in Washington

Known from 3 historical (and presumed extirpated) occurrences in Washington (Table 3). One other site from San Juan County has not been relocated and may be a false report (Gamon 1991). The last population in the state was observed in 1976. Unsuccessful efforts were made to relocate the state populations in 1981, 1987, 1990, 2005, and 2006.

Abundance

Considered extirpated in Washington.

Habitat

Swamps and freshwater marshes, mostly near the coast below 450m (1500 feet).

Threats

In Washington, threatened by conversion of habitat to industrial or residential development and changes in plant communities through natural succession. In California, one population is being impacted by competition from other wetland plants due to enhanced productivity from increased nutrient inputs (US Fish and Wildlife Service 2008).

Table 3. Location data for *Arenaria paludicola* in Washington.

Population	County	Ecoregion	Ownership	Year Last Obs.	Status
Mud Mountain (EO # 002)	King	North Cascades	Unknown	1973	Not relocated in 1981 or 1987; presumed extirpated
Carlisle Bog (EO # 006)	Grays Harbor	Pacific NW Coast	Carlisle Bog NAP	1976	Not relocated in 1990, 2005, or 2006; presumed extirpated
Tacoma (EO # 008)	Pierce	Puget Trough	Unknown	1896	Presumed extirpated

Trends

Downward; probably extirpated in the state. One of two known populations in California is now considered extirpated (last observed in 1985) and the other had declined by nearly 75% since 1998 (US Fish and Wildlife Service 2008). The status of populations in Mexico and Central America is poorly known (Hartman et al. 2005).

Managed Areas and Ownership

Carlisle Bog Natural Area Preserve.

2017 Research, Monitoring, and Updates

No surveys were conducted for this species in 2017. The last major effort to relocate Swamp sandwort in Washington occurred in 2006 when the Carlisle Bog population was visited, but no plants were found. The species is presently considered extirpated in Washington.

References

- Gamon, J. 1991. Report on the status of *Arenaria paludicola* Robinson. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 20 pp.
- Hartman, R.L., R.K. Rabeler, and F.H. Utech. 2005. *Arenaria*. In: Flora of North America Editorial Committee, eds. 1993+. Flora of North America North of Mexico. 20+ vols. New York and Oxford. Vol. 5: Magnoliophyta: Caryophyllidae, part 2. pp 51-56.
- Kennison, J.A. 1980. *Arenaria paludicola* Robinson. California Native Plant Society, February 1980.
- Kennison, J. A. and R. J. Taylor. 1979. Status report for *Arenaria paludicola*, Appendix for Washington. Biology Department, Western Washington University, Bellingham, Washington.
- Morey, S.C. 1989. Report to the Fish and Game Commission on the status of marsh sandwort (*Arenaria paludicola*). Natural Heritage Division Status Report 89-23.
- Morey, S.C. 1990. A management strategy for the recovery of marsh sandwort (*Arenaria paludicola*). State of California, Department of Fish and Game, Endangered Plant Program, Natural Heritage Division. 14 pp.
- U.S. Fish and Wildlife Service. 1993. Endangered and Threatened Wildlife and Plants; Determination of Endangered Status for Two Plants, *Arenaria paludicola* (Marsh Sandwort) and *Rorippa gambelii* (Gambel's Watercress). U.S. Fish and Wildlife Service, Department of the Interior, Final Rule. Federal Register 58 (147): 41378-41383.
- U.S. Fish and Wildlife Service. 1995. Draft recovery plan for marsh sandwort (*Arenaria paludicola*) and Gambel's watercress (*Rorippa gambelii*). Ventura Field Office.
- U.S. Fish and Wildlife Service. 2008. *Arenaria paludicola* (Marsh sandwort) 5 Year Review: Summary and Evaluation. US Fish and Wildlife Service Ventura Fish and Wildlife Office, Ventura, CA. 21 pp.

***Castilleja levisecta* – Golden paintbrush (Orobanchaceae)**

Current Status Summary

Legal Status

Listed as Threatened under the ESA in 1997 (US Fish and Wildlife Service 1997).

Natural Heritage Rank

G2/S2; WA: Threatened

Range

Historically, *Castilleja levisecta* occurred from southeastern Vancouver Island and adjacent islands in British Columbia to the San Juan Islands and Puget Trough in western Washington and the Willamette Valley of western Oregon (Linn, Marion, and Multnomah counties). By the 1980s it was considered extirpated in southwestern Washington and Oregon. Since 2006, populations have been successfully reintroduced in British Columbia, Washington, and the Willamette Valley from Portland to Eugene, Oregon. In Washington, extant (native and reintroduced) populations are found in Island, Jefferson, San Juan, and Thurston counties within the Puget Trough ecoregion (Figure 1). Additional populations have been out-planted in Clark and Clallam counties, but these have not been present long enough to be considered established. *Castilleja levisecta* is extirpated in King, Kitsap, Pierce, and Skagit counties.

Number of Occurrences in Washington

Currently known from 11-12 extant and 23 introduced populations in Washington. (The Admiralty Inlet NAP population is counted as two populations in terms of potential recovery, but is considered one occurrence by WNHP.) Eleven additional populations, including the type occurrence at Mill Plain/Fort Vancouver, are historical or extirpated.

Abundance

In 2017, nine of the state's 11 naturally-occurring populations were monitored and 2359 plants were observed. Adding the unsurveyed Rocky Prairie NAP site (which contained 3597 plants in 2016), the total of naturally-occurring plants increases to approximately 5956 individuals. Out-planted populations that meet recovery objectives (i.e. are not comprised of hybrid plants and have been established from *in situ* seedlings or plugs that have persisted for more than 3 years) contained 166,108 plants in 2017. Statewide, the number of naturally-occurring and out-planted *C. levisecta* is approximately 172,064 plants.

Habitat

Mainland populations are found in open, undulating remnant prairies dominated by Roemer's fescue (*Festuca roemerii*) and Red fescue (*F. rubra*) on gravelly or clayey glacial outwash. Island populations are often on the upper slopes or rims of steep, southwest or west facing sandy bluffs that are exposed to salt spray. Populations may also occur on remnant coastal prairie flats on glacial deposits of sandy loam. Island prairies may have historically been dominated by forbs and Foothill sedge (*Carex tumilicola*) rather than grasses (Chappell and Caplow 2004). Many

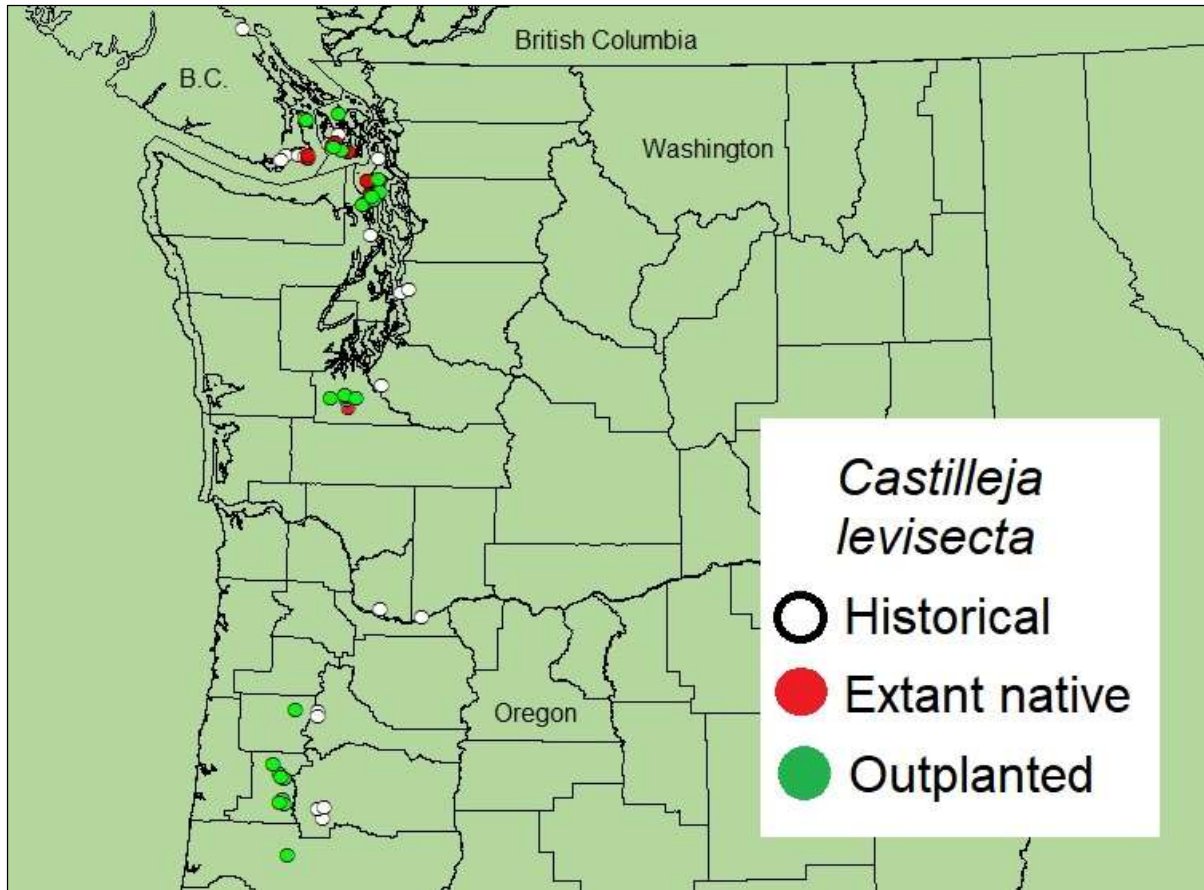


Figure 1. Distribution of historical, extant native, and out-planted populations of *Castilleja levisecta* in the Pacific Northwest.

island sites are now dominated by Red fescue or weedy forbs and all sites are threatened from encroachment by woody vegetation. Historically, fire was probably significant in maintaining open prairie conditions (Gamon 1995).

Threats

The major threat to *C. levisecta* has been conversion of prairie and shoreline habitat to agriculture and human residential development. Related to this has been degradation of native prairie habitat by invasion of non-native weedy species and encroaching forest vegetation augmented by fire suppression. Other threats include impacts from recreation (primarily in the San Juan Islands), loss of pollinators, bank erosion, and hybridization with *Castilleja hispida* (Gamon 1995, US Fish and Wildlife Service 2000).

Trends

Historically downward. At least 9 populations in Washington have not been relocated since 1936. Two others were last observed in 1980 and 1995 and have not been relocated in subsequent site visits; these are now presumed to be extirpated. Extant naturally-occurring populations in Washington have all been declining since 2012. The state's five largest native populations have decreased by 52-85% during this time span. Overall state numbers have

increased significantly, however, due to the success of out-planted populations. Some older out-plantings are beginning to decline, and the long-term abundance and persistence of these populations is yet to be determined.

Managed Areas and Ownership (WA only)

National Park Service: San Juan Islands National Historic Park; US Fish and Wildlife Service: Protection Island National Wildlife Refuge; Other Federal: Naval Air Station Whidbey, DOD – Forbes Point. State of Washington: Admiralty Inlet Natural Area Preserve, Fort Casey State Park, Mima Mounds Natural Area Preserve, Rocky Prairie Natural Area Preserve; WDFW Scatter Creek Wildlife Area. County Government: Thurston County. Private NGOS: Center for Natural Lands Management, San Juan Preservation Trust, Whidbey-Camano Land Trust, Wolf Haven.

2017 Research, Monitoring, and Updates

Washington Surveys

Nine naturally occurring and 10 reintroduced populations of *Castilleja levisecta* in Washington were monitored by members of the Golden paintbrush technical team and citizen volunteers* in 2017. Only 2359 flowering plants were counted in naturally occurring populations, while 174,417 flowering plants were documented through census and extrapolation from subsamples in out-planted populations (Table 4). Out-plantings include both individual plugs of specimens grown off-site in a greenhouse and plants derived from seed sown on-site. Only those out-planted individuals derived from seed or which have survived as plugs for more than 3 years were counted towards meeting recovery objectives. Out-planted individuals meeting recovery criteria in 2017 numbered 166,108 plants. The total number of *C. levisecta* plants (naturally occurring and out-planted) from Washington in 2017 was 168,467 (Table 4).

Rangewide Numbers and Population Trends in 2017

No monitoring or census work was done in British Columbia in 2017. In Oregon, Tom Kaye of the Institute for Applied Ecology and others monitored 26 out-planted populations and documented 128,588 flowering plants. As in Washington, only those plants that were derived from seed sown on site or plugs over three years old were counted towards recovery goals. Thus the total number of plants counting towards recovery in Oregon is 126,002 (Table 5). Between Washington and Oregon, 294,469 flowering individuals of *Castilleja levisecta* were recorded in 2017 (Tables 4, 5).

*Participants included Joe Arnett (WNHP), Peter Dunwiddie (University of Washington), Kathleen Foley (San Juan Preservation Trust), Judy Lantor (US Fish and Wildlife Service), Adam Martin (Center for Natural Lands Management), Mark Sheehan (Whidbey Camano Land Trust), and Ted Thomas (US Fish and Wildlife Service).

Table 4. 2017 *Castilleja levisecta* population counts in Washington.

Out-plants applicable to recovery were either grown on site from seed, were established from plugs that persisted for more than 3 years, or are first-generation recruits from out-planted individuals. * indicates hybrid populations no longer counting towards recovery.

Population	State	2017 Flowering Plants			
		Out-plants	Out-plants applicable to recovery	Naturally occurring plants	Total plants applicable to recovery
Cavness	WA	79,910	79,910	0	79,910
Cedar Rock Preserve, Shaw Island	WA	No data	No data	0	0
Davis Point (EO #23)	WA	0	0	No data	0
Glacial Heritage Preserve	WA	52,405	52,405	0	52,405
Kah Tai Prairie, Port Townsend	WA	No data	No data	0	0
Long Island (EO #27)	WA	0	0	No data	0
Lopez Island, Flint Beach	WA	No data	No data	0	0
Lopez Island, Iceberg Point	WA	6	0	0	0
Mima Mounds Natural Area Preserve	WA	6,937	802	0	802
*Morgan/Tenalquot	WA	720	0	0	0
Protection Island	WA	71	71	0	71
Rocky Prairie NAP (EO #11)	WA	0	0	No data	0
San Juan Island, American Camp	WA	29	29	0	29
San Juan Island, Cady Mountain	WA	9	0	0	0
San Juan Island, Cattle Point	WA	No data	No Data	0	0
San Juan Island, False Bay Middle (EO #20)	WA	130	22	28	50
San Juan Island, False Bay North (EO #25)	WA	No data	No data	No data	0
San Juan Island, False Bay South (EO #24)	WA	1	1	171	172
San Juan Island, San Juan Valley (no EO #)	WA	0	0	466	466
San Juan Island, West Side Preserve	WA	7	7	0	7
Scatter Creek South	WA	19	19	0	19
Steigerwald National Wildlife Refuge	WA	232	0	0	0
USFWS Headquarters, Dungeness	WA	399	0	0	0
Waldron Island, Bitte Baer Preserve	WA	No data	No data	0	0
West Beach (EO #12)	WA	0	0	9	9
*West Rocky Prairie	WA	700	0	0	0
Whidbey Island, Admiralty Inlet NAP, Naas Prairie Unit (EO #09a)	WA	1363	1363	550	1913
Whidbey Island, Admiralty Inlet NAP, South Bluff Prairie Unit (EO #09b)	WA	360	360	46	406
Whidbey Island, Ebey's Landing	WA	416	416	0	416
Whidbey Island, Forbes Point (EO #16)	WA	84	84	27	111
Whidbey Island, Fort Casey (EO #05)	WA	0	0	375	375
Whidbey Island, Hill Road – Ebey's Landing (EO #21)	WA	0	0	687	687
Whidbey Island, NPS Ebey Overlook	WA	No data	No data	0	0
Whidbey Island, Perego's Bluff	WA	No data	No data	0	0
Whidbey Island, Sherman Farm Field	WA	No data	No data	0	0
Whidbey Island, Smith Prairie, PRI	WA	22,544	22,544	0	22,544
Wolf Haven, Tenino	WA	8,075	8,075	0	8,075
TOTAL	WA	174,417	166,108	2359	168,467

Table 5. 2017 *Castilleja levisecta* population counts in British Columbia and Oregon.

Out-plants applicable to recovery were either grown on site from seed, were established from plugs that persisted for more than 3 years, or are first-generation recruits from out-planted individuals.

Population	State/ Prov	2017 Flowering Plants			
		Out-plants	Out-plants applicable to recovery	Naturally occurring plants	Total plants applicable to recovery
Alpha Islet	BC	0	0	No data	0
Beacon Hill Park, Victoria	BC	0	0	No data	0
D'Arcy Island, Gulf Islands National Preserve	BC	No data	No data	0	0
Trial Island	BC	0	0	No data	0
ACOE S. Eaton Cherry Lane	OR	11,087	11,087	0	11,087
ACOE, Fern Ridge Reserve	OR	18,701	18,701	0	18,701
Ankeney Nat. Wildlife Refuge, Field 24	OR	194	194	0	194
Bald Hill Park	OR	3	3	0	3
Baskett Slough Nat. Wildlife Refuge, Baskett Butte East	OR	1321	1321	0	1321
Baskett Slough Nat. Wildlife Refuge, Baskett Butte West	OR	2868	2796	0	2796
Beazell Memorial Forest, Benton County	OR	732	732	0	732
Cardwell Hill, Benton County Preserve	OR	398	398	0	398
Carnine	OR	56	56	0	56
City of Eugene, Coyote Prairie	OR	120	120	0	120
Finley Nat. Wildlife Refuge, Bellfountain Prairie	OR	18,896	18,896	0	18,896
Finley Nat. Wildlife Refuge, Bald Top	OR	No data	No data	0	0
Finley Nat. Wildlife Refuge, Bluebird Strip	OR	15,681	15,681	0	15,681
Finley Nat. Wildlife Refuge, Fender's Prairie	OR	1998	1998	0	1998
Finley Nat. Wildlife Refuge, Field 1	OR	32	32	0	32
Finley Nat. Wildlife Refuge, Field 29	OR	5040	5040	0	5040
Finley Nat. Wildlife Refuge, large east plot	OR	2514	0	0	0
Finley Nat. Wildlife Refuge, large west plot	OR	2085	2085	0	2085
Finley Nat. Wildlife Refuge, Pigeon Butte	OR	495	495	0	495
Fitton Green, Benton County	OR	719	719	0	719
Hoyer	OR	36	36	0	36
Howell Savannah	OR	44,700	44,700	0	44,700
Lupine Meadows Preserve	OR	689	689	0	689
Portland Metro, Cooper Mountain Nature Park	OR	6	6	0	6
Portland Metro, Graham Oaks	OR	126	126	0	126
Portland Metro, Peach Cove	OR	74	74	0	74
Tualatin River Nat. Wildlife Refuge, Field 5S	OR	No data	No data	0	0
Wild Iris Ridge	OR	17	17	0	17
TOTAL		128,588	126,002	0	126,002

Determining long-term trends for *Castilleja levisecta* is complicated by the fact that not all populations are surveyed every year. Arnett and Goldner (2017) derived a system for estimating population numbers for missing years based on the average annual change in population size between pairs of years with census data and then incrementally adding (or subtracting) this total (Table 6). This method reduces the variance in population counts from year to year caused by absence of census data. However, these extrapolations are only a best approximation, and can mask actual oscillations in population numbers. These data show a general downward trend from 2013-2017 for the 15 extant naturally-occurring populations of *Castilleja levisecta* in Washington and British Columbia (Table 6, Figure 2).

Population size can vary markedly from year-to-year in monitored populations, depending on climate conditions and survivorship of out-planted individuals. These fluctuations are summarized in Table 7, where the minimum and maximum counts for each occurrence are provided, as well as the long-term average (1980-2017) and past five-year average (2013-2017). Populations can range from a single plant to an estimated 134,098 at the Glacial Heritage out-planting site in 2014. Average population size, however, is typically 1/3 to 1/2 smaller than the maximum count. The average numbers over the last five years also tend to be smaller than the long-term average, suggesting there has been a moderate decline in most individual populations in recent years (Table 7). This decline has been masked by growth in a small number of very large populations (such as the Glacial Heritage Preserve and Cavness out-plantings in Washington and Howell Savanna site in Oregon). Using all available data, overall population numbers are up in 2017 following a one-year decline in 2016 (Figure 2).

Based solely on the sum of the minimum and maximum counts for each site, the total rangewide population of *Castilleja levisecta* is estimated to be between 90,110-444,657 plants (Table 7). Using the more conservative average number of plants recorded at each extant site, the total population would be 233,691. Just based on data since 2013, total numbers have averaged 191,515 plants per year (Table 7).

Hybridization

Kaye and Blakely-Smith (2008) reported on the potential for hybridization between *Castilleja levisecta* and *C. hispida*, an orange-flowered species that also occurs in the Puget Trough region of Washington. Widespread hybridization has now been confirmed at the Morgan/Tenalquot and West Rocky Prairie out-planted sites in Washington and could become a problem at other sites (such as Glacial Heritage and Wolf Haven) where the two species are sympatric (Dunwiddie 2017). The resulting hybrids may be sterile or fertile, depending on the ploidy level of the parental *C. hispida* stock (Tom Kaye, personal communication). Differentiating hybrid plants from their parent species can be difficult in the field (Adam Martin, personal communication), complicating monitoring efforts.

Both *Castilleja* species (and presumably their hybrids) are potential larval host plants for the Endangered Taylor's checkerspot butterfly (*Euphydryas editha taylori*) (Aubrey 2013, but see Severns and Warren 2008), and so hybrid populations still retain some conservation value. For the purposes of recovery, however, the Golden Paintbrush Technical Team has recommended that populations with excessive hybridization not be counted towards meeting delisting

Table 6. Counted and Extrapolated Totals for Extant Native *Castilleja levisecta* Populations between 2006 and 2017.

Extrapolations are shown in [] and are derived from incrementally averaged changes in population numbers between years with actual count data.

Population, State/Prov	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Alpha Islet, BC	165	[165]	[165]	[165]	[165]	[165]	[165]	[165]	[165]	[165]	[165]	[165]
Trial Island, BC	3192	[3089]	[2985]	[2881]	[2777]	[2673]	[2569]	2465	[2465]	[2465]	[2465]	[2465]
Davis Point, WA (EO #23)	[0]	0	[0]	[0]	[0]	[0]	[0]	[0]	[0]	[0]	[0]	[0]
Long Island, WA (EO #27)	[154]	[154]	[154]	[154]	[154]	[154]	[154]	[154]	[154]	[154]	[154]	[154]
Rocky Prairie NAP, WA (EO # 11)	[7834]	[8613]	9392	[8322]	[7252]	6183	8910	[7240]	5569	[4583]	3597	[3597]
San Juan Island, False Bay Middle, WA (EO #20)	54	40	42	33	32	20	11	22	16	6	5	28
San Juan Island, False Bay North, WA (EO #25)	[12]	[12]	[12]	0	[0]	[0]	[0]	[0]	[0]	[0]	[0]	[0]
San Juan Island, False Bay south, WA (EO #024)	312	401	453	407	319	430	193	245	321	232	134	171
San Juan Island, San Juan Valley, WA (no EO #)	[6296]	[5676]	[5056]	[4436]	[3816]	[3196]	[2576]	[1956]	1336	477	664	466
West Beach, WA (EO #012)	189	69	97	75	47	65	20	14	18	24	11	9
Whidbey Island, Admiralty Inlet NAP, Naas Prairie Unit, WA (EO #009a)	94	86	148	241	274	347	1128	841	658	537	404	550
Whidbey Island, Admiralty Inlet NAP, South Bluff, WA (EO # 009b)	[80]	[80]	[80]	[80]	80	71	67	103	109	94	57	46
Whidbey Island, Forbes Point, WA (EO #016)	260	105	201	56	50	18	54	84	108	60	40	27
Whidbey Island, Fort Casey, WA (EO #005)	760	1544	1713	1497	1538	2471	2534	1196	227	952	1004	375
Whidbey Island, Hill Road - Ebey's Landing, WA (EO #021)	214	747	601	[1044]	1487	1984	2656	4612	2191	883	766	687
Counted Total	5240	2992	12,647	2309	3827	11,589	15,573	9582	10,553	3265	6682	2359
Extrapolated Total []	14,376	17,789	8452	17,082	14,164	6188	5464	9515	2784	7367	2784	6381
Counted & Extrapolated Total	19,616	20,781	21,099	19,391	17,991	17,777	21,037	19,097	13,337	10,632	9,466	8740

objectives (Dunwiddie 2017). The Morgan/Tenalquot population consisted of 720 flowering plants in 2017 and the West Rocky Prairie site had 700 plants (Table 4), but neither population was included in population totals applicable to recovery.

Progress Toward Recovery

According to the *Castilleja levisecta* recovery plan (US Fish and Wildlife Service 2000), this species can be considered for delisting once at least 20 stable populations are found throughout the plant’s historic range in the United States and at least 15 of these populations are in protected sites. To be considered “stable”, a population must “maintain a 5-year running average population size of at least 1,000 individuals”. Populations are considered protected if they are either owned or managed by a government agency or private organization and have permanent conservation objectives in place by policy or binding easement/covenant (US Fish and Wildlife Service 2000). In the 2007 five-year review, recovery goals were changed from 20 to 15 stable, protected populations, only flowering plants were to be counted, and the five-year running average could not exhibit a sharp decline (even if technically meeting the 1000 plant threshold) (US Fish and Wildlife Service 2007).

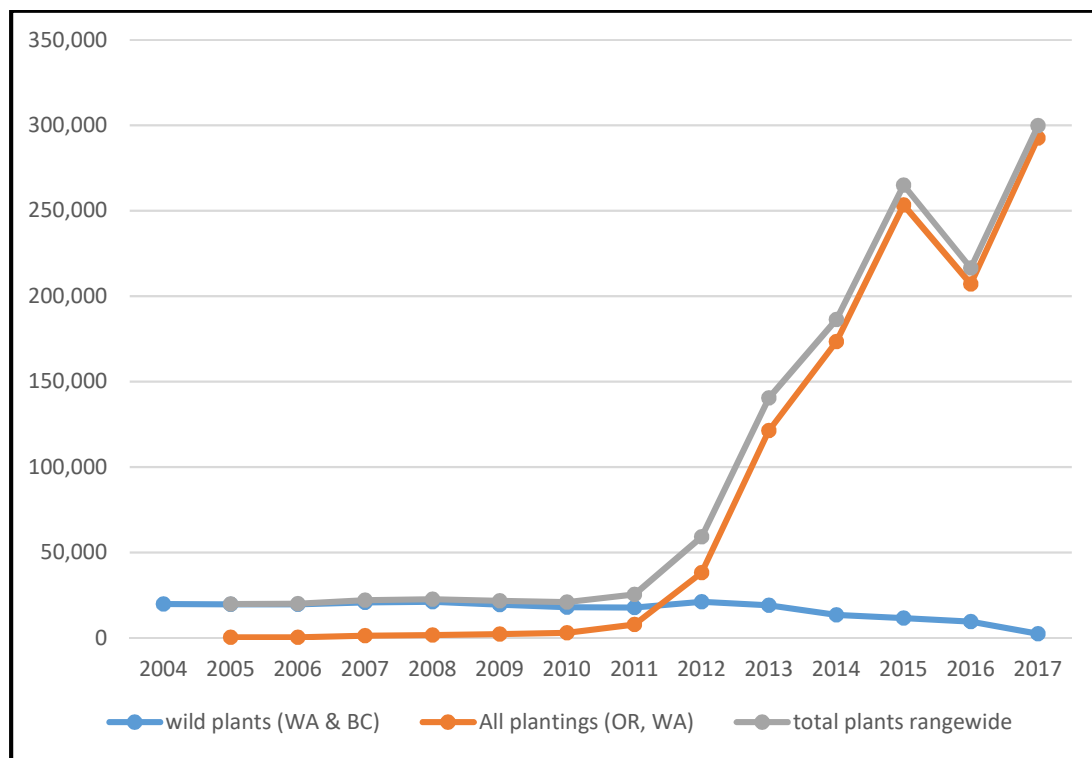


Figure 2. Global population counts (wild, planted, and total) for *Castilleja levisecta* between 2004 and 2017. This graph includes extrapolated estimates of wild populations for years in which census.

Table 7. Minimum, Maximum, Long-term Average, and 5-year Average Population Counts for all Extant Native and Out-planted *Castilleja levisecta* populations.

Native (N) or Out-planted (O) status is indicated in columns 3 and 4. Form Prot (formally protected) indicates populations that are owned or managed by government agencies or private organizations mandated to conserve *C. levisecta* habitat through binding management directives, conservation easements, or covenants. * Indicates populations not eligible for meeting US Endangered Species Act recovery objectives (this includes Canadian and hybrid populations).

Population	St/ Prov	N	O	Min Pop	Max Pop	Long- term Avg	5 year Avg (2013-17)	Form Prot
*Alpha Islet	BC	x		165	1333	850	0	
*Beacon Hill Park, Victoria	BC	x		0	3	2	0	
Gulf Islands National Reserve	BC		x	4	30	17	14	x
*Trial Island	BC	x		2150	3192	2592	1985	
Ankeny NWR Field 24	OR		x	194	194	194	146	x
Bald Hill Park	OR		x	3	4	4	4	
Baskett Slough NWR, Baskett Butte East	OR		x	1321	9925	4880	4033	x
Baskett Slough NWR, Baskett Butte West	OR		x	136	2796	664	901	x
Bezell Memorial Forest, Benton County	OR		x	74	3233	1388	1176	x
Cardwell Hill, Benton County Preserve	OR		x	39	673	341	265	x
Carnine	OR		x	56	71	64	48	
City of Eugene, Coyote Prairie	OR		x	83	120	102	77	x
Fern Ridge, ACOE, Fern Ridge Res.	OR		x	172	29788	7001	9242	x
Finley NWR, Bellfountain Prairie	OR		x	1	18896	3592	5624	x
Finley NWR, Bald Top	OR		x	3	101	52	40	x
Finley NWR Bluebird Strip	OR		x	15681	19744	17264	13173	x
Finley NWR, Fender's Prairie	OR		x	450	1998	1112	891	x
Finley NWR Field 1	OR		x	32	1120	637	448	x
Finley NWR, Field 29	OR		x	40	5040	1895	1745	x
Finley NWR large west plot	OR		x	1377	2085	1731	1299	x
Finley NWR, Pigeon Butte	OR		x	24	495	245	193	x
Fitton Green, Benton County	OR		x	38	719	271	258	x
Hoyer	OR		x	36	76	56	43	
Howell Savannah	OR		x	16007	44700	30354	22766	
Lupine Meadows Preserve	OR		x	2	689	298	249	x
Portland Metro, Cooper Mountain Nature Park	OR		x	5	6	6	5	
Portland Metro-Graham Oaks	OR		x	53	132	104	73	
Portland Metro-Peach Cove	OR		x	74	116	95	72	
Tualatin River NWR Field 5S	OR		x	0	1	1	1	
Wild Iris Ridge	OR		x	17	17	17	13	
Cavness	WA		x	47343	75985	67746	47769	x
Davis Point (EO # 023)	WA	x		0	5	2	0	
Glacial Heritage Preserve	WA		x	97	134098	59658	48465	
Kah Tai prairie, Port Townsend	WA		x	1	18	6	8	
Long Island (EO 027)	WA	x		22	154	77	0	
Lopez Island, Iceberg Point	WA		x	0	0	0	0	

Mima Mounds Natural Area Preserve	WA		x	78	992	491	393	x
Table 7 continued								
Population	St/Prov	N	O	Min Pop	Max Pop	Long-term Avg	5 year Avg (2013-17)	Form Prot
Morgan/ Tenalquot	WA		x	89	1974	814	721	X
Protection Island	WA		x	66	194	110	93	x
Rocky Prairie NAP (EO 011)	WA	x		2942	15634	7064	6413	x
San Juan Island, American Camp	WA		x	29	185	102	80	x
San Juan Island, Cady Mountain	WA		x	0	20	7	8	
San Juan Island, False Bay Middle (EO 020)	WA	x	x	15	128	45	51	
San Juan Island, False Bay North (EO 025)	WA	x	x	0	100	54	0	
San Juan Island, False Bay South (EO 024)	WA	x	x	12	506	277	203	
San Juan Island, San Juan Valley (no EO #)	WA	x		466	7528	2415	980	x
San Juan Island, West Side Preserve	WA		x	7	12	10	8	x
Scatter Creek south	WA		x	19	156	80	66	x
Waldron Island, Bitte Baer Preserve,	WA		x	22	78	45	38	x
West Beach (EO 012)	WA	x		9	1255	230	380	
West Rocky Prairie	WA		x	84	6747	3003	2461	x
Whidbey Island, Admiralty Inlet NAP, Naas Prairie Unit (EO 009a)	WA	x	x	59	2987	957	1007	x
Whidbey Island, Admiralty Inlet NAP, Bluff (EO 009b)	WA	x	x	67	406	155	159	x
Whidbey Island, Ebey's Landing & Perego's Bluff	WA		x	7	4323	1538	1469	
Whidbey Island, Forbes Point (EO 016)	WA	x	x	78	2700	654	863	x
Whidbey Island, Ft. Casey (EO 005)	WA	x	x	109	2881	848	966	x
Whidbey Island, Hill Road - Ebey's Landing (EO 21)	WA	x		214	7627	1989	2462	x
Whidbey Island, NPS Ebey overlook	WA		x	0	19	6	7	
Whidbey Island, Sherman Farm Field	WA		x	2	29	11	11	
Whidbey Island, Smith Prairie, PRI	WA		x	4	22544	6635	7299	
Wolf Haven	WA		x	32	8075	2833	2737	
Total All Populations				90,110	444,657	233,691	191,515	35
Total of Populations Eligible for Recovery				87,618	431,378	226,413	186,334	32

Based on 2017 monitoring data, three of the 13 naturally occurring *Castilleja levisecta* populations in Washington have averaged over 1000 plants over the last five years (Table 7). The Rocky Prairie NAP and Whidbey Island/Hill Road populations are averaging over 1000 plants without supplemental out-plantings, though both have experienced a downward population trend since 2013. The Whidbey Island/Admiralty Inlet NAP (Naas unit) has been augmented with plugs and seeds since 2007. Out-planted individuals comprised about two-thirds of the total population in 2017 (Table 4); without supplemental plantings this population would have only contained 550 individuals and not met potential recovery goals.

There are currently five additional out-planted populations in Washington and eight in Oregon that have averaged more than 1000 flowering plants in the five-year period from 2013-17 (Table 7). The West Rocky Prairie out-planted population in Washington has also averaged more than 1000 plants for the past five years, but now consists of a high percentage of *Castilleja levisecta* × *C. hispida* hybrids and is ineligible for recovery. All told, 17 populations in Washington and Oregon have averaged more than 1000 flowering plants over the past 5 years.

Presently 31 of the 55 populations eligible for recovery in Washington and Oregon receive some formal protection based on binding land management policies or conservation easements (Table 7). Protected populations on public lands are managed by the National Park Service (San Juan Islands National Historic Park), US Fish and Wildlife Service (Ankeny, Baskett Slough, Finley, and Protection Island National Wildlife Refuges), state of Washington (Fort Casey State Park, WDFW Scatter Creek Wildlife Preserve, WDNR Admiralty Inlet, Mima Mounds, and Rocky Prairie Natural Area Preserves) and city and county governments. Privately protected occurrences are managed by the Greenbelt Land Trust, The Nature Conservancy, Center for Natural Lands Management, Whidbey Camano Land Trust, and San Juan Preservation Trust. Thirteen of the currently protected populations of *Castilleja levisecta* have also averaged more than 1000 plants for the last five years.

Based on the number of populations averaging over 1000 individuals that are also formally protected, *Castilleja levisecta* is close to meeting the delisting objectives specified in the 2000 recovery plan. The remarkable increase in the number and size of populations can be attributed to the success of the reintroduction and augmentation program. Since 2012, the number of established out-planted individuals has exceeded the number of naturally occurring plants (Arnett & Goldner 2017). The estimated number of *C. levisecta* plants has nearly doubled since 2013 (Figure 2), driven in part by the addition of 16 large out-plantings. Presently out-planted individuals outnumber naturally-occurring ones by a ratio of 27:1 (Table 7).

The potential recovery of *Castilleja levisecta* comes with three important caveats:

First, the exceptional increase in the total number of plants is being driven by the success of a small number of very large populations. In 2017, eight populations (out of 43 visited) accounted for 89% of all plants recorded. Any changes in the status of these “mega” populations will have an outsized impact on overall population numbers.

Second, naturally-occurring populations have been declining in recent years. While the number of out-planted *C. levisecta* plants has grown six-fold since 2012, the estimated number of

naturally-occurring plants has decreased by nearly half from 21,037 to 10,757 (Table 6). Most troublesome is that all five of the largest natural occurrences in Washington have been decreasing since 2012. The state's largest natural population at Rocky Prairie NAP is down 60% from 8910 plants in 2012 to 3597 in 2016 (no counts were made in 2017) (Table 6). Admiralty Inlet NAP/Naas has decreased by 52% since 2012 (although it did show an increase in 2017). San Juan Valley is down 65% since 2014. Ebey's Landing/Hill Road and Fort Casey have both declined 85% since 2013.

Third, several successful out-plantings are beginning to decline as they age. The decline is not uniform across all out-plantings (many are stable to increasing), but at least 17 have decreased since 2014. One notable example is the Glacial Heritage Preserve site in Washington south of Olympia. This population was started in 2001 with 24,000 seeds and augmented with additional sowings and out-planting of plugs through 2013. The population finally became established in 2010 and contained 97 plants. Numbers steadily increased, surpassing 11,000 plants in 2012 and reaching a maximum of 135,098 individuals in 2014 (this is also the highest count achieved for any population of *C. levisecta*). Since then, the population has decreased for three consecutive years (Table 7). Although it still numbered 52,405 plants in 2017, this represents a 61% decline from 2014. Many currently successful out-plantings, especially in Oregon, have not been established for more than two or three years, so it remains unknown how they will respond over time. The large decrease in overall numbers in 2016 (Figure 2) is a potential lesson that there may not be enough data points yet to be certain of the long-term trend for this species.

References

- Arnett, J. 2011. *Castilleja levisecta* (golden paintbrush). Monitoring and reporting methodology. Natural Heritage Report 2011-07. Washington Natural Heritage Program, Washington Department of Natural Resources, Olympia, WA. 19 pp. + app.
- Arnett, J. and A. Goldner. 2017. Monitoring federally listed and candidate plant taxa in Washington state 2016. Natural Heritage Report 2017-03. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 63 pp. + app.
- Arnett, J. and P. Dunwiddie. 2010. Evaluating northern Puget Sound area sites for establishing populations of golden paintbrush (*Castilleja levisecta*). Natural Heritage Report 2010-02. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 77 pp.
- Arnett, J. and T. Thomas. 2007. Golden paintbrush (*Castilleja levisecta*) Five-year review: summary and evaluation. Natural Heritage Report 2007-08. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.
- Aubrey, D. 2013. Oviposition preference in Taylor's checkerspot butterflies (*Euphydryas editha taylori*): Collaborative research and conservation with incarcerated women. Master's thesis, Environmental Studies, The Evergreen State College, Olympia, WA. 72 pp.
- Basey, A., J. Fant, and A. Kramer. 2015. Genetic changes associated with ex situ native plant propagation and consequences for reintroductions; case study in *Castilleja levisecta*. In Conservation without Borders conference abstracts, Cascadia Prairie-Oak Partnership 2015 conference, October 26-29, 2015.
- Caplow, F. 2004. Reintroduction Plan for Golden Paintbrush (*Castilleja levisecta*). Natural Heritage Report 2004-01. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 77 pp.

- Caplow, F. and C. Chappell. 2005. South Puget Sound Site Evaluations for Reintroduction of Golden Paintbrush. Natural Heritage Report 2005-07. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 30 pp. + app.
- Chappell, C. and F. Caplow. 2004. Site Characteristics of Golden Paintbrush Populations. Natural Heritage Report 2004-03. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.
- Douglas, G.W. and M. Ryan. 1998. Status of the Golden Paintbrush, *Castilleja levisecta* (Scrophulariaceae) in Canada. Canadian Field Naturalist.
- Dunwiddie, P. 2017. Golden paintbrush Technical Team Meeting. September 13, 2017. 5 pp.
- Dunwiddie, P. and R.A. Martin. 2016. Microsites matter: Improving the success of rare species reintroductions. PLOS One. DOI:10.1371/journal.pone.0150417. March 1, 2016.
- Dunwiddie, P.W., R. Davenport, and P. Speaks. 2001. Effects of burning on *Castilleja levisecta* at Rocky Prairie Natural Area Preserve, Washington: a summary of three long-term studies. In: Reichard, S.H., P.W. Dunwiddie, J. Gamon, A.R. Kruckeberg, and D.L. Salstrom, editors. Conservation of Washington's native plants and ecosystems. Washington Native Plant Society, Seattle, WA. pp 161-172.
- Evans, S., R. Schuller, and E. Augenstein. 1984. A report on *Castilleja levisecta* Greenm. at Rocky Prairie, Thurston County, Washington. Unpublished report to The Nature Conservancy, Washington Field Office, Seattle, WA. 56 pp.
- Fisher, L. L. 2015. Seed production and viability of putative *Castilleja levisecta* × *C. hispida* hybrids. In Conservation without Borders conference abstracts, Cascadia Prairie-Oak Partnership 2015 conference, October 26-29, 2015.
- Gamon, J. 1995. Report on the status of *Castilleja levisecta* Greenman. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 57 pp.
- Gamon, J. 2001. Assessing the viability of golden paintbrush (*Castilleja levisecta*). . In: Reichard, S.H., P.W. Dunwiddie, J. Gamon, A.R. Kruckeberg, and D.L. Salstrom, editors. Conservation of Washington's native plants and ecosystems. Washington Native Plant Society, Seattle, WA. pp 161-172.
- Godt, M.W., F. Caplow, and J.L. Hamrick. 2005. Allozyme diversity in the federally threatened golden paintbrush, *Castilleja levisecta* (Scrophulariaceae). Conservation Genetics 6: 87-99.
- Haan, N.L. 2015. Host plants of golden paintbrush influence its suitability as a food source for checkerspot butterfly larvae. In Conservation without Borders conference abstracts, Cascadia Prairie-Oak Partnership 2015 conference, October 26-29, 2015.
- Kaye, T.N. 2001. Restoration research for golden paintbrush (*Castilleja levisecta*), a threatened species. <http://www.appliedeco.org/Reports>
- Kaye, T.N. 2002. Preliminary notes on the breeding system of *Castilleja levisecta*. Institute for Applied Ecology, Corvallis, OR.
- Kaye, T.N. and M. Blakeley-Smith. 2008. An evaluation of the potential for hybridization between *Castilleja levisecta* and *C. hispida*. Washington Department of Natural Resources, Olympia, WA and Institute for Applied Ecology, Corvallis, OR.
- Kaye, T. N. and B. Lawrence. 2003. Fitness effects of inbreeding and outbreeding on golden paintbrush (*Castilleja levisecta*): Implications for recovery and reintroduction. Washington Department of Natural Resources and Institute for Applied Ecology.
- Kellum, C. 2002. Population Census at Rocky Prairie. Natural Areas Program, Washington Department of Natural Resources.

- Lawrence, B.A. 2003. 2003 *Castilleja levisecta* seed collecting summary. Details of seed collection at Ebey's Bluff, Forbes Point, Mar Vista, and San Juan Valley.
- Lawrence, B.A. 2005. Golden Paintbrush (*Castilleja levisecta*) common garden studies: selecting seed sources and reintroduction sites to support recovery of an endangered prairie species. *Community Analysis* 3(17): 1-7.
- Lawrence, B.A. 2005. Studies to Facilitate Reintroduction of Golden Paintbrush (*Castilleja levisecta*) to the Willamette Valley, Oregon. Unpublished Master's Thesis, Oregon State University, Corvallis, OR.
- Lawrence, B.A. and T.N. Kaye. 2011. Reintroduction of *Castilleja levisecta*: Effects of ecological similarity, source population genetics, and habitat quality. *Restoration Ecology* 19 (2): 166-176.
- Martin, R. A. and P.W. Dunwiddie. 2015. Establishing new populations of a rare species: lessons from golden paintbrush. In Conservation without Borders conference abstracts, Cascadia Prairie-Oak Partnership 2015 conference, October 26-29, 2015.
- Pearson, S. and P. Dunwiddie. 2006. Experimental outplanting of Golden paintbrush (*Castilleja levisecta*) at Glacial Heritage and Mima Mounds, Thurston County, WA.
- Pischalko, M. and R. Holmes. 2005 Population Census of *Castilleja levisecta* at Rocky Prairie. Natural Area Program, Washington Department of Natural Resources, Olympia, WA.
- Ransom Seed Laboratory, Inc. 2005. *Castilleja levisecta* seed viability analysis.
- Rush, T. 1998. Habitat Restoration for *Castilleja levisecta*. Washington Natural Heritage Program, Department of Natural Resources. Olympia, WA.
- Ryan, M. and G.W. Douglas. 1994. Status report on the golden paintbrush *Castilleja levisecta* Greenm.
- Unpublished, draft report prepared by the British Columbia Ministry of Environment, Lands and Parks. Victoria, B.C. 21 pp.
- Severns, P.M. and A.D. Warren. 2008. Selectively eliminating and conserving exotic plants to save an endangered butterfly from local extinction. *Animal Conservation* 2008:1-8.
- Sheehan, M. 2014. Admiralty Inlet Natural Area Preserve (Naas Prairie Unit) 2014 *Castilleja levisecta* census. Monitoring report on file at the Washington Natural Heritage Program, Olympia, WA.
- Sheehan, M. and N. Sprague. 1984. Report on the status of *Castilleja levisecta*. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 82 pp.
- Swenerton, K.K. 2003. Soil suitability and site preparation techniques for *Castilleja levisecta* restoration on Whidbey Island, Washington. College of Forest Resources. University of Washington, Seattle, WA.
- Thomas, T.B., J. Arnett, P.W. Dunwiddie, T.N. Kaye, J. Lantor, and S. Pearson. 2015. Golden paintbrush, on the road to recovery: What have we accomplished, what next? In Conservation without Borders conference abstracts, Cascadia Prairie-Oak Partnership 2015 conference, October 26-29, 2015.
- U.S. Fish and Wildlife Service. 1997. Endangered and threatened wildlife and plants: determination of threatened status for *Castilleja levisecta* (Golden Paintbrush). *Federal Register* 62(112): 31740-31748.
- U.S. Fish and Wildlife Service. 2000. Recovery plan for the golden paintbrush (*Castilleja levisecta*). U.S. Fish and Wildlife Service, Portland, OR. 51 pp.

- U.S. Fish and Wildlife Service. 2007. Golden paintbrush (*Castilleja levisecta*) 5-year review: summary and evaluation. US Fish and Wildlife Service, Western Washington Fish and Wildlife Office, Lacey, WA. 17 pp + app.
- Wayne, W.C. 2004. Factors affecting the reintroduction of golden paintbrush (*Castilleja levisecta*), a threatened plant species. Center for Urban Horticulture. University of Washington, Seattle, WA.
- Wentworth, J. B. 1994. The demography and population dynamics of *Castilleja levisecta*, an endangered perennial [thesis]. University of Washington, Seattle, WA. 53 pp.
- Wentworth, J. B. 1996. Conservation Recommendations for *Castilleja levisecta* in Washington. Washington Natural Heritage Program, Washington Department of Natural Resources, Olympia, WA. 9 pp.
- Wentworth, J. B. 2001. The demography and population dynamics of *Castilleja levisecta*, a federally threatened perennial of Puget Sound Grasslands in R.S. Reichard, P. Dunwiddie, J. Gamon, A.
- Kruckeberg, and D. Salstrom, editors. Conservation of Washington's Native Plants and Ecosystems. Washington Native Plant Society, Seattle, WA.

***Eriogonum codium* – Umtanum desert buckwheat (Polygonaceae)**

Current Status Summary

Legal Status

Listed as Threatened under the ESA in 2013 (US Fish and Wildlife Service 2013c). There is no recovery plan.

Natural Heritage Rank

G1/S1; WA Endangered

Range

Endemic to the east end of Umtanum Ridge in Benton County, Washington in the Columbia Plateau ecoregion.

Number of Occurrences in Washington

Known from a single occurrence first discovered in 1993 and last visited in 2017.

Abundance

5169 plants were counted in 2011, the last year in which a complete census of all known subpopulations at Umtanum Ridge was conducted. Newsome (2017) estimates that the population after the Silver Dollar Fire may be 1906 plants.

Habitat

Found on the rim of north-facing basalt cliffs on fine pebbly or pumice-like basalt of the Kiona Silt loam series in sparse cushion plant-bunchgrass community bordered by sagebrush grassland. Prior to the Silver Dollar fire, the surrounding vegetation was dominated by *Artemisia tridentata*, *Grayia spinosa*, *Salvia dorrii*, *Poa secunda*, and *Elymus spicatus* (Dunwiddie et al. 2001).

Threats

Wildfire, competition from invasive annuals, trampling, low rate of seedling establishment.

Trends

Downward. Kaye (2007) conducted a population viability assessment based on 10 years of monitoring data and predicted a 72% chance of the population declining by half within 100 years. About 60% of the population burned in the Silver Dollar wildfire in July 2017. Full impacts from the fire will not be known until a new census is completed in 2018, but the population probably decreased by at least 65% in 2017.

Managed Areas and Ownership

Hanford Site (DOE).

2017 Research, Monitoring, and Updates

Seedling Monitoring

Spring monitoring of seedlings occurred on 18 April, 2017 and was conducted by Heidi Newsome, Joe Arnett, Terri Knoke, Meg Duhr, and Keith and Jane Abel. The team observed 69 seedlings in 24 permanent plots. This represented an increase of 27% from the total observed in 2016 and is the fourth highest number observed since spring monitoring began in 1996 (Table 8).

Silver Dollar Fire

On 2 July, 2017, the Silver Dollar fire was first reported from near the junction of Highway 24 and Highway 241. Spread by high winds, the fire burned over most of Umtanum Ridge population of *Eriogonum codium* (Newsome 2017). The fire occurred just before annual monitoring of the population was scheduled to begin on July 6. WNHP botanist Joe Arnett, in consultation with Heidi Newsome of the US Fish and Wildlife Service, decided to cancel the 2017 monitoring (Newsome 2017).

Table 8. *Eriogonum codium* PVA Monitoring and Census Data from 1995-2017.

PVA monitoring is divided between April counts of seedlings and July counts and measurements of mature plants within 24 permanent monitoring plots in three transects.

Year	April Seedling Count	July Adult Count			Total Population Census
		New Adult	Persisting Adult	Newly Dead	
1995	No data	No data	No data	No data	4900
1996	4	No data	106	0	
1997	26	0	105	1	5207
1998	3	0	105	0	
1999	20	0	101	4	
2000	73	0	101	0	
2001	37	0	97	4	
2002	0	0	96	1	
2003	3	0	93	3	
2004	6	0	90	3	
2005	0	0	87	3	4408
2006	5	No data	No data	No data	
2007	154	No data	No data	No data	
2008	12	No data	No data	No data	
2009	5	No data	No data	No data	
2010	67	No data	No data	No data	
2011	81	1	79	0	5169
2012	4	1	77	3	
2013	7	0	77	3	
2014	7	3	74	3	
2015	6	3	69	8	
2016	54	6	68	4	
2017	69	No data (monitoring cancelled due to Silver Dollar Fire)			Estimated 1906-2921 survived the Silver Dollar Fire

Arnett, Newsome, US Forest Service botanist Mark Darrach, and others interested in *Eriogonum codium* held a field meeting on 18 July to inspect damage caused by the fire and discuss potential rehabilitation or restoration efforts. The group visited the three permanent monitoring transects and 24 monitoring plots on Umtanum Ridge. Transects 1 and 3 were partly burned but Transect 2 was largely unburned (Newsome 2017). Two plots within the transects were completely burned, 12 were partially burned, and 10 were unburned (Figure 3). Additional plants to the east of the monitoring transects were lightly burned, and the population along the ridgeline to the west was partially burned.

The last full census of the entire population was done in 2011, at which time these five subpopulations contained 5,169 plants (Arnett and Goldner 2017, Newsome 2017). The three transects contained 3499 plants, while the area to the east had 562 and the ridgeline to the west contained 1108. Based on the amount of fire damage to these transects and a brief reconnoiter of the adjacent populations, Newsome, Arnett, and Darrach estimated that 1906 plants survived the fire unburned (36.9% of the pre-fire estimated population). Another 1015 plants (19.6%) were lightly burned (monitoring in 2018 will determine if they survived) and 1015 (19.6%) were partially burned and not expected to survive. The remaining 1233 plants (23.9%) were completely burned (Newsome 2017).

Scorched plants were observed to be notably drier than unburned plants and appeared to be entering dormancy (Newsome 2017). Some of the surviving but lightly burned plants were putting out new green leaves (Figure 4). On a follow-up site visit in October a few plants were observed still producing yellow flower heads.

2018 Plans and Recommendations

A full census of the entire population to determine how many individuals survived the Silver Dollar fire should be a priority in 2018. A wildfire in 1996 killed about 15% of the population (Caplow 1997), so comparable losses might be expected.

Newsome (2017) advised that the burned area remain closed to entry to minimize additional disturbance to the population. She also recommended that as much seed as possible should be salvaged from the population for seed banking and to develop a nursery population to produce additional seed (Newsome and volunteer Jane Abel have extensive experience with propagating and out-planting *Eriogonum codium*). Newsome estimates that at least 3500-6000 new plants will be needed each year for out-planting to compensate for the losses from the Silver Dollar fire.

Additional out-planting sites (besides the existing ones at Yakima Ridge and Saddle Mountain) should be established in potential Umtanum buckwheat habitat outside of the Umtanum Ridge area to reduce the risk of a single catastrophic wildfire extirpating the entire species. Rehabilitation of the burned area with native, weed-free grass seed and replanting with native shrubs is needed to reduce soil erosion and reduce the likelihood of invasion by annual weeds. Herbicide treatments may be needed to contain the spread of invasive plant species. Additional fire breaks may be needed to help protect the ridgeline area from future wildfires (Newsome 2017).



Figure 3. View of *Eriogonum codium* habitat on Umtanum Ridge burned by the July 2017 Silver Dollar fire. Most of the ridge burned, though small unburned patches (at right) were spared. Photo by Keith Abel/US Fish and Wildlife Service. From Newsome (2017).



Figure 4. *Eriogonum codium* plant considered partially burned from 2017 Silver Dollar fire. It remains to be determined if such plants will be able to survive. Photo by Keith Abel/US Fish and Wildlife Service. From Newsome (2017).

2017 Out-planting Monitoring

Two out-plantings have been attempted to establish new populations of *Eriogonum codium*. Three sites on Yakima Ridge were initially planted in November 2011 with 42 plants grown in a nursery. An additional cohort of 60 plants was planted at Yakima Ridge in November 2012 and four cohorts of 446 plants were installed at three sites on Saddle Mountain each year from 2012-2015 (Newsome and Goldie 2017). Each site is revisited in July to assess the survivorship of out-planted individuals. At Yakima Ridge, 32-57% of out-planted individuals survived the first winter and spring (8 months after planting), but survival declined to 9.5-10% the second year (20 months) and 2.3-3% in year three (44 months). As of 2016, the Yakima Ridge population was down to three stressed plants and cannot be considered established (Newsome and Goldie 2017). The Saddle Mountain out-planting had excellent initial survival rates for the 2013 and 2014 cohorts (86-96%) but both sets of plants died out completely in their second year. The 2015 cohort had an initial survival rate of 43% after 9 months and 15% after 21 months. In July 2017, 42 of the total of 566 seedling plants planted at Saddle Mountain were still alive, though at least 18 of these were considered stressed (Newsome and Goldie 2017). No out-planted individuals have yet been observed reproducing.

Newsome and Goldie (2017) now have several years of data that demonstrate that site characteristics and environmental conditions play an important role in the success (or failure) of out-plantings. Cohorts planted in 2011, 2012, and 2013 experienced unusually dry winter conditions, while 2014 was atypically warm and 2015 was unusually warm and wet. Additional information is needed on soil characteristics that are most conducive for establishing Umtanum buckwheat. GIS-modeling could be valuable in identifying future out-planting sites. Other microhabitat features, such as aspect, may be important in project success (Newsome and Goldie 2017).

Earliest Collection

While examining herbarium specimens from the Umtanum Ridge area on the Consortium of Pacific Northwest Herbarium website in October, I noticed a specimen of *Eriogonum codium* that had been incorrectly entered as *E. nudum*. The specimen was collected by C.Z. McKinnon and C. Kemp (#417A PNNL) on 15 June 1993 and was originally determined as *E. strictum* var. *anserinum*. James Reveal annotated the specimen as *E. codium* in 1995, apparently after the manuscript describing this new species was accepted for publication (Reveal et al. 1995), as the collection is not included as a paratype. The McKinnon and Kemp specimen precedes by one year the earliest collection previously known for *E. codium*, but does not extend its known range.

References

- Arnett, J. 2012. Hanford Endemic Plants Population Monitoring: Umtanum desert-buckwheat (*Eriogonum codium*), White Bluffs bladderpod (*Physaria douglasii* ssp. *tuplashensis*), and a summary of other Hanford rare plant occurrences. Natural Heritage Report 2012-01. Washington Natural Heritage Program, Department of Natural Resources, Olympia.
- Arnett, J. 2013. Hanford Endemic Plants Population Monitoring: Umtanum desert-buckwheat (*Eriogonum codium*) and White Bluffs bladderpod (*Physaria douglasii* ssp. *tuplashensis*). Natural Heritage Report 2013-07. Washington Natural Heritage Program, Department of Natural Resources, Olympia.

- Arnett, J. 2013. Monitoring Methodology for *Eriogonum codium* (Umtanum desert buckwheat), Population Viability Analysis. Modified from a 1997 methodology by Kathryn Beck. Washington Natural Heritage Program, Washington Department of Natural Resources, Olympia.
- Arnett, J. and A. Goldner. 2017. Monitoring federally listed and candidate plant taxa in Washington state 2016. Natural Heritage Report 2017-03. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 63 pp + app.
- Beck, K. 1999. Research and overview of *Eriogonum codium*, 1995-1998. Prepared for The Nature Conservancy of Washington by Kathryn Beck, Calypso Consulting, Bellingham, WA. 39 pp.
- Caplow, F. 2003. Studies of Hanford Rare Plants, 2002. Prepared for Washington office of The Nature Conservancy. Natural Heritage Report 2003-04. Washington Natural Heritage Program, Washington Department of Natural Resources.
- Caplow, F. 2005. Seedling studies of *Eriogonum codium* (Umtanum wild buckwheat). Natural Heritage Report 2005-05. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 10 pp. + app.
- Caplow, F, T.N. Kaye, and J. Arnett. 2007. Population Viability Analysis for *Eriogonum codium* (Umtanum desert buckwheat). Natural Heritage Report 2007-04, Washington Natural Heritage Program, Washington Department of Natural Resources, Olympia, WA.
- Dunwiddie, P.W., K.A. Beck, and F.E. Caplow. 2000. Demographic studies of *Eriogonum codium* Reveal Caplow & Beck (Polygonaceae) in Washington. In: Reichard *et al.* editors. Conservation of Washington's native plants and ecosystems. Washington Native Plant Society, Seattle, WA.
- Kaye, T.N. 2007. Draft population viability analysis for *Eriogonum codium* (Umtanum buckwheat). Institute for Applied Ecology, Corvallis, Oregon.
- Newsome, H. and K. Goldie. 2016. Umtanum Desert buckwheat experimental out-planting Report 2016.
- U.S. Fish and Wildlife Service Mid-Columbia River National Wildlife Refuge Complex.
- Newsome, H. and K. Goldie. 2017. Umtanum Desert buckwheat experimental out-planting Report 2017.
- U.S. Fish and Wildlife Service Mid-Columbia River National Wildlife Refuge Complex.
- Newsome, H. 2017. Evaluation of the impacts from the Silver Dollar fire July 2, 2017 to the extant population of Umtanum desert buckwheat (a Threatened plant species). Memorandum, US Fish and Wildlife Service. 10 pp.
- Reveal, J. L., F. Caplow, and K. Beck. 1995. *Eriogonum codium* (Polygonaceae: Eriogonoideae), a new species from southcentral Washington. *Rhodora* 97(892): 350–356.
- Rush, T. and J. Gamon. 1999. Report on the status of *Eriogonum codium* Reveal, Caplow, & Beck. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 18 pp. + app.
- U.S. Fish and Wildlife Service. 2012. Endangered and threatened wildlife and plants; threatened status for *Eriogonum codium* (Umtanum desert buckwheat) and *Physaria douglasii* ssp. *tuplashensis* (White Bluffs bladderpod). Proposed Rule. Federal Register 77 (94): 28704.
- U.S. Fish and Wildlife Service. 2013a. Endangered and threatened wildlife and plants; threatened status for *Eriogonum codium* (Umtanum desert buckwheat) and *Physaria douglasii* ssp. *tuplashensis* (White Bluffs bladderpod). Federal Register 78 (78): 23984-24005.

- U.S. Fish and Wildlife Service. 2013b. Endangered and threatened wildlife and plants; Designation of critical habitat for *Eriogonum codium* (Umtanum desert buckwheat) and *Physaria douglasii* ssp. *tuplashensis* (White Bluffs bladderpod). Final Rule. Federal Register 78 (78): 24008-24032.
- U.S. Fish and Wildlife Service. 2013c. Endangered and threatened wildlife and plants; threatened status for *Eriogonum codium* (Umtanum desert buckwheat) and *Physaria douglasii* ssp. *tuplashensis* (White Bluffs bladderpod) and designation of critical habitat. Final Rule; revision. Federal Register 78 (245): 76995-77004.

***Hackelia venusta* – Showy stickseed (Boraginaceae)**

Current Status Summary

Legal Status

Listed as Endangered under the ESA in 2002 (US Fish and Wildlife Service 2002).

Natural Heritage Rank

G1/S1; WA Endangered

Range

Local endemic of the Wenatchee Mountains (Chelan County) west of Leavenworth in central Washington.

Number of Occurrences in Washington

Known from one extant occurrence (last surveyed in 2015) and one historical population, last visited in 1968. Several populations with dark blue flowers were once reported from higher elevation sites in the Alpine Lakes Wilderness Area. These populations are now recognized as a different species, Taylor's stickseed (*Hackelia taylorii*) which was described in 2013 (Harrod et al. 2013).

Abundance

The single extant population contained at least 477 plants in 2012 (Arnett 2012). Portions of the population were re-surveyed in 2014, with 275 flowering and vegetative plants counted in an area that two years earlier had contained 316 plants. Attempts to establish additional populations in the Tumwater Canyon and Icicle Creek areas in 1994-96 failed, but a second out-planting effort began in 2015.

Habitat

Found most frequently on loose granitic sand or granite talus in eroding gullies on sparsely vegetated slopes at 450-2250 meters (1500-7400 ft) (Arnett 2007).

Threats

Fire suppression has increased cover of competing vegetation. Highway construction and maintenance and use of de-icing chemicals and herbicides is a potential threat. This species appears to have low fecundity.

Trends

The population declined from 1984 to 2011, but increased in 2012. Some of the population increase may be due to the discovery of additional satellite populations beyond the original core sites.

Managed Areas and Ownership

Tumwater Special Interest Area, Wenatchee National Forest.

2017 Research, Monitoring, and Updates

Monitoring of Out-Plantings

On 5 June, 2017, Wendy Gibble (Washington Rare Care) and Joe Arnett (WNHP) visited the 2015 out-planted population of Showy stickseed in Tumwater Canyon to conduct annual monitoring. A total of 228 individuals were planted at four sites in Tumwater Canyon in 2015 and another 39 were reintroduced to a former out-planting site near Icicle Creek (Arnett and Goldner 2017). Survivorship of out-planted individuals at Tumwater Canyon continued to decline in 2017, dropping from an average of 83% in year one (2016) to 51% in year two. All four monitoring plots exhibited a decline, with the worst plot showing just 32% survival, and the best having 62% survival. These plots are all located in the vicinity of the single known extant population (Gibble 2017). No data are yet available on the Icicle Creek population.

Rare Care began preparing another cohort of seedlings for out-planting in the fall of 2017. Most of the plants died from damping-off when they were transferred from a growth chamber to covered outdoor hoop-houses. A new crop of seedlings was initiated in August 2017 to test the soil media and growing environment and prevent further problems with damping off fungi (Gibble 2017).

Previous out-plantings in Tumwater Canyon and Icicle Canyon from 1994-1996 have apparently failed. The last plants at the Tumwater out-planting were observed in 2003. Two plants were still present at Icicle Canyon in 2012, but the site has not been revisited since (Arnett and Goldner 2017). Additional potential re-introduction sites were identified by Arnett (2011a). Establishing at least two additional self-sustaining populations (in addition to the extant native population) is one of the recovery goals for potential down-listing of *Hackelia venusta* (US Fish and Wildlife Service 2007).

Population Counts and Site Monitoring

Joe Arnett (personal communication) had planned to collect data in 2017 on various environmental and biological attributes of the Tumwater out-planting sites and other potential re-introduction areas. This work had to be delayed due to weather and scheduling issues and will be attempted again in 2018.

No census was undertaken at the naturally-occurring population in Tumwater Canyon in 2017. The last full census was done in 2012 when 477 plants were counted by Arnett, Gibble, and others. In 2014, 238 flowering and 37 vegetative plants were observed in a subset of the population (Arnett and Goldner 2017). The 2014 count contained 41 fewer plants than the 2012 survey of the same subunits.

References

- Arnett, J. 2007. *Hackelia venusta* (showy stickseed) report on monitoring, inventory, and reintroduction. Natural Heritage Report 2007-02. Washington Natural Heritage Program, Washington Department of Natural Resources.
- Arnett, J. 2011a. Inventory of potential outplanting sites for *Hackelia venusta* (showy stickseed). Natural Heritage Report 2011-01. Washington Natural Heritage Program, Department of Natural Resources, Olympia.

- Arnett, J. 2011b. *Hackelia venusta* (showy stickseed). Monitoring and Inventory, 1968-2011. Natural Heritage Report 2011-03. Washington Natural Heritage Program, Department of Natural Resources, Olympia.
- Arnett, J. 2012. Review of endemic plants of the Wenatchee Mountains and adjacent areas. Natural Heritage Report 2012-06. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.
- Arnett, J. 2014. *Hackelia venusta*, Tumwater Canyon. Monitoring Layout and Summary Washington Natural Heritage Program, Washington Department of Natural Resources.
- Arnett, J. and A. Goldner. 2017. Monitoring federally listed and candidate plant taxa in Washington state 2016. Natural Heritage Report 2017-03. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 63 pp + app.
- Barrett, J.A., E. Augenstein, and N. Sprague. Report of the status of *Hackelia venusta* (Piper) St. John. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.
- Chalker-Scott, L. and J. Brickey. Determination of the effects of anti-icer compounds upon the rare plant *Hackelia venusta*. Washington State Transportation Center, University of Washington, Seattle WA.
- Edson, J.L., A.D. Leege-Brusven, R.L. Everett, and D.L. Wenny. 1996. Minimizing growth regulators in shoot culture of an endangered plant, *Hackelia venusta* (Boraginaceae). In Vitro Cell. Dev. Biol.-Plant 32:267-271.
- Gamon, J.G. 1988. Habitat management guidelines for *Hackelia venusta* on the Wenatchee National Forest. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.
- Gamon, J.G. 1988. Report on the status of *Hackelia venusta* (Piper) St. John. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.
- Gamon, J.G. 1997. Report on the status of *Hackelia venusta* (Piper) St. John. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.
- Gentry, J.L. and R.L. Carr. 1976. A revision of the genus *Hackelia* (Boraginaceae) in North America, North of Mexico. Memoirs of the New York Botanical Garden 26(1): 121-227.
- Gibble, W. 2017. Progress report for August 2, 2016 through September 30, 2017 FWS Cooperative Agreement F16AC00646. Washington Rare Plant Care and Conservation, University of Washington Botanic Gardens, Seattle, WA. 2 pp.
- Harrod, R.J., L.A. Malmquist, and R.L. Carr. 1999. A review of the taxonomic status of *Hackelia venusta* (Boraginaceae). *Rhodora* 101(905):16-27.
- Harrod, R., L. Malmquist, and R. Carr. 2013. *Hackelia taylori* (Boraginaceae), a new species from north central Washington State (U.S.A.). *J. Bot. Res. Inst. Texas* 7(2): 649-657.
- Hipkins, V.D., B.L. Wilson, and R.J. Harrod. 2003. Isozyme variation in showy stickseed, a Washington endemic plant, and relatives. *Northwest Science* 77 (2): 170-177.
- U.S. Fish and Wildlife Service. 2002. Endangered and threatened wildlife and plants: determination of Endangered status for the Washington plant *Hackelia venusta* (Showy Stickseed). *Federal Register* 67: 5515-5525.
- U.S. Fish and Wildlife Service. 2007. Recovery plan for *Hackelia venusta* (Showy Stickseed). U.S. Fish and Wildlife Service, Portland, Oregon. xii + 60 pages.
- Vance, J.M. 2013. An examination of the soils supporting *Hackelia venusta*, Washington State's most endangered species. A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science, University of Washington.

- Wendling, B. and E. DeChaine. 2011. A molecular analysis of *Hackelia venusta* (Boraginaceae) and related taxa. Report to the U.S. Fish and Wildlife Service, received at the Washington Natural Heritage Program 28 August 2011.
- Wenny, D.L. and R. Everett. 1992. A micropropagation plan to conserve *Hackelia venusta*, a category-one federal candidate species. June 15, 1992. Internal report on file at the Washington Natural Heritage Program, Olympia, WA.
- Wenny, D.L. and R. Everett. 1993. A plan to micropropagate *Hackelia venusta*. Progress report on Phase 2. December 29, 1993. Internal report on file at the Washington Natural Heritage Program, Olympia, WA.

***Howellia aquatilis* – Water howellia (Campanulaceae)**

Current Status Summary

Legal Status

Listed as Threatened under the ESA in 1994 (US Fish and Wildlife Service 1994).

Natural Heritage Rank

G3/S2; WA Threatened

Range

Washington, northern Idaho, western Montana, western Oregon, and northern California. In Washington, found in Clark, Pierce, Spokane, and Thurston counties.

Number of Occurrences in Washington

In Washington, 66 extant occurrences are recognized (another 7 occurrences discovered since 1986 have not been relocated and might be extirpated) (Table 9). Fifty-five occurrences have been discovered or relocated since 2000, with 19 visited most recently in 2015. At least two other occurrences in western Washington (Mason and Thurston counties) are historical (Mincemoyer 2005). Many occurrences in the Spokane area and on Joint Base Lewis-McChord are found in the same drainage or are less than 1.5 km from other populations and might be lumped into larger “metapopulations”. For example, the 35 occurrences recognized on Turnbull National Wildlife Refuge would become 15 if NatureServe minimum distance criteria were applied (Arnett and Goldner 2017). If occurrences are aggregated, Washington has only 10-12 metapopulations.

Abundance

Individual occurrences may contain 1-20 plants or number in the low thousands. Long-term monitoring studies indicate that numbers fluctuate from year to year in response to moisture conditions and availability of mudflats for fall germination. Mincemoyer (2005) tabulated census data from 49 sites in Washington and found the minimum and maximum number of plants statewide was 6724-37,694. These totals are influenced by a relatively small number of large populations. Of the 55 occurrences that have been relocated since 2000, 34 contained fewer than 100 plants (Table 9).

Habitat

In eastern Washington, populations are found in aspen (*Populus tremuloides*) wetlands within channeled scablands. Populations in western Washington occur mostly in small vernal ponds or wetlands with Oregon ash (*Fraxinus latifolia*). The occurrence in Clark County is found on a broad floodplain of the Columbia River with Oregon ash. Populations across the state are usually found on clayey soils that are dry in fall but inundated in the spring.

Table 9. Location data for *Howellia aquatilis* in Washington.

Population	County	Ecoregion	Ownership	Yr Last Obs.	Status
Dishman Hills (EO # 001)	Spokane	Columbia Plateau	Dishman Hills NRCA	2011	50 plants observed in 2011, highest count was 217 in 2002
Blackwater Island RNA (EO #002)	Clark	Puget Trough	Blackwater Island RNA, Ridgefield NWR	2014	2014: 100s of plants observed (highest count yet recorded). 1980: abundant
Cheney-Spangle & Curtis roads (EO # 003)	Spokane	Columbia Plateau	unknown	1986	Hundreds to thousands estimated in 1986
Curtis Road (EO #004)	Spokane	Columbia Plateau	unknown	1986	Hundreds reported in 1986
Bretz Pothole (EO # 005)	Spokane	Columbia Plateau	unknown	1990	1990: observed; 1986: several 100 to 1000; not relocated in 1991 or 1992
Cameron Road (EO # 006)	Spokane	Columbia Plateau	unknown	1987	No data
Jennings Road (EO # 007)	Spokane	Columbia Plateau	Private	1987	No data
Cross Tracks I (EO # 008)	Spokane	Columbia Plateau	Private	1987	1987: noted as "small population"
Cross Tracks II (EO # 009)	Spokane	Columbia Plateau	unknown	1987	No data
Cross Tracks III (EO # 010)	Spokane	Columbia Plateau	Private	1987	1987: "very few plants" observed
Turnbull NWR, E of Findley Lake (EO # 011)	Spokane	Columbia Plateau	Turnbull NWR	2007	2007: 100s observed; 1996: 402 plants
E of Kepple Lake (EO # 012)	Spokane	Columbia Plateau	unknown	1987	No data
Pond E of Campbell Lake (EO # 013)	Spokane	Columbia Plateau	Turnbull NWR	2008	2008: 6 plants
Squirrel View (EO # 014)	Spokane	Columbia Plateau	Turnbull NWR	2008	2008: 105+ plants; 1996: 16 plants
Lily Pond (EO # 015)	Spokane	Columbia Plateau	unknown	1987	1987: "small population"
Anderson Road (EO # 016)	Spokane	Columbia Plateau	unknown	1987	1987: "scattered"
N of West Tritt Lake (EO # 017)	Spokane	Columbia Plateau	Turnbull NWR	1990	1990: "very few"; Not relocated in 2008, 2009, 2012
Pond 10, Pine Creek RNA S pond (EO # 018)	Spokane	Columbia Plateau	Turnbull NWR	2007	2007: 60-120 plants; 1996: 156 plants; 1993: 2 plants
S of West Blackhorse Lake (EO # 019)	Spokane	Columbia Plateau	Turnbull NWR	2010	2010: 2 small clusters; 1997-2009: not found; 1990: "fair" population
Pond 85 Turnbull NWR (EO # 020)	Spokane	Columbia Plateau	Turnbull NWR	2009	2009: observed but not censused, 1996: 57 plants
Pond 21A Turnbull NWR (EO # 021)	Spokane	Columbia Plateau	Turnbull NWR	2009	2009: 2 plants; 1997: 0; 1993: 1 plant
Pond 77 Turnbull NWR, Findley Lake NE (EO # 022)	Spokane	Columbia Plateau	Turnbull NWR	2007	2007: 1 plant
Pond 72 Turnbull NWR (EO # 023)	Spokane	Columbia Plateau	Turnbull NWR	2010	2010: 240 plants; 1993: 2 plants
Pond 55 Turnbull NWR (EO # 024)	Spokane	Columbia Plateau	Turnbull NWR	2008	2008: 10 plants; 1996: 150 plants; 1993: 2 plants
Pond 39 Turnbull NWR (EO # 025)	Spokane	Columbia Plateau	Turnbull NWR	2008	2008: 23 plants
Pond 21C Turnbull NWR (EO # 026)	Spokane	Columbia Plateau	Turnbull NWR	2009	2009: observed, but not censused; 2007: 200+ plants; 1993: 1 plant

Table 9. continued					
Population	County	Ecoregion	Ownership	Yr last Obs	Status
Pond 61 Turnbull NWR (EO # 028)	Spokane	Columbia Plateau	Turnbull NWR	2007	2007: 250+ plants; 1997: 50-75 plants; 1996: 46 plants
Pond 18 Turnbull NWR (EO # 029)	Spokane	Columbia Plateau	Turnbull NWR	2008	2008: 1 plant, 1993: 1 plant
Pond 21B Turnbull NWR (EO # 030)	Spokane	Columbia Plateau	Turnbull NWR	2009	2009: observed but not censused; 1993: 2-3 plants
Pond 31 Turnbull NWR (EO # 031)	Spokane	Columbia Plateau	Turnbull NWR	2008	2008: 297 plants; 1993: 3 plants
Pond 29 Turnbull NWR (EO # 032)	Spokane	Columbia Plateau	Turnbull NWR	2007	2007: 15 plants; 1997: 2 plants; 1996: 18 plants; 1993: 50+ plants
Pond 12 Turnbull NWR (EO # 033)	Spokane	Columbia Plateau	Turnbull NWR	2007	2007: 40-70 plants
Pond 1A Stubblefield Lake Turnbull NWR (EO # 034)	Spokane	Columbia Plateau	Turnbull NWR	1993	1993: 1 plant; Could not be relocated in 2010, 2011, or 2012
Pond 112 Turnbull NWR (EO # 035)	Spokane	Columbia Plateau	Turnbull NWR	1993	Could not be relocated in 2011 Rare Care search; 1993: 3 plants
Pond 96 Turnbull NWR (EO # 036)	Spokane	Columbia Plateau	Turnbull NWR	2007	2007: 110+ plants; 1996: 15 plants
NW of Hog Lake (EO # 037)	Spokane	Columbia Plateau	BLM	2012	2012: ca 50 plants; monitored almost yearly; no plants in 2017; 1993: 50
Pond 107 Turnbull NWR (EO # 038)	Spokane	Columbia Plateau	Turnbull NWR	2009	2009: scattered throughout pond; 1996: 30 plants; 1993: 2 plants
Foot Lake (EO # 039) JBLM wetland #1	Pierce	Puget Trough	Joint Base Lewis McChord	2015	2015: 120-170 plants. 1998: 338 plants
S of Bentsen (EO # 040) JBLM wetland # 3	Pierce	Puget Trough	Joint Base Lewis McChord	1998	1998: 4 plants; 2015: 0 plants observed
Bentsen wetland (EO # 041) JBLM wetland # 2	Pierce	Puget Trough	Joint Base Lewis McChord	2015	2015: 5 plants. 1998: Could not be relocated; 1994: large pop, scattered
Binocular Pond (EO # 042) JBLM wetland # 15	Pierce	Puget Trough	Joint Base Lewis McChord	2015	2015: 7 plants; 1998: 90 plants
Shaver Kettle (EO # 043) JBLM wetland # 7	Pierce	Puget Trough	Joint Base Lewis McChord	2015	2015: 200 plants. 2001: 80-140 plants; 1998: estimated 800 plants
Trench Wetland (EO # 044) JBLM wetland # 6	Pierce	Puget Trough	Joint Base Lewis McChord	2015	2015: 230-330 plants. 1998: 20 plants
NE Chambers Satellite (EO # 045) JBLM wetland # 11	Pierce	Puget Trough	Joint Base Lewis McChord	2015	2015: 52 plants. 1998: not relocated; 1996: "a few plant fragments"
North Chambers Pond (EO # 046) JBLM wetland # 9	Pierce	Puget Trough	Joint Base Lewis McChord	2015	2015: 107-182 plants. 1998: 706 plants
West Shaver Pond (EO # 047) JBLM wetland # 8	Pierce	Puget Trough	Joint Base Lewis McChord	2015	2015: 148-198 plants. 1998: 804 plants
Crone Marsh (EO # 048) JBLM wetland # 4	Pierce	Puget Trough	Joint Base Lewis McChord	2015	2015: 105 plants (Crone West) and 1200 plants (Crone East). 1998: 1000+ plants
Joseph Marsh (EO # 049) JBLM wetland # 5	Pierce	Puget Trough	Joint Base Lewis McChord	2015	2015: 202 plants; 1999: ca 500 plants
Middle East Chambers (EO # 050) JBLM wetland # 10	Pierce	Puget Trough	Joint Base Lewis McChord	1998	1998: 53 plant; 2015: 0 plants observed
Dailman Lake (EO # 051) JBLM wetland # 14	Pierce	Puget Trough	Joint Base Lewis McChord	2015	2015: 8 plants. 1998: 39 plants; 1997: 100s of plants

Table 9. continued					
Population	County	Ecoregion	Ownership	Yr last Obs	Status
Hamilton Lake (EO # 052) JBLM wetland # 16	Pierce	Puget Trough	Joint Base Lewis McChord	2015	2015: 16 plants. 1998: 13 plants; 1997: 4 plants
Chambers East (EO # 053) JBLM wetland # 13	Pierce	Puget Trough	Joint Base Lewis McChord	2015	2015: 144-194 plants. 1998: 91 plants
Turnbull NWR Pond 13 South RNA (EO # 054)	Spokane	Columbia Plateau	Turnbull NWR	2008	2008: 32-35 plants; 1993: 9 plants
Turnbull NWR Pond 82 (EO # 055)	Spokane	Columbia Plateau	Turnbull NWR	2008	2008: 25 plants; 1993: 1 plant
Turnbull NWR Pond 63 (EO # 056)	Spokane	Columbia Plateau	Turnbull NWR	1993	Not relocated in 1997, 2008, 2009, 2012 visits; 1993: 3 plants
Turnbull NWR pond 32 (EO # 057)	Spokane	Columbia Plateau	Turnbull NWR	2008	2008: ca 1000; 1996: 39
Turnbull NWR pond 138 (EO # 058)	Spokane	Columbia Plateau	Turnbull NWR	2009	2009: observed but not censused; 1997: 10-20 plants; 1993: 100+ plants
Turnbull NWR pond 139 (EO # 059)	Spokane	Columbia Plateau	Turnbull NWR	2009	2009: 1 patch; 1996: 9 plants; 1993: 1 plant
Turnbull NWR pond 117 (EO # 060)	Spokane	Columbia Plateau	Turnbull NWR	2009	2009: observed but not censused; 1996: 1 plant; 1993: 3 plants
Turnbull NWR pond 18 (EO # 061)	Spokane	Columbia Plateau	Turnbull NWR	2008	2008: 48 plants; 1997: 1 plant; 1993: 3 plants
Turnbull NWR pond 149 (EO # 062)	Spokane	Columbia Plateau	Turnbull NWR	2009	2009: <200; 1996: 111 plants
Turnbull NWR pond 150 (EO # 063)	Spokane	Columbia Plateau	Turnbull NWR	2008	2008: observed throughout pond; 1996: 76 plants
Powder Factory (EO # 064)	Thurston	Puget Trough	Scatter Creek Wildlife Area	2008	2008: observed but not censused; 1995: "small population"
Turnbull NWR, NW of Campbell Lake (EO # 065)	Spokane	Columbia Plateau	Turnbull NWR	1997	1997: 7 plants
Willow Kettle, 13th Div Prairie (EO # 066) JBLM wetland # 17	Pierce	Puget Trough	Joint Base Lewis McChord	2015	2015: 80 plants. 1998: scattered and in clusters
Smythe Rd North (EO # 067)	Spokane	Columbia Plateau	WA DNR	2011	2011: 85-120 plants; 999: 1260-1860 plants
Burnett Rd (EO # 068)	Spokane	Columbia Plateau	WA DNR	2013	2013: observed but not censused; 2010: 1000+; 1999: ca 1100
N of S Luke Rd (EO # 069)	Spokane	Columbia Plateau	unknown	2012	2012: <100 plants
Combs (EO # 70) JBLM wetland # 22	Pierce	Puget Trough	Joint Base Lewis McChord	2015	2015: 120 plants
Lynch (EO # 71) JBLM wetland # 21	Pierce	Puget Trough	Joint Base Lewis McChord	2015	2015: 485 plants
Roy (EO # 72) JBLM wetland # 20	Pierce	Puget Trough	Joint Base Lewis McChord	2015	2015: 11 plants
Ressa (EO # 73) JBLM wetland # 19	Pierce	Puget Trough	Joint Base Lewis McChord	2015	2015: 3 plants
Shaver Puddle (EO # 74) JBLM wetland # 18	Pierce	Puget Trough	Joint Base Lewis McChord	2015	2015: 30 plants

Threats

Competition from invasive plant species (especially *Phalaris arundinacea*), succession, changes in hydrology (flooding or dewatering), and impacts from timber harvest.

Trends

The number of occurrences has steadily increased with more surveys. Trend data are lacking for nearly 40% of all Washington populations. Abundance data can be variable, depending on changes in hydrology from year to year. Changes in habitat quality (especially invasion of woody plants and *Phalaris* and the increase in woody debris) is probably leading to a general population decline at Joint Base Lewis-McChord, where at least 8 of 21 known populations are declining (trend data are lacking for 8 sites and populations are increasing at 5).

Managed Areas and Ownership

Blackwater Island Research Natural Area, Spokane Bureau of Land Management, Dishman Hills Natural Resource Conservation Area, Joint Base Lewis McChord, Ridgefield National Wildlife Refuge, Scatter Creek Wildlife Area, Turnbull National Wildlife Refuge, state, private.

2017 Research, Monitoring, and Updates

2017 Site Visits

BLM staff visited the population northwest of Hog Lake in the Fishtrap Allotment (EO # 037) in 2017, but no plants were observed. Kim Frymire (personal communication) noted that this was the second year in a row that the pond did not dry out to create mudflat habitat for seedling germination.

Rod Gilbert and I visited 8 *Howellia aquatilis* occurrences scattered across Joint Base Lewis-McChord in October 2017, but were too late in the season to observe any living howellia plants. We did note the dense cover of woody debris and Reed canary-grass (*Phalaris arundinacea*) at most sites and the presence of deep standing water at one pond locality (there were no mudflats exposed for seed germination). No formal surveys have been done at the base since 2015 (Table 9), but there are plans to monitor populations in 2018 (Rod Gilbert, personal communication).

None of the *Howellia aquatilis* populations at Turnbull National Wildlife Refuge were relocated in 2017 (Mike Rule, personal communication).

Post De-Listing Monitoring

A draft *Howellia aquatilis* recovery plan was written in 1996 (though never formally adopted) that focused on implementing management plans for populations on federally-managed lands, conducting research on the life history and management of the species, and encouraging conservation practices on state and private lands (Shelly and Gamon 1996). In 2013, USFWS issued a five-year review of the status of *H. aquatilis*. The Service concluded that *H. aquatilis* was more common and widespread and less threatened than originally suspected due to changes in management practices and no longer warranted listing under the Endangered Species Act (US Fish and Wildlife Service 2013).

A draft post-delisting monitoring plan for *Howellia aquatilis* was developed by the US Fish and Wildlife Service in fall 2017 in collaboration with state and federal stakeholders throughout its

range (US Fish and Wildlife Service 2017). The goal of the monitoring plan is to revisit a minimum of 60 of the 307 known *H. aquatilis* sites across its range, with a minimum of 30 being from Washington. Due to the difficulty of detecting and counting individual *Howellia* plants, the monitoring plan will employ qualitative abundance categories (none, <50 plants, 50-100 plants, > 100 plants) within quarter-acre survey subdivisions. Additional photo monitoring of habitat condition and qualitative assessment of competing Reed canary-grass cover will also be conducted. Monitoring will continue for at least 5 years after the species is de-listed * and the range-wide results analyzed to determine whether *H. aquatilis* should remain de-listed or be placed back on the Endangered Species list (US Fish and Wildlife Service 2017).

*As of 25 March 2018, a formal proposal for de-listing *Howellia aquatilis* had not been published in the Federal Register.

References

- Arnett, J. and A. Goldner. 2017. Monitoring federally listed and candidate plant taxa in Washington state 2016. Natural Heritage Report 2017-03. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 63 pp + app.
- Gamon, J. 1992. Report on the status in Washington of *Howellia aquatilis* Gray. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.
- Gamon, J. 1998. Inventory and management plan for water howellia (*Howellia aquatilis*) on Fort Lewis. Washington Department of Natural Resources, Division of Forest Resources, Natural Heritage Program. In coordination with The Nature Conservancy of Washington.
- Gamon, J. 2002. Endangered species management plan for the water howellia (*Howellia aquatilis*), Fort Lewis, Washington. Washington Natural Heritage Program, Department of Natural Resources.
- Gamon, J. and T. Rush. 1998. Defining potential habitat and compiling a monitoring plan for water howellia (*Howellia aquatilis*) on Fort Lewis, Washington. Washington Department of Natural Resources, Division of Forest Resources, Natural Heritage Program. In coordination with The Nature Conservancy of Washington.
- Griggs, F.T. and J.E. Dibble. 1979. Status report, *Howellia aquatilis* Gray, for the Mendicino National Forest.
- Johnson, P. 1998. *Howellia aquatilis*: investigations in autecology and competition. Plant ecology contract, 6/8/98. In Washington Natural Heritage Program files, Olympia, WA.
- Lesica, P. 1992. Autecology of the endangered plant *Howellia aquatilis*; implications for management and reserve design. *Ecological Applications* 2(4): 411-421.
- Lesica, P. 1997. Spread of *Phalaris arundinacea* adversely impacts the endangered plant *Howellia aquatilis*. *Great Basin Naturalist* 57(4): 366-368.
- Lesica, P., R.F. Leary, F.W. Allendorf, and D.E. Bilderback. 1988. Lack of genic diversity within and among populations of an endangered plant, *Howellia aquatilis*. *Conservation Biology* 2 (3): 275-282.
- Lichthardt, J. and K. Gray. Monitoring of *Howellia aquatilis* (water howellia) and its habitat at the Harvard-Palouse River Flood Plain site, Idaho: Third Year results. Idaho Department of Fish and Game, Natural Resource Policy Bureau, Boise, Idaho.
- Mincemoyer, S. 2005. Range-wide status assessment of *Howellia aquatilis* (water howellia). Prepared for U.S. Fish and Wildlife Service. Montana Natural Heritage Program, Natural Resources Information System, Montana State Library. 21 pp. + app.

- Rush, T. 1998. *Howellia aquatilis* Habitat characteristics on Fort Lewis Military Reservation and Turnbull National Wildlife Refuge. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.
- Shelly, J. S. and J. Gamon, 1996. Technical Draft, *Howellia aquatilis* (water howellia) Recovery Plan. Montana Natural Heritage Program and U.S. Forest Service, Missoula, Montana; Washington Natural Heritage Program, Olympia, WA.
- U.S.D.A. Forest Service. 1994. Conservation Strategy, *Howellia aquatilis*. Flathead National Forest, Northern Region.
- U.S. Fish and Wildlife Service. 1994. Endangered and threatened wildlife and plants; the plant, Water Howellia (*Howellia aquatilis*), determined to be a threatened species; Final rule. Federal Register 59(134): 35860-35864.
- U.S. Fish and Wildlife Service. 1996. Availability of draft recovery plan for the Water howellia (*Howellia aquatilis*) for review and comment. 61 FR 50044–50045.
- U.S. Fish and Wildlife Service. 2013. Water howellia (*Howellia aquatilis*) 5-year review: Summary and evaluation. US Fish and Wildlife Service Montana Ecological Services Field Office, Helena, MT. 39 pp.
- U.S. Fish and Wildlife Service. 2017. Draft Post-delisting monitoring plan for Water howellia (*Howellia aquatilis*). US Fish and Wildlife Service Montana Ecological Services Field Office, Helena, MT. 30 pp.

***Lomatium bradshawii* – Bradshaw’s lomatium (Apiaceae)**

Current Status Summary

Legal Status

Listed as Endangered under the ESA in 1988 (US Fish and Wildlife Service 1988)

Natural Heritage Rank

G2/S1; WA Endangered

Range

Endemic to the Willamette Valley in western Oregon and the southern Puget Trough in southwestern Washington (Clark County).

Number of Occurrences in Washington

Treated as a single large occurrence comprised of two main subpopulations that are located less than 1 km apart.

Abundance

When first discovered in 1994, the population in Washington was estimated to be several thousand plants. This number was revised upward to more than 70,411 based on ocular estimates in 1995 (Wentworth 1996). More detailed mapping and sampling lead to a projection of more than 816,000 plants in 1999 (St. Hilare 1998). Based on sampling and extrapolation from 26 plots, Dillon (2007) estimated the population was more than 22 million individuals. Arnett (2010) identified relatively homogeneous polygons that excluded unsuitable habitat and then established random transects and quadrats to determine the number of plants per square meter and total area occupied. Based on these calculations, *Lomatium bradshawii* occupied at least 51,715 square meters of habitat and numbered 9,149,912 individuals (Arnett 2010).

Habitat

Seasonally flooded, prairies and grasslands in a narrow hydrologic ecotone between drier uplands and wet creek or river banks. Commonly associated species include Oregon ash (*Fraxinus latifolia*), Tufted hairgrass (*Deschampsia cespitosa*), Poverty rush (*Juncus tenuis*) and sedges (*Carex arcta* and *C. unilateralis*) (Camp and Gamon 2011).

Threats

Loss of habitat to human settlement and conversion to agriculture; competition from introduced plants, invasion of meadow sites by shrubs and trees; fire suppression; and changes in hydrology.

Trends

Historically, trends are probably downward due to the extreme loss of prairie habitat in the south Puget Trough. Recent trends in the Lacamas Prairie area appear to be stable, although measuring trend is complicated by the difficulty in identifying individual plants within dense patches. Trend data from the Lacamas Prairie Natural Area Preserve indicate that populations can oscillate from year to year, but overall trend appears downward since 1998 (Wilderman 2017).

Managed Areas and Ownership

Lacamas Prairie Natural Area Preserve (WA DNR), private.

2017 Research, Monitoring, and Updates

Monitoring at Lacamas Prairie NAP

Only 111 acres of *Lomatium bradshawii* habitat in Washington is contained within the Lacamas Prairie Natural Area Preserve, managed by the Washington state Department of Natural Resources. This area has been actively monitored by DNR staff since 1998. Originally, the NAP population was monitored using subsampling quadrats within two large macroplots, with these results then extrapolated across the entire area to predict abundance. This protocol was discontinued following the 2013 field season, after the number of plants within the quadrats declined precipitously and it was decided to conduct a full census within the original macroplots instead (Wilderman 2017). In 2017, NAP staff counted 804 plants at the preserve which represented a decrease of 16% from the previous year (Table 10). The Lacamas Prairie NAP population has fluctuated since 2000, but the overall trend is down sharply since 2007 and from the highest estimate of 13829 plants when monitoring started in 1998.

Expansion of the Lacamas Prairie NAP and Natural Resources Conservation Area has been approved by the Washington Natural Heritage Advisory Council and the Commissioner of Public lands, pending the availability of funding and agreement on terms with willing landowners (Figure 5).

Table 10. Monitoring and Census Data for *Lomatium bradshawii* at Lacamas Prairie NAP, Washington from 1998-2017.

Derived from Wilderman (2017). Numbers include both reproductive (flowering and fruiting) and vegetative plants.

	1998	1999	2000	2001	2002	2003	2004	2007	2013	2015	2016	2017
Total number of plants in quadrats (Macroplot 2)	1608	1360	842	300	645	810	1109	593	20	N/A	N/A	N/A
Mean # plants/quadrat (Macroplot 2)	160.8	136	84.2	30	64.5	81	110.9	59.3	2.0	N/A	N/A	N/A
Estimated population in Macroplot 2 extrapolated from quadrats	13829	11696	7241	2580	5547	6966	9537	5100	172	N/A	N/A	N/A
Census data Macroplot 2										420	520	496
Census Data for rest of Lacamas Prairie NAP											447	308
Total Population Census Lacamas Prairie NAP											967	804

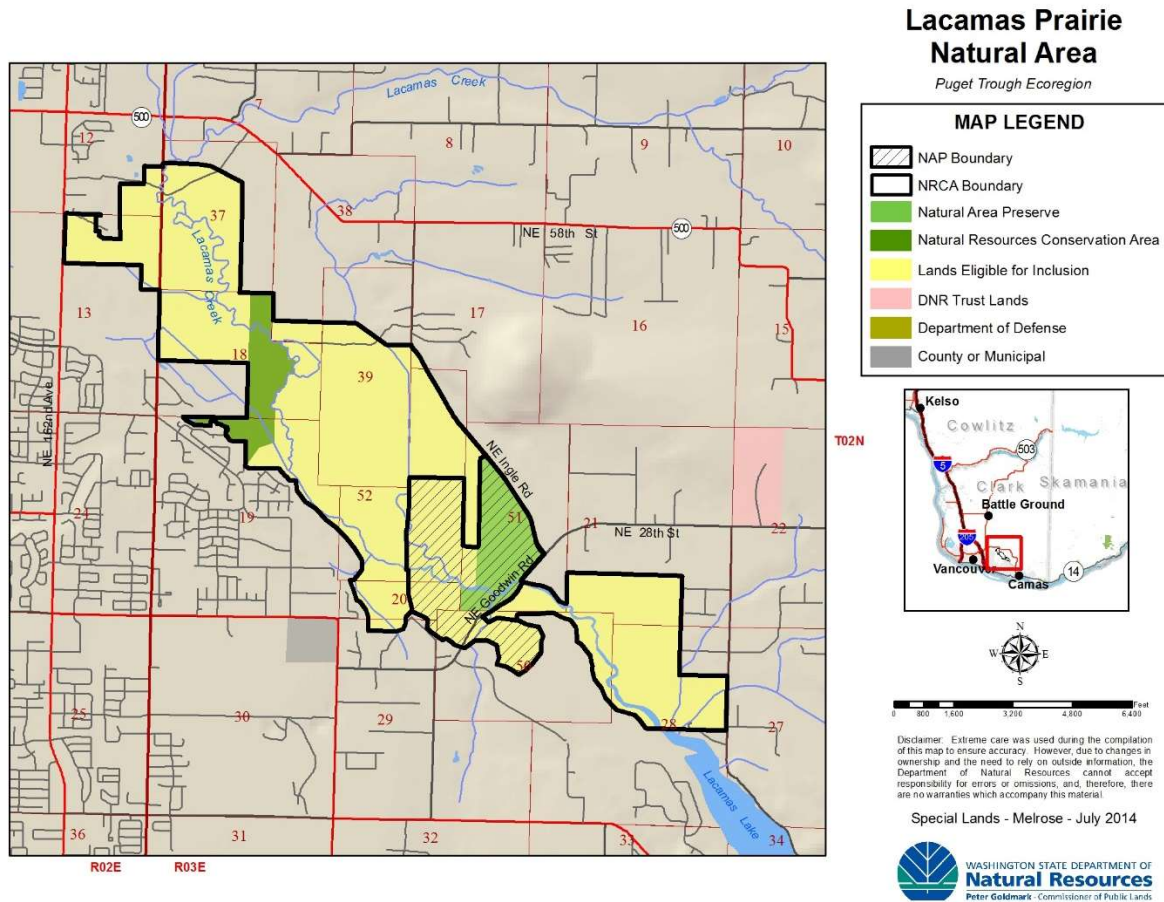


Figure 5. Lacamas Prairie Natural Area Preserve and Natural Resources Conservation Area.

References

- Arnett, J. 2010. Recovery Actions for *Lomatium bradshawii* (Bradshaw's lomatium). Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.
- Arnett, J., K. Birkhauser, and T. Kemper. 2007. Southwestern Washington Prairies: Inventory and Conservation Planning for Rare Plants of Southwestern Washington Grasslands. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.
- Camp, P. and J.G. Gamon. 2011. Field Guide to the Rare Plants of Washington. University of Washington Press, Seattle, WA. 392 pp.
- Cornelius, L. 2001. Prairie Restoration Fact Sheet, Green Mountain Resort Conservation Area. The Nature Conservancy.
- Dillon, J. 2007. Map of Lacamas Meadows, Clark County, WA (Monitoring Site ID No. 7). Population surveys for all plant forms on 4/19/2007 and 4/25/2007 for *Lomatium bradshawii* (Species ID No. 21). Washington Natural Heritage Program Geographic Manual File.
- Habegger, E. 1998. Site report for the Green Mountain Resort Conservation Agreement, Clark County, Washington. Prepared for the Nature Conservancy Washington Field Office, Seattle, WA.

- Kagan, J. S. 1980. The biology of *Lomatium bradshawii* (Apiaceae), a rare plant of Oregon. M.S. Thesis, University of Oregon, Eugene, OR. 71 pp.
- Kaye, T.N. and M. Kirkland. 1994. Population biology of *Lomatium bradshawii*. II. Insect interactions, phenology, and breeding system. USDI Bureau of Land Management, Eugene District and Oregon Department of Agriculture, Plant Conservation Biology Program.
- Habegger, E. 1998. Site Report for the Green Mountain Resort Conservation Agreement, Clark County, Washington. Prepared for The Nature Conservancy.
- Jackson, G. 1999. Formal consultation on the Camas Meadow Golf Project Clark County, Washington. (1-3-99-F-1283). U.S. Fish and Wildlife Service Memorandum to the State Supervisor, Western Washington Office, Lacey, Washington.
- Reynolds, N. 2004. Oak woodlands restoration plan and schedule for the Green Mountain Resort Conservation Area. Prepared for The Nature Conservancy of Washington by LaCamas Ecoscience, Camas, WA.
- Rush, T. and J. Gamon. 1999. Amendment to the Recovery Plan for Bradshaw's lomatium (*Lomatium bradshawii*). Washington Natural Heritage Program, Division of Forest Resources, Department of Natural Resources, Olympia, WA.
- Silvernail, I, A. Ottombrino-Haworth, L. Guenther, D. Andersen, R. Currin, M. Gisler, and T. Kaye. 2015. Range-wide inventory of Bradshaw's Lomatium (*Lomatium bradshawii*), a federally-listed endangered species. Report (in draft) to the US Fish and Wildlife Service. Cooperative agreement #F11AC00128. Institute for Applied Ecology, Corvallis, OR.
- Smith, D.R. 1994. Wildlife resources assessment of the Green Mountain Resort, Clark County, Washington. Prepared for Green Mountain Resorts, Inc., by Wildlife Dynamics, Inc.
- St. Hilaire, K. R. 1994. Botanical Survey for *Lomatium bradshawii* and *Eryngium petiolatum* for the proposed Green Mountain Golf Course. Prepared for Coastal Management Group, Inc.
- St. Hilaire, K. 1997. Conservation agreement for *Lomatium bradshawii* on the Camas Meadows Development. Prepared for Vanport Manufacturing, Inc., Camas, WA.
- St. Hilaire, K. 1998. Annual Monitoring Report (Monitoring activities in Year 1997) for *Lomatium bradshawii* on the Camas Meadows Development. Prepared for Vanport Manufacturing, Inc., Camas, WA.
- St. Hilaire, K. 1999. Second Annual Monitoring Report (Monitoring activities in Year 1998) for *Lomatium bradshawii* on the Camas Meadows Development. Prepared for Vanport Manufacturing, Inc., Camas, WA.
- St. Hilaire, K. 2001. Third Annual Monitoring Report (Monitoring activities in Year 2000) for *Lomatium bradshawii* on the Camas Meadows Development. Prepared for Lake Development, Inc., Camas, WA.
- State of Washington. 2007. Department of Natural Resources, Commissioner's Order establishing the Lacamas Prairie Natural Area. Signed by Doug Sutherland, Commissioner of Public Lands, April 18, 2007.
- 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: 38448-38451.
- U.S. Fish and Wildlife Service. 1993. Recovery Plan for Bradshaw's lomatium (*Lomatium bradshawii*) U.S. Department of the Interior Fish and Wildlife Service, Region One, Portland, Oregon. August 1993. [Superseded by USFWS 2010]

- U.S. Fish and Wildlife Service. 2010. Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington. U.S. Fish and Wildlife Service, Portland, Oregon. xi + 241 pp.
- Wentworth, J. B. 1996. Report on the status in Washington of *Lomatium bradshawii*. Washington Natural Heritage Program, Department of Natural Resources, Olympia WA.
- Wilderman, D. 2007. *Lomatium bradshawii* monitoring results, 1998-2013, Green Mountain Resort Macroplot 2. Washington Natural Area Program, Olympia, WA.

***Lupinus oreganus* – Kincaid’s lupine (Fabaceae)**

Current Status Summary

Synonym

Lupinus sulphureus var. *kincaidii*

Legal Status

Listed as Threatened under the US Endangered Species Act in 2000 (USFWS 2000).

Natural Heritage Rank

G4T2/S1S2 WA Endangered

Range

Endemic to the Willamette Valley of west-central Oregon and the southern Puget Trough in southwestern Washington (Lewis County). Historically, it was also known from southern British Columbia.

Number of Occurrences in Washington

This species was not known from Washington until 1986, when Cathy Maxwell discovered a population at Boistfort Prairie. An earlier collection deposited at the Oregon State University herbarium had been made in 1970 about 1 mile north of Toledo, but was initially misidentified and remained unknown until 1997. Kincaid’s lupine is presently known from three additional sites in Washington, all of which have been relocated since 2010 (most recently surveyed in 2017).

Abundance

Populations in Washington range in size from one individual to nearly 1100 (Arnett and Goldner 2017).

Habitat

Upland prairie remnants and open oak woodlands with slightly dry to mesic soils maintained by fire.

Threats

Conversion of prairie habitat to urban development and agriculture, competition from invasive weeds or brush, fire suppression or absence of grazing resulting in changes in community structure, and herbicide spraying.

Trends

Historically downward, due to extreme loss of prairie habitat in the south Puget Trough and Willamette Valley areas. In Washington, ocular estimates of lupine cover at two sites in 2016 suggested the populations were declining (Arnett and Goldner 2017, Ottombrino-Haworth et al. 2016) (Table 11) The cover of lupine plants at the Lozier Preserve has oscillated from 33% in 2012 to 15% in 2014 and back to 41% in 2017 (Reynolds personal communication).

Table 11. Summary of Washington Populations of *Lupinus oreganus*.

Element Occurrence #	Location	Lupine Cover in square meters (year)	Number of Stems (year)
1	Boistfort – Dairy (2016)	1040 (2016 – data from Ottombrino-Haworth et al. 2016); 4,000 (2006)	-
	Boistfort – Cemetery Hill (2016)	150 (2008); appears to be declining (2016)	-
3	Cowlitz Prairie-adjacent to School District property (2008)	286	250-300 (estimate)
	Cowlitz Prairie-Lozier Preserve (2017)	21.8 (2011), 33 (2012), 21 (2013), 15 (2014), 29 (2015), 34 (2016), 41.6 (2017)	980 (2011), 1,096 (2012), 753 (2013), 570 (2014), 643 (2015), 475 (2016) , 2136 (2017)
	Cowlitz Prairie-School District property (2016)	100 – 150 (calculated from number of plants)	333
4	Drews Prairie (2016)	1	1
5	Cowlitz Prairie, eastern end-south parcel of (2016)	1,040 (2010) appears to be declining without grazing (2016)	Not counted
	Cowlitz Prairie, eastern end-middle parcel (2012)	Not estimated-access has not been obtained.	Not estimated-access has not been obtained.
	Cowlitz Prairie, eastern end-north parcel (2012)	Small patches	Not counted

Managed Areas and Ownership

All known populations in the state are on private or tribal lands. Part of one occurrence is owned by the Toledo School District. A population is protected in the Lozier Prairie Preserve by the Cowlitz Indian Tribe.

2017 Research, Monitoring, and Updates

Monitoring

Nathan Reynolds, biologist with the Cowlitz Indian Tribe, coordinated annual monitoring of the Kincaid’s lupine population on the Lozier Prairie Preserve near Toledo in 2017. Reynolds’ team documented 2136 flowering stems and measured total foliar cover of lupine of 41.63 square meters. Both values are the highest recorded at the Lozier Preserve since monitoring began in 2011 (Reynolds 2016). The increase in inflorescences reverses a general decline since 2012, while the increase in foliar cover continues an upward trend since 2015.

In 2016, three blocks covering 45 square meters were each sown with 1500 seed in the first attempt to augment the Kincaid’s lupine population at the Lozier Preserve. Seeds were planted at a density of 100 per square meter. Seedlings were observed in nearly every square meter in two of the drier blocks in 2017, but did not become successfully established in the third, wetter block. A second set of four blocks was seeded in 2017 at a density of 49 seeds per square meter. Good seed production in the population in 2017 allowed for 6000-7000 seed to be collected for a third out-planting in a new 120 square meter area in 2018 (Nathan Reynolds, personal communication).

Other known occurrences in Washington were not revisited in 2017. The current status of the Washington populations is summarized in Table 11.

References

- Arnett, J. 2009. The Boistfort Valley: A Southwest Washington Prairie Remnant. Natural Heritage Report 2009-01. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 14 pp. + app.
- Arnett, J. 2010. Recovery of Kincaid's Lupine (*Lupinus sulphureus* ssp. *kincaidii*). Natural Heritage Report 2010-10. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.
- Arnett, J. 2014. Conservation Recommendations for Southwest Washington Prairie Species, Cowlitz, Drews, and Boistfort Prairies. Natural Heritage Report 2014-07. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.
- Arnett, J., K. Birkhauser, and T. Kemper. 2007. Southwestern Washington Prairies: Inventory and Conservation Planning for Rare Plants of Southwestern Washington Grasslands. Natural Heritage Report 2007-03. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.
- Arnett, J. and A. Goldner. 2017. Monitoring federally listed and candidate plant taxa in Washington state 2016. Natural Heritage Report 2017-03. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 63 pp + app.
- Arnett, J., J. Lantor, N. Reynolds, and J. Stellini. 2012. 2012-2016 Restoration and Management Plan for Kincaid's Lupine Conservation on the Hosquah Lozier Prairie Preserve near Toledo, Lewis County, Washington. Draft of January 31, 2012, on file at the Washington Natural Heritage Program, Department of Natural Resources, Olympia, Washington.
- Caplow, F. and J. Miller. 2004. Southwest Washington Prairies: Using GIS to find rare plant habitat in historic prairies. Natural Heritage Report 2004-02. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.
- Crawford, R. 2013. Vegetation/Landuse Map of Potential Habitat of Southwest Washington Prairie Species. Natural Heritage Report 2013-06. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.
- Crawford, R. and H. Hall. 1997. Changes in the South Puget Prairie Landscape. Pgs. 11-15 in Dunn, P.V. and K. Ewing. 1997. Ecology and Conservation of the South Puget Sound Prairie Landscape. The Nature Conservancy, Seattle, WA.
- Maxwell, C.L. 1991a. Vascular flora of the Willapa Hills and Lower Columbia River Area of Southwest Washington. In Plant Life of Washington State: Dungeness Spit, Willapa Hills, and Lower Columbia River. Douglasia Occasional Papers, Washington Native Plant Society Vol. 4.
- Maxwell, C.L. 1991b. Monitoring from May 1991 to August 1991 of *Delphinium leucophaeum* and *Lupinus sulphureus* var. *kincaidii* at Boistfort Valley, Lewis County, Washington. Report filed at the Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.
- Maxwell, C.L. 1994. Monitoring from May 1994 to August 1994 of *Delphinium leucophaeum* and *Lupinus sulphureus* var. *kincaidii* at Boistfort Valley, Lewis County, Washington. Report filed at the Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.

- Ottombrino-Haworth, A., R. Gleason, R.E. Curtin, and T.N. Kaye. 2016. Range-wide inventory of Kincaid's lupine (*Lupinus oregonus*), a federally-listed Threatened species. Institute for Applied Ecology, Corvallis, OR. 336 pp.
- Reynolds, N. 2015. Lozier *Lupinus oregonus* monitoring data-2014. Comprehensive data summary, 2011-2014. On file at Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.
- Reynolds, N. 2016. Lozier Kincaid's lupine (LUOR) sampling short report: 2016. Cowlitz Indian Tribe, Natural Resources Dept., Longview, WA. 4 pp.
- Severns, P.M. 2003. Propagation of a long-lived and threatened prairie plant, *Lupinus sulphureus* ssp. *kincaidii*. Restoration Ecology 11(3):334-342.
- Severns, P.M. 2008. Patterns of genetic diversity in Washington state populations of Kincaid's lupine (*Lupinus oregonus* var. *kincaidii* = *Lupinus sulphureus* ssp. *kincaidii*). Department of Botany and Plant Pathology, Oregon State University, Corvallis, OR. 15 pp.
- Severns, P.M., S.C. Meyers, and T. Tran. 2012. Taxonomic clarification of *Lupinus oregonus* and *Lupinus biddlei* in the Pacific Northwest, USA. Western North American Naturalist 72(3):407-411.
- U.S. Department of Agriculture, Soil Conservation Service. 1987. Soil Survey of Lewis County Area, Washington. In cooperation with Washington State Department of Natural Resources and Washington State University Agriculture Research Center.
- U.S. Fish and Wildlife Service. 2000. Endangered and Threatened Wildlife and Plants; Endangered status for "*Erigeron decumbens*" var. "*decumbens*" (Willamette daisy) and Fender's blue butterfly ("*Icaricia icarioides fenderi*") and Threatened status for "*Lupinus sulphureus*" ssp. "*kincaidii*" (Kincaid's Lupine). Federal Register 65(16): 3875-3890.
- U.S. Fish and Wildlife Service. 2006. Endangered and Threatened Wildlife and Plants; designation of Critical Habitat for the Fender's blue butterfly (*Icaricia icarioides fenderi*), *Lupinus sulphureus* ssp. *kincaidii* (Kincaid's lupine), and *Erigeron decumbens* var. *decumbens* (Willamette daisy); final rule. Federal Register 71(210): 63862-63910.
- U.S. Fish and Wildlife Service. 2010. Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington. U.S. Fish and Wildlife Service, Portland, Oregon. xi + 241 pp.

***Physaria douglasii* ssp. *tuplashensis* – White Bluffs bladderpod (Brassicaceae)**

Current Status Summary

Synonym

Lesquerella tuplashensis

Legal Status

Listed as Threatened under the ESA in December 2013 (US Fish and Wildlife Service 2013b).

Natural Heritage Rank

G4?T2/S1S2; WA Endangered

Range

Endemic to the White Bluffs area along a 17 km band on the east bank of the Columbia River in Franklin County, Washington.

Number of Occurrences in Washington

Known from a single population that is between 30 to 40 feet wide and extends for about 11 miles.

Abundance

Based on sampling from permanent monitoring plots, the population reached a peak abundance in 2011 with an estimated 58,887 plants. In 2016, the population declined to an estimated 7591 plants (Arnett and Goldner 2017, Newsome 2016). Following a cool and wet winter in 2016/17, the population rebounded to 58,472 in 2017 (Newsome 2017). Another 376 plants were located in 2017 in an out-planting west of the native population. This group included 65 surviving individuals from the original out-planted cohorts and 311 second-generation seedlings.

Habitat

Restricted to a cemented calcium carbonate (“caliche”) layer exposed along the rim and uppermost slopes of the White Bluffs above the Columbia River.

Threats

Landslides and erosion of bluff habitat (potentially enhanced by irrigation), trampling by off-road vehicles, competition from invasive weeds, and wildfire.

Trends

Over the past 20 years of monitoring, population numbers have oscillated around a relatively stable mean of approximately 23,000 individuals. The lowest numbers occurred in 2015 when only 2529 plants were estimated to occur. By 2017, the number had increased to 58,472. Trends may be influenced by short term fluctuations in winter and spring temperature or precipitation.

Managed Areas and Ownership

Hanford Reach National Monument (DOE), South Columbia Wildlife Area (WDFW).

2017 Research, Monitoring, and Updates

2017 Population Monitoring

On 25 May 2017, Heidi Newsome of the US Fish and Wildlife Service Mid-Columbia River National Wildlife Refuge Complex and a team of 8 volunteers conducted annual monitoring of 19 of 20 permanent transects for White Bluffs bladderpod. Newsome's team counted 30,026 plants, which represented a seven-fold increase from 2016 when only 4103 plants were observed (Newsome 2016, 2017a). Based on an extrapolation formula used for the past 20 years (Beck 1999, Caplow 2003), the total population for the White Bluffs area is estimated at 58,472 in 2017. This is the second highest total ever recorded for *Physaria douglasii* ssp. *tuplashensis* and reverses a five-year decline (Newsome 2017a). Individual transects ranged in size from 216-3,869 plants, for an average of 1,580 plants per transect.

Caplow (2003) recommended that management actions might be needed if populations in the monitoring transects fell below a threshold of 10,500 individuals for two consecutive years. This threshold was crossed in both 2014/15 and 2015/16 (Arnett and Goldner 2017). The marked increase in numbers in 2017 raises the 2016/17 average well above the critical threshold (the average for the past two years has increased from 5060 to 33,032).

2017 Out-Planting Monitoring

Heidi Newsome and University of Washington Rare Care initiated an experimental out-planting in 2013. A reintroduction site was chosen at the west end of the White Bluffs in Grant County. This site has similar soils and is also protected within the Hanford Reach National Monument. Plants were grown from seed beginning in fall 2012. The first cohort was planted in fall 2013, followed by three additional cohorts in fall 2014, spring 2015, and fall 2015. In all, 893 plants were planted from 2013-15. No additional out-plantings have been done since.

In May 2017, all nine out-planting transects were revisited. Newsome (2017b) reports that 65 of the original 893 out-planted individuals were still alive in 2017 (7%). Another 311 seedlings were counted in the transects. All of these seedlings were derived from the original set of out-planted individuals, indicating that the original cohorts were able to successfully become established, flower, and produce fruit and viable seeds. No individuals from the original 2013 cohort were still alive after 2016, but these plants produced seed giving rise to 141 seedlings in 2017. Only 12 out-planted individuals from 2014 were still alive, but 105 second generation seedlings have been produced by this group. Nineteen plants from the spring 2015 cohort and 26 from the fall 2015 group were still alive in 2017 and in two years these plants have produced 65 new seedlings (Newsome 2017b). Out-planted bladderpods had first-year survivorship rates of 84-96%, but then usually had a significant drop in survival the second year, with only 5-12% surviving in most plots. The one exception to this pattern were plants from the fall 2015 out-planting which had 60% survival in their second year in 2017, perhaps benefiting from the high precipitation levels in the winter of 2016/17 (Newsome 2017b). Between 0-8% survived to year three and to date no out-plants have made it to year four. These mortality rates are similar to

those observed in naturally-occurring plants. More significantly, surviving out-planted individuals flowered and produced fruit 1-2 years after introduction.

References

- Al-Shehbaz, I.A. and S.L. O’Kane. 2002. *Lesquerella* is united with *Physaria* (Brassicaceae). *Novon* 12: 319-329.
- Anderson, C. L. 2013. Sequence variation among *Physaria douglasii* isolates. University of Idaho Laboratory for Evolutionary, Ecological and Conservation Genetics.
- Arnett, J. 2012. Hanford endemic plants, population monitoring. Natural Heritage Report 2012-01. Washington Natural Heritage Program, Olympia, WA.
- Arnett, J. 2013. Hanford Endemic Plants Population Monitoring: Umtanum desert-buckwheat (*Eriogonum codium*) and White Bluffs bladderpod (*Physaria douglasii* ssp. *tuplashensis*). Washington Natural Heritage Program Washington Department of Natural Resources. Olympia, WA.
- Arnett, J. and A. Goldner. 2017. Monitoring federally listed and candidate plant taxa in Washington state 2016. Natural Heritage Report 2017-03. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 63 pp + app.
- Beck, K. 1999. Research and overview of *Lesquerella tuplashensis*, 1994-1998. Prepared for The Nature Conservancy of Washington by Kathryn Beck, Calypso Consulting, 29 pp.
- Caplow, F. 2003. Studies of Hanford Rare Plants, 2002. Prepared for Washington office of The Nature Conservancy. Natural Heritage Report 2003-04. Washington Natural Heritage Program, Washington Department of Natural Resources.
- Newsome, H. 2016. Annual update of the current status of *Physaria douglasii* ssp. *tuplashensis* on the Hanford Reach National Monument (2016). U.S. Fish and Wildlife Service Mid-Columbia River NWRC, Burbank, WA. Draft.
- Newsome, H. 2017a. Annual update of the current status of *Physaria douglasii* ssp. *tuplashensis* on the Hanford Reach National Monument (2017). U.S. Fish and Wildlife Service Mid-Columbia River NWRC, Burbank, WA. 14 pp.
- Newsome, H. 2017b. White Bluffs bladderpod experimental out-planting monitoring report 2017. U.S. Fish and Wildlife Service Mid-Columbia River NWRC, Burbank, WA. 17 pp.
- Newsome, H., F. Healy, and K. Lotz. 2016. White Bluffs bladderpod Experimental Out-planting Monitoring Report 2016. U.S. Fish and Wildlife Service Mid-Columbia River NWRC, Burbank, WA.
- Rollins, R.C., K.A. Beck, and F.E. Caplow. 1995. An undescribed species of *Lesquerella* (Cruciferae) from the state of Washington. *Rhodora* 97 (891): 201-207.
- U.S. Fish and Wildlife Service. 2009. Spotlight species action plan, White Bluffs bladderpod, *Physaria tuplashensis*. Region 1, Eastern Washington Field Office.
- U.S. Fish and Wildlife Service. 2012. Endangered and threatened wildlife and plants; threatened status for *Eriogonum codium* (Umtanum desert buckwheat) and *Physaria douglasii* ssp. *tuplashensis* (White Bluffs bladderpod). Proposed Rule. Federal Register 77 (94): 28704.

U.S. Fish and Wildlife Service. 2013b. Endangered and threatened wildlife and plants; threatened status for *Eriogonum codium* (Umtanum desert buckwheat) and *Physaria douglasii* ssp. *tuplashensis* (White Bluffs bladderpod) and designation of critical habitat. Final Rule; revision. Federal Register 78 (245): 76995-77004.

U.S. Fish and Wildlife Service. 2014. Spotlight Species Action Plan. White Bluffs bladderpod. Region 1, Eastern Washington Field Office.

***Sidalcea nelsoniana* – Nelson’s checker-mallow (Malvaceae)**

Current Status Summary

Legal Status

Listed as Threatened under the US Endangered Species Act in 1993 (US Fish and Wildlife Service 1993).

Natural Heritage Rank

G2G3/S1 WA Endangered

Range

Endemic to the Willamette Valley in western Oregon from Benton and Linn County north to Columbia County and in the southern Puget Trough of southwestern Washington in Cowlitz and Lewis counties.

Number of Occurrences in Washington

Known from two extant native populations in Washington, where it was first discovered in 1991. Both occurrences were revisited in 2014. Out-plantings have been installed at Ridgefield and Steigerwald Lake National Wildlife Refuges in Clark County.

Abundance

Based on 2014 surveys, naturally-occurring Washington populations range in size from 13-245 plants. Out-planted populations contained approximately 4300 plants in 2017.

Habitat

Moist prairie and grassland sites that may be seasonally flooded or have a high water table. Often associated with tall fescue (*Schedonorus pratensis*), velvetgrass (*Holcus lanatus*), sedges, and western buttercup (*Ranunculus occidentalis*) (Camp and Gamon 2011).

Threats

Threatened by conversion of wet prairie habitat to agriculture or human development, fire suppression allowing invasion of woody species, changes in hydrology, herbicide spraying along roadsides, competition from invasive weeds, and mowing. In Oregon, some populations are impacted by native seed-feeding weevils (US Fish and Wildlife Service 2010). *Sidalcea nelsoniana* can hybridize with other *Sidalcea* species where their ranges overlap (US Fish and Wildlife Service 2010).

Trends

Historically, the population trend is probably downward based on loss of wet prairie habitat over the past 150 years. One naturally-occurring population in Washington has been declining since it was first discovered in 1991, while the second population is stable to increasing (Arnett and Goldner 2017).

Managed Areas and Ownership

Introduced populations are found in Ridgefield National Wildlife Refuge and Steigerwald Lake National Wildlife Refuge. Native occurrences in the state are on private lands.

2017 Research, Monitoring, and Updates

Monitoring of Out-Planted Populations

As part of the recovery effort for *Sidalcea nelsoniana* (US Fish and Wildlife Service 2010), two new populations were established on suitable wet prairie habitat in Ridgefield National Wildlife Refuge in 2007 and Steigerwald Lake National Wildlife Refuge in 2011. These populations have been monitored annually since 2009 and 2013, respectively.

In 2017, Alex Chmielweski of the US Fish and Wildlife Service and others monitored each of the outplanted subpopulations at both wildlife refuges. Complete census counts were done for each subpopulation except for the largest one at Smith Lake in Ridgefield National Wildlife Refuge. This site is the most successful of the out-plantings but has become too dense with *Sidalcea nelsoniana* and other vegetation for individual checker-mallow plants to be easily discerned. Rather than being censused, the Smith Lake population was monitored using 16 randomly distributed 100 meter belt transects divided into 15-18 one square meter quadrats. Within each quadrat the cover of Nelson’s checker-mallow plants was estimated using modified Daubenmire cover classes (0, trace-5%, 5-25%, 25-50%, 50-75%, and 75-100%). Average cover of *S. nelsoniana* per transect was calculated using the median cover value in each plot. Frequency was also calculated. These values are summarized in Table 12. The 2017 percent

Table 12. Summary of Percent Cover and Frequency of *Sidalcea nelsoniana* at Smith Lake, Ridgefield NWR, 2017.

Based on 16 100-square meter transects.

Transect	Average Percent Cover	Average Percent Frequency
1	4.6	41
2	5.2	25
3	7.2	65
4	13.5	55.6
5	10.9	68.8
6	9.2	73.3
7	5.7	66.7
8	13	73.3
9	10.5	62.5
10	7.2	50
11	12.3	75
12	15.9	62.5
13	19.7	55.6
14	0.8	31.3
15	0.2	5.9
16	0.2	6.3
Average	8.5	51.1

cover and frequency data are not easily compared to previous count-based monitoring, but will provide a baseline to assess changes in abundance in the future (Chmielewski personal communication).

The other out-planted populations at Ridgefield National Wildlife Refuge exhibited a modest population increase in 2017, but overall have declined by 81-95% since the populations became established in 2009 (Table 13). The three subpopulations at Steigerwald Lake National Wildlife Refuge also showed a population increase from 2016 to 2017 (Table 14). The CLT (Straub) Field subpopulation has been stable since being established in 2011, but the two other subpopulations have declined by 68-98% (Chmielewski personal communication).

Table 13. Summary of Ridgefield NWR *Sidalcea nelsoniana* Out-Plantings, 2009-2017.

Survivorship is based on the percentage of flowering plants present each year relative to the original number of out-planted plugs

# Plants	2009	2010	2011	2012	2013	2014	2015	2016	2017
Smith Lake (estimated 1,846 plugs originally planted)									
Total Live Plants	1,710	1,554	2,142	1,435	1,500	1,990	2,947	3,871	No data (see Table 12)
Flowering plants	1,575	1,464	1,412	1,360	1,392	1,578	2,523	3,399	No data
Survivorship	85	79	76	74	75	85	137	184	No data
100 acre field north (160 plugs originally planted)									
Total Live Plants	104	97	82	86	51	58	57	30	37
Flowering plants	65	84	61	42	44	44	23	8	30
Survivorship	40	53	38	26	28	28	14	5	19
100 acre field south , the hacking tower site (400 plugs originally planted). Herbicide was inadvertently applied to part of the planting area in 2012.									
Total Live Plants	195	211	163	103	39	67	115	79	84
Flowering plants	163	188	146	25	30	67	94	72	78
Survivorship	41	47	36.5	6	8	17	24	18	18
Texas Island (100 plugs originally planted)									
Total Live Plants	53	34	28	39	15	6	7	4	5
Flowering plants	36	22	28	26	12	4	6	4	5
Survivorship	36	22	28	26	12	4	6	4	5

Table 14. Summary of Steigerwald Lake NWR *Sidalcea nelsoniana* Out-Plantings, 2011-2017.

Survivorship is based on the percentage of flowering plants present each year relative to the original number of out-planted plugs

# Plants	2011	2012	2013	2014	2015	2016	2017
CLT (Straub) Field (165 plugs)							
Total live plants	158	151	134*	168	141	125	163
Flowering plants	62	106	101*	147	131	101	157
Survivorship	39	70	61	89	79	61	95
Trailhead Pond (64 plugs)							
Total live plants	61	13	2	2	1	0	2
Flowering plants	38	8	1	1	0	0	1
Survivorship	62	13	2	2	0	0	2
East Stevenson (Office Road) Field (346 plugs)							
Total live plants	338	250	82	104	112	96	114
Flowering plants	230	207	66	104	87	82	111
Survivorship	67	60	19	30	25	24	32

*Fifteen plants were inadvertently sprayed in 2013.

References

- Arnett, J. 2009. The Boistfort Valley: A Southwest Washington Prairie Remnant. Natural Heritage Report 2009-01. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.
- Arnett, J., K. Birkhauser, and T. Kemper. 2007. Southwestern Washington Prairies: Inventory and Conservation Planning for Rare Plants of Southwestern Washington Grasslands. Natural Heritage Report 2007-03. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.
- Arnett, J., R. Crawford, and J. Rocchio. 2010. Recovery Actions for *Sidalcea nelsoniana* (Nelson's checkermallow) and *Lomatium bradshawii* (Bradshaw's lomatium) at Ridgefield National Wildlife Refuge. Natural Heritage Report 2010-04. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.
- Arnett, J. and A. Goldner. 2017. Monitoring federally listed and candidate plant taxa in Washington state 2016. Natural Heritage Report 2017-03. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 63 pp + app.
- Camp, P. and J.G. Gamon. 2011. Field Guide to the Rare Plants of Washington. University of Washington Press, Seattle, WA. 392 pp.
- Caplow, F. and J. Miller. 2004. Southwest Washington Prairies: Using GIS to find rare plant habitat in historic prairies. Natural Heritage Report 2004-02. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.

- Crawford, R. 2013. Vegetation/Landuse Map of Potential Habitat of Southwest Washington Prairie Species. Natural Heritage Report 2013-06. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.
- Dillon, J. 2007. Introduction of *Sidalcea nelsoniana* on the Ridgefield National Wildlife Refuge, Clark County, Washington.
- Dillon, J. 2011. Introduction of *Sidalcea nelsoniana* on the Steigerwald Lake National Wildlife Refuge, Clark County, Washington.
- Hitchcock, C.L. and A.R. Kruckeberg. 1957. A study of the perennial species of *Sidalcea*. Part I: taxonomy and Part II: Chromosome numbers and interspecific hybridizations. University of Washington Publications in Biology, Volume 18. University of Washington Press, Seattle, WA.
- Silvernail, I., A. Ottobrino-Haworth, L. Guenther, D. Andersen, R. Currin, M. Gisler, and T. Kaye. 2015. Range-wide inventory of Nelson's checkermallow (*Sidalcea nelsoniana*), a federally-listed threatened species. Report (in draft) to the US Fish and Wildlife Service. Cooperative agreement #F11AC00128. Institute for Applied Ecology, Corvallis, OR.
- U.S. Department of Agriculture, Soil Conservation Service. 1987. Soil Survey of Lewis County Area, Washington. In cooperation with Washington State Department of Natural Resources and Washington State University Agriculture Research Center.
- U.S. Fish and Wildlife Service. 1993. Determination of threatened status for the plant *Sidalcea nelsoniana* (Nelson's checker-mallow). Federal Register 58: 8235-8243.
- U.S. Fish and Wildlife Service. 2010. Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington. U.S. Fish and Wildlife Service, Portland, Oregon. xi + 241 pp.

***Sidalcea oregana* var. *calva* – Wenatchee Mountain checker-mallow (Malvaceae)**

Current Status Summary

Legal Status

Listed as Endangered under the ESA in 1999 (US Fish and Wildlife Service 1999).

Natural Heritage Rank

G5T1/S1?; WA Endangered

Range

Endemic to the Wenatchee Mountains of central Washington in Chelan County. Additional reports from Kittitas County have not been relocated since 1982 (including surveys in 2001, 2007, and 2010) and may be extirpated or was misidentified. Found in the East Cascades ecoregion.

Number of Occurrences in Washington

Known from five extant occurrences and seven historical or extirpated populations. Extant populations have all been discovered or relocated since 2001, most recently in 2017. Two of the extant populations may be false reports based on misidentifications.

Abundance

The largest population contains approximately 12,000 plants, while smaller occurrences have 8-300 individuals (US Fish and Wildlife Service 2004).

Habitat

Moist meadows with a high water table (or with surface water) well into summer. Also in openings in Douglas-fir forests and edges of shrub thickets. Found at elevations between 480-1000m (1600-3200 ft).

Threats

Conversion of habitat for agriculture or residential development, seed predation by weevils, succession due to absence of fire, and competition from invasive exotics.

Trends

Historically, trend has been downward. Over the past 20-30 years, at least two occurrences appear to be stable and one may be increasing (US Fish and Wildlife Service 2004).

Managed Areas and Ownership

Camas Meadows Natural Area Preserve, Colockum Wildlife Area (may be a false report), Wenatchee National Forest.

2017 Research, Monitoring, and Updates

Table 15. Location Data for *Sidalcea oregana* var. *calva* in Washington.

Populations indicated by a * may be mis-identifications

Population	County	Ecoregion	Ownership	Yr Last Obs	Status
Peshastin (EO # 003)	Chelan	East Cascades	unknown	1893	Considered historical and probably extirpated.
Leavenworth (EO # 004)	Chelan	East Cascades	Wenatchee NF	1904	Considered historical and probably extirpated
Tip Top (EO # 005)	Chelan	East Cascades	Wenatchee NF	1934	Considered historical and probably extirpated; John Gamon failed to relocate in 1987
Camas Meadows (EO # 009)	Chelan	East Cascades	Camas Meadows NAP, Wenatchee NF	2017	Largest known population, 8193 plants observed in 2017; total population estimated at 12,000 over 73 polygons.
*Colockum, S of Grouse Spring (EO # 011)	Kittitas	East Cascades	Colockum Wildlife Area	1980	No plants found in surveys in 1981, 2001, 2007, 2010; includes former EO 002. May be a misidentification.
Icicle Creek (EO # 012)	Chelan	East Cascades	Wenatchee NF	1893	Considered historical and probably extirpated
*Lost Lake Trail (EO # 015)	Kittitas	East Cascades	Wenatchee NF	1982	not relocated in 1987 - might be false report
Pendleton Canyon (EO # 016)	Chelan	East Cascades	Wenatchee NF	2001	Forest Service transect present; 2001: 150-200 plants
Upper Camas Land Meadow (EO # 019)	Chelan	East Cascades	Wenatchee NF	1987	Not relocated in 1999 or 2001, considered extirpated
Mountain Home Meadow (EO # 020)	Chelan	East Cascades	Private	2017	Population estimated at >100 plants in 2017. 2011: 2581 plants found in census. 2005: 2248 plants observed in census
Camas Creek tributary south (EO # 021)	Chelan	East Cascades	Private	2001	2001: 8 plants observed
FS Rd 120 (EO # 022)	Chelan	East Cascades	Wenatchee NF	2008	2008: 13 plants observed (1 flowering)

2017 Monitoring

The Camas Meadows Natural Area Preserve has the largest known population of Wenatchee Mountain checker-mallow and has been monitored every year since 2012. The area was originally surveyed and mapped in 1999-2000 and the population was estimated to contain 11,125 plants in at least 123 discrete patches. Since 2012 a subset of polygons have been mapped and counted each year. As of 2017, a maximum of 12,000 plants have been found in 73 polygons, suggesting that the population has been stable to increasing, though the number of patches may have declined.

In 2017, Joe Arnett, Dave Wilderman, and Emma Hoskins from DNR and Wendy Gible and volunteers from Rare Care mapped 23 polygons containing *Sidalcea oregana* var. *calva* at Camas Meadows NAP and counted 8,193 plants. This represented about 1/3 of the known checker-mallow polygons and about 68% of the total population. Two sets of 100 one square meter frequency plots were also read in a 2006 burn area and an unburned control. The burned plots had a frequency of 70%, while the control plots had a frequency of 90%. In the years before the burn and for two years afterwards, the burned plots had a higher frequency than the

unburned plots at this site, but that pattern changed from 2010 to the present. At another set of treatments (not re-read in 2017), the burned plots had consistently higher frequencies of checker-mallow plants from 2002 to 2016, including the years before and since the burn event.

Site Revisits

In addition to the annual monitoring at Camas Meadows NAP, one other population was revisited in 2017 by Pene Speaks. This occurrence is on private land that is in the state registry program. The population was not formally censused, but was estimated to contain over 100 individuals.

The current status of all known Wenatchee Mountain checker-mallow populations is summarized in Table 15.

References

- Arnett, J. 2011. *Sidalcea oregana* var. *calva* (Wenatchee Mountains checker-mallow) Monitoring and Inventory Washington Natural Heritage Program, Department of Natural Resources. Olympia, WA
- Arnett, J. 2012. Review of endemic plants of the Wenatchee Mountains and adjacent areas. Natural Heritage Report 2012-06. Washington Natural Heritage Program, Department of Natural Resources, Olympia.
- Arnett, J. and K. Birkhauser. 2008. Monitoring Seed Predation of *Sidalcea oregana* (Nutt.) Gray var. *calva* C.L. Hitchcock (Wenatchee Mountain checker-mallow). Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.
- Bleckinger, A.E. 2001. The monitoring and management of the endangered plant, *Sidalcea oregana* var. *calva* (Wenatchee Mountains checker mallow). Masters project submitted in partial fulfillment of the requirements for the Master of Environmental Management degree in the Nicholas School of the Environment and Earth Sciences of Duke University.
- Caplow, F. 2003. Report on the Status of *Sidalcea oregana* (Nutt.) Gray var. *calva* C.L. Hitchcock. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.
- Gamon, J. 1987. Report on the Status of *Sidalcea oregana* (Nutt.) Gray var. *calva* C.L. Hitchcock. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.
- Hitchcock, C.L. and A.R. Kruckeberg. 1957. A study of the perennial species of *Sidalcea*. Part I: taxonomy and Part II: Chromosome numbers and interspecific hybridizations. University of Washington Publications in Biology, Volume 18. University of Washington Press, Seattle.
- U.S. Fish and Wildlife Service. 1999. Determination of endangered status for *Sidalcea oregana* var. *calva* (Wenatchee Mountains Checker-Mallow). Federal Register 64:71680-71687.
- U.S. Fish and Wildlife Service. 2004. Recovery plan for *Sidalcea oregana* var. *calva* (Wenatchee Mountains Checker-mallow). U.S. Fish and Wildlife Service, Region 1, Portland, Oregon.
- U.S. Forest Service. 1999. SIORCA Monitoring Protocol. Report on file at the Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.

- U.S. Forest Service. 2004. SIORCA Statistical analysis and results. Report on file at the Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.
- Wilderman, D. 2015. Camas Meadows Habitat Restoration Final Project Report. USFWS Grant Agreement # F12AP00480. Natural Areas Program, Washington Department of Natural Resources.
- Wilderman, D. and F. Caplow. 2005. Ecological monitoring plan for: *Sidalcea oregana* var. *calva*. Site Name: Camas Meadows NAP. Washington Natural Areas Program, Washington Department of Natural Resources.

***Silene spaldingii* – Spalding’s catchfly (Caryophyllaceae)**

Current Status Summary

Legal Status

Listed as Threatened under the Endangered Species Act in 2001 (US Fish and Wildlife Service 2001).

Natural Heritage Rank

G2/S2; WA Threatened

Range

Southern British Columbia to western Montana, south to eastern Washington, northeastern Oregon, and north-central Idaho. In Washington, known from Adams, Asotin, Lincoln, Spokane, and Whitman counties in the Columbia Plateau ecoregion.

Number of Occurrences in Washington

Known from 49 extant occurrences and 3 historical or extirpated populations in Washington (Table 16). Thirty-five occurrences have been relocated or discovered since 2000, with 14 documented in 2017. The criteria used to define *Silene spaldingii* occurrences was standardized in 2009, resulting in the number of accepted occurrences dropping from 71 to 51 (Table 16) (Arnett and Holt 2009). These can be aggregated into 11 "Key Conservation Areas" (KCA) divided among three main physiographic provinces: Canyon Grasslands, Channeled Scablands, and Palouse Grasslands (Table 17, Figure 6) (Arnett and Goldner 2017). KCAs are the main focus of recovery efforts for the species across its range.

Abundance

Hill and Gray (2004) estimated the entire Washington population to be 5,264 plants (out of a total of 24,365 individuals across its full range). The state total may be closer to 12,000 plants after a large population was discovered at Asotin Creek Wildlife Area (estimated at 6000 plants) in 2008. Individual occurrences in Washington mostly range from 1 to 2000.

Habitat

Idaho fescue grasslands with sparse shrub cover or patchy grassland and Ponderosa pine. Sites typically have deep loamy soils. Washington populations occur at elevations of 470-1160m (1550-3800 ft). Populations are often restricted to small "eyebrows" of undisturbed habitat embedded within a matrix of agricultural fields.

Threats

Loss of habitat to agriculture or human settlements, competition with invasive exotic plants, wildfire, population and habitat fragmentation, grazing and trampling, herbicides, and off-road vehicle recreation (US Fish and Wildlife Service 2007).

Table 16. Location Data for *Silene spaldingii* in Washington.

Population	County	Ecoregion	Ownership	Yr Last Obs	Status
Pullman West (EO # 002)	Whitman	Columbia Plateau	state	1951	Historical, probably extirpated
Hill S of Winona (EO # 003)	Whitman	Columbia Plateau	unknown	1925	Historical; not relocated in 1990
Liberty Lake (EO # 005)	Spokane	Canadian Rockies	Private	1982	Not found in 1990 survey (but habitat good); 1982: 10 plants; 1979: 53 plants
Kramer Palouse Biological Study Area (EO # 006)	Whitman	Columbia Plateau	Kramer Palouse BSA	2017	2017: ca 400 plants; 2000: 216 plants 1981: 147 plants
Berry Lake, SW of Lamont (EO # 007)	Whitman	Columbia Plateau	unknown	1995	1995: 38 plants; 1980: ca 50; includes former EO 07 & 15
WSU Prairie preserve, Pullman (EO # 008)	Whitman	Columbia Plateau	Campus Prairie BSA (Washington State University)	2013	2014: no plants found, late in season, 2013: 3 plants; 1995: 18 plants; 1983: 33 plants
Upper Wawawai (EO # 009)	Whitman	Columbia Plateau	DNR, private (registry)	2002	2002: 3 plants; 1990: 17 plants; 1981: 21 plants
Spaulding Road (EO # 010)	Whitman	Columbia Plateau	Private	1990	1995: no plants found; 1990: 2 plants
Wawawai Eyebrows (EO # 011)	Whitman	Columbia Plateau	Private	1995	1995: 11 plants; 1983: 51 plants
Upper Steptoe Canyon (EO # 012)	Whitman	Columbia Plateau	DNR, private	1995	2013: no plants found; 1995: 18 plants; 1981: 34 plants
East Upper Steptoe Canyon (EO # 013)	Whitman	Columbia Plateau	unknown	1990	1995: not found; 1990: 4 plants; 1981: 12 plants; 1980, ca 40
Pitts Cemetery (EO # 014)	Whitman	Columbia Plateau	private	2017	2017: ca 50 plants. 2004: 41 plants; 1995: 62 plants; 1990: 60 plants; 1981: 12 plants
Gooseneck Steppe (EO # 016)	Asotin	Columbia Plateau	Private	1990	1995: not found; 1990: 59 plants; 1980: 60+ plants
Smoot Hill BSA (EO # 018)	Whitman	Columbia Plateau	Smoot Hill BSA (Washington State University)	1981	1981: 4 plants; not relocated in 1990, 1995, or 2014
Johnson-Pullman Rd (EO # 019)	Whitman	Columbia Plateau	Private	1981	1981: 9 plants; 1990: not found
Steptoe Butte (EO # 020)	Whitman	Columbia Plateau	Steptoe Butte State Park	2017	2017: observed but not censused; 2008: 10-20 plants; 1990: 15 plants
Cheney-Spangle Eyebrow (EO # 021)	Spokane	Columbia Plateau	Private	2005	2005: 3 plants; 1995: 5 plants
Strangland Road (EO # 022)	Spokane	Columbia Plateau	Private	1990	1990: 29 plants; 1995: not found
Tucker Prairie (EO # 023)	Spokane	Columbia Plateau	DNR	2002	2002: 9 plants; 1999: 12 plants; 1990: 46 plants
Armstrong (EO # 025)	Whitman	Columbia Plateau	Private	1995	1995: 48 plants; 1990: 21 plants
Mohler (EO # 026)	Lincoln	Columbia Plateau	BLM	2017	2017: 5 subpops monitored by BLM, 17 plants observed (pop estimated at 126). 2010: 68 plants; 2007: 58 plants; 1993: ca 123 plants

Table 16 continued					
Population	County	Ecoregion	Ownership	Yr Last Obs	Status
Sprague Parcel (EO # 027)	Lincoln	Columbia Plateau	BLM, private	2017	2017: 11 subpops visited & 23 plants observed. Pollinator survey conducted. 2014: observed; 2010: 246 plants; monitored by BLM since 1993
Pine Tree Lake (EO # 028)	Lincoln	Columbia Plateau	Private	1993	1993: 17 plants
Downs Lake (EO # 029)	Lincoln	Columbia Plateau	WA DNR	2007	2007: 1 plant; 1993: 25 plants
Crab Creek (EO # 030)	Lincoln	Columbia Plateau	BLM	2016	2016: 4 subpops visited with 61 plants 2014: observed; 2010: 1014 plants
Thorpe Steppe (EO # 031)	Spokane	Columbia Plateau	Private	1995	1995: 3 plants; 1994: 7 plants
Miller Ranch acquisition, Fishtrap Lake, Hog Lake (EO # 032)	Lincoln, Spokane	Columbia Plateau	BLM	2017	2017: 11 subpops visited with 73 plants. 2014: observed; 2010: 708 plants.
Fairchild AFB (EO # 044)	Spokane	Columbia Plateau	Fairchild Air Force Base	2017	2017: 134 plants observed. 2016: 141 plants; 2015: 91 plants 2013: 63 plants; 2004: 67 plants; 1994: 11 plants.
Watson Benchmark (EO # 045)	Lincoln	Columbia Plateau	BLM	2017	2017: Western portion monitored (after 2015 fire), pop estimated at 153 plants. 2014: observed; 2010: 150 plants
Rocky Ford (EO # 046)	Lincoln	Columbia Plateau	BLM	2016	2016: 2 subpops surveyed with 11 plants. 2014: observed; 2010: 580 plants
Coal Creek ACEC (EO # 048)	Lincoln	Columbia Plateau	BLM, Coal Creek ACEC	2017	2017: two new subpops discovered. Total of 12 subpops visited, and 160 plants observed. 2015: observed; 2010: 770 plants.
Sourdough Ridge (EO # 049)	Asotin	Columbia Plateau	Umatilla NF, Asotin Creek Wildlife Area	2017	2017: observed & monitored (data not available yet). 2015: ca 1200 plants
Prune Orchard Road (EO # 051)	Whitman	Columbia Plateau	private	1995	1995: 8 plants
Twin Lakes (EO # 052)	Lincoln	Columbia Plateau	BLM, private, state WDFW	2017	2017: 11 plants observed at 1 subpop. 2015: observed; 2010: ca 1055 plants
Rock Creek acquisition (EO # 059)	Whitman	Columbia Plateau	BLM, private	2016	2016: 3 subpops visited with 84 plants. 2014: observed; 2010: 275 plants
Clear Lake area (EO # 060)	Spokane	Columbia Plateau	WA DNR	2013	2013: 1 plant; 1999: 2 plants
Turnbull NWR/Pine Lakes (EO # 061)	Spokane	Columbia Plateau	Turnbull NWR	2017	2017: 67 plants counted in 9 monitoring plots; another 18 plants observed by Rare Care volunteers; 2016: 201 plants; 2012: 140 plants; 2002: 61 plants
Turnbull NWR/Cossalman Lake (EO # 062)	Spokane	Columbia Plateau	Turnbull NWR	2000	2002: 21 plants; not relocated in Rare Care surveys in 2002, 2009, 2011, or 2015
Rock Lake South (EO # 070)	Whitman	Columbia Plateau	Private	2001	2001: 1 plant

Table 16 continued					
Population	County	Ecoregion	Ownership	Yr Last Obs	Status
Rock Creek south (EO # 071)	Whitman	Columbia Plateau	Private	2001	2001: 15 plants
Negro Creek West (EO # 074)	Spokane	Columbia Plateau	Private	2001	2001: 9 plants
Negro Creek (EO # 075)	Spokane	Columbia Plateau	Private	2001	2001: 70 plants
Swanson Lake WA (EO # 078)	Lincoln	Columbia Plateau	WA DFW	2010	2010: 81 plants; 2002: 52 plants
Cheney (EO # 080)	Spokane	Columbia Plateau	unknown	1903	Historical and possibly extirpated
Rock Creek; Escure Ranch (EO # 083)	Adams	Columbia Plateau	BLM	2016	2016: 57 plants. 2014: observed; 2010: 66 plants
Telford Parcel (EO # 085)	Lincoln	Columbia Plateau	Swanson Lakes Wildlife Area	2015	2015: observed; 2010: ca 3060 plants
Blankinship Allotment (EO # 086)	Asotin	Columbia Plateau	BLM	2016	2016: 3 plants. 2004: 2 plants
Smoothing Iron Ridge (EO # 088)	Asotin	Columbia Plateau	Asotin Creek Wildlife Area	2009	2009: 10000 estimated (6010 counted)
Whelan Cemetery (EO # 089)	Whitman	Columbia Plateau	Private	2017	2017: ca 30 plants observed ;2005: 11 plants
Buffalo Eddy Nez Perce NHP, Snake River (EO # 090)	Asotin	Columbia Plateau	Nez Perce NHP	2007	2007: observed; 2006: 11 plants
NW of Hatten Lake (EO # 091)	Lincoln	Columbia Plateau	BLM	2008	2008: 20 plants (not visited in 2017)
Smoothing Iron Ridge (EO # 092)	Asotin	Columbia Plateau	Asotin Creek Wildlife Area	2015	2015: 39 plants

Trends

Declining over the past century as habitat has been lost to agriculture and development. Numbers may vary each year within a population due to prolonged dormancy of some mature individuals (not all plants produce above-ground stems each year, but persist below ground).

Managed Areas and Ownership

Asotin Creek Wildlife Area, Spokane Bureau of Land Management, Campus Prairie Biological Station, Coal Creek Area of Critical Environmental Concern, Fairchild Air Force Base, Kramer Palouse Biological Station, Nez Perce National Historic Park, Smoot Hill Biological Station, Washington Department of Fish and Wildlife, Washington Department of Natural Resources, Steptoe Butte State Park, Swanson Lakes Wildlife Area, Turnbull National Wildlife Refuge, Umatilla National Forest, private.

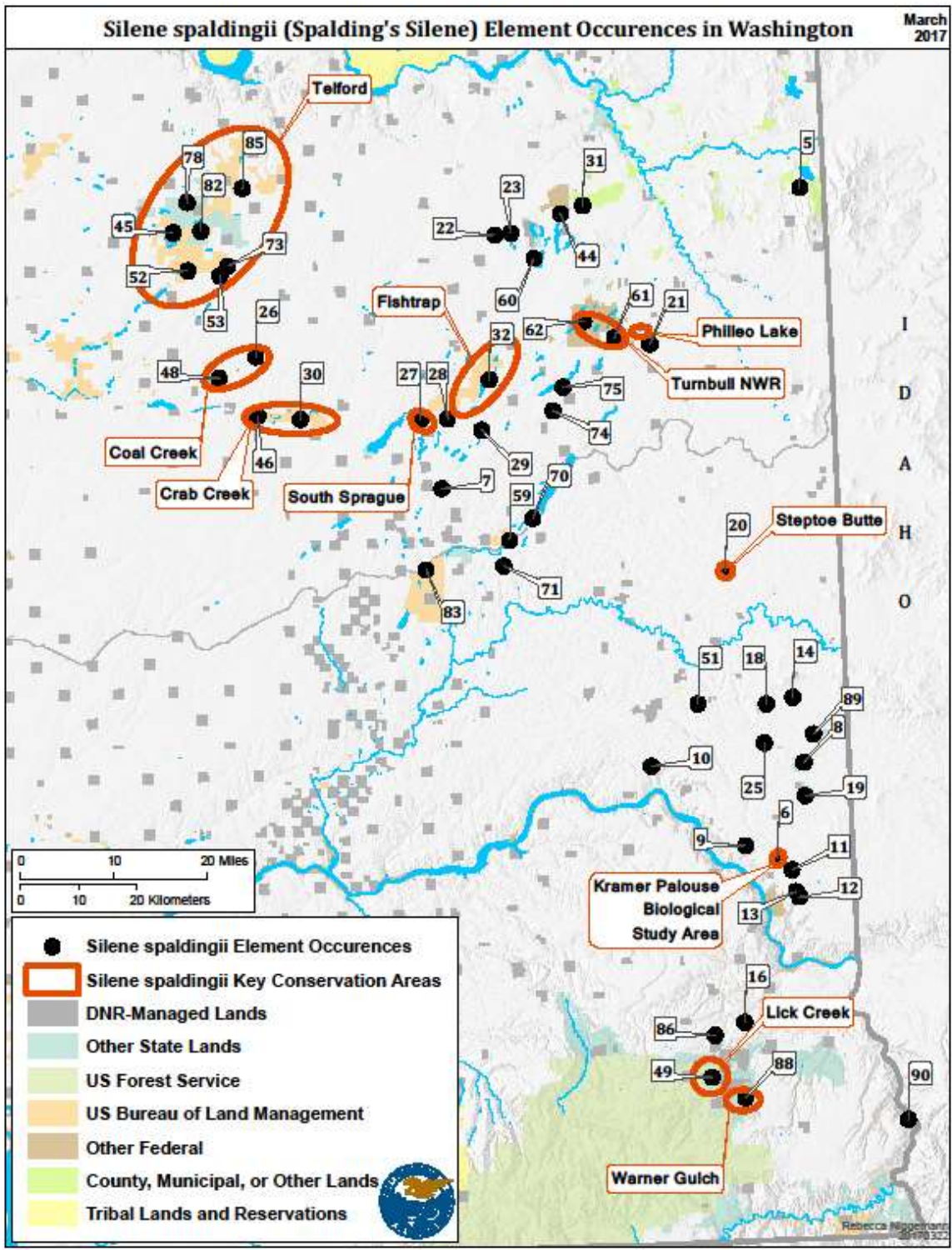


Figure 6. *Silene spaldingii* occurrences and Key Conservation Areas in Washington.

Table 17. *Silene spaldingii* Key Conservation Areas in Washington.

Key Conservation Area Name/Element Occurrences	Ownership	Physiographic Province	Number of Plants
Greater Telford (Eos 45, 52, 53, 73, 78, 82, 85)	Spokane BLM, Washington Dept of Fish & Wildlife	Channeled Scablands	ca 5400 plants (4500 on BLM, 900 on WDFW)
Crab Creek (Eos 30, 46)	Spokane BLM	Channeled Scablands	ca 2200 plants
Lick Creek (EO 49)	Umatilla NF	Canyon Grasslands	1200 plants
Coal Creek (Eos 26, 48)	Spokane BLM	Channeled Scablands	1000 plants
Fishtrap (EO 32)	Spokane BLM	Channeled Scablands	ca 700 plants
South Sprague (EO 27)	Spokane BLM	Channeled Scablands	ca 300 plants
Kramer Palouse Biological Study Area (EO 06)	Washington State University	Palouse Grasslands	ca 400 plants
Philleo Lake (no EO #, near EO 21)	USFWS	Channeled Scablands	0 plants (intended as a reintroduction site)
Warner Gulch (Smoothing Iron) (EO 88)	WA State Dept of Fish and Wildlife and Department of Natural Resources	Canyon Grasslands	ca 10,000 plants
Turnbull National Wildlife Refuge (Eos 61, 62)	USFWS	Channeled Scablands	ca 500 plants
Steptoe Butte (EO 20)	Washington State Parks	Palouse Grasslands	ca 10-20 plants

2017 Research, Monitoring, and Updates

2017 Monitoring

Mike Rule counted 67 Spalding’s catchfly plants in 9 monitoring plots on Turnbull National Wildlife Refuge in 2017. The population is nearly stable compared to monitoring in 2016 when 66 plants were found in just 7 of the 9 plots (Colson 2018). Another 18 plants were observed in the Turnbull NWR population by Rare Care volunteers in 2017 (EO # 061). Part of this occurrence may contain *Silene scouleri* instead of *S. spaldingii*. The total population at the site may be more than 500 (Mike Rule, personal communication). No plants were located in a second colony at Turnbull NWR (EO #062); this population has not been observed since 2000.

In October, 250 seedlings were planted at Turnbull NWR to augment the existing population. Twenty-eight one square meter plots were also direct-seeded. Monitoring in 2018 will determine whether the seeding was successful (Mike Rule, personal communication). Another seeding is planned for the Philleo Lake potential Key Conservation Area (Table 17, Figure 6) in the next two years. Currently, this site does not contain *Silene spaldingii* plants, but 1000 seedlings are planned for introduction in an area of 20 acres.

Julie Conley and James Rebholz of the US Fish and Wildlife Service conducted annual monitoring of the Fairchild Air Force Base population in August 2017 (Conley 2017). *Silene spaldingii* was observed at 8 of 10 monitoring locations on the base and a total of 134 plants was observed, which represented a modest decrease from the record 141 plants found in 2016. Overall trend at the site has been upward since 2014 and the population has almost doubled since 1999. Two plots that no longer contain *S. spaldingii* plants will be the focus of efforts to remove competing weed species and out-plant new plugs (Conley 2017).

Joe Arnett and James Riser (Palouse Conservation District) documented a small population of *Silene spaldingii* at Steptoe Butte in the summer of 2017. The north portion of the butte is a Washington State Park, while the south half is privately owned and managed for conservation (the area is being considered as a potential state Natural Area Preserve or Natural Resource Conservation Area) (Arnett 2017, Fertig et al. 2017). Riser planted 500 seedlings in two native prairie areas with low weed cover at Steptoe Butte in 2017 (Colson 2018).

Kim Frymire and colleagues from the BLM Spokane Field Office monitored 41 subpopulations of *Silene spaldingii* within six occurrences on BLM lands in eastern Washington in 2017. The BLM biologists documented 437-546 plants at these sites. In 2016, five other occurrences were monitored and 216 plants documented in 11 subpopulations (Table 16). Two new subpopulations were discovered at Coal Creek to expand the known area of that occurrence (Colson 2018).

James Riser surveyed populations of Spalding's catchfly at three sites in 2017. He found close to 400 plants at the Kramer Palouse Biological Study Area managed by Washington State University (Colson 2018). At Pitts Cemetery, Riser relocated tagged individuals and found additional untagged plants. The total population is close to 60 plants. Another cemetery site (Whelan Cemetery) contained about 30 individuals (Colson 2018).

In total, 14 occurrences of Spalding's catchfly in Washington were relocated in 2017 (representing 7 of the 11 designated Key Conservation Areas). These populations contained at least 1146-1259 plants (Table 16).

References

- Arnett, J. 2017. Steptoe Butte notes and recommendations. Washington Natural Heritage Program, Olympia, WA. 5 pp.
- Arnett, J. and J. Holt. 2009. *Silene spaldingii* (Spalding's catchfly) Species Review. Natural Heritage Report 2010-01. Washington Natural Heritage Program.
- Arnett, J. 2011. Spalding's Catchfly (*Silene spaldingii*), Annual site monitoring, Fairchild Air Force Base, 2011. Natural Heritage Report 2011-06. Washington Natural Heritage Program, Department of Natural Resources. Olympia, WA.
- Biodiversity Legal Foundation. 1994. Spalding's catchfly, *Silene spaldingii*, Draft petition for a rule to list the Spalding's Catchfly, *Silene spaldingii*, as "threatened" or "endangered" in the conterminous United States under the Endangered Species Act. In the office of endangered species, Fish and Wildlife Service, U.S. Department of the Interior.
- Caplow, F. 2001. Annual report for Spalding's Catchfly (*Silene spaldingii*) on Fairchild AFB, Washington. Washington Natural Heritage Program, Department of Natural Resources. Olympia, WA.
- Caplow, F. 2002a. Annual report for Spalding's Catchfly (*Silene spaldingii*) on Fairchild AFB, Washington. Washington Natural Heritage Program, Department of Natural Resources. Olympia, WA.
- Caplow, F. 2002b. *Silene spaldingii* Wats. (Spalding's catchfly) field inventory and management

- recommendations. Washington Natural Heritage Program, Department of Natural Resources. Olympia, WA.
- Caplow, F. 2003. Annual report for Spalding's Catchfly (*Silene spaldingii*) on Fairchild AFB, Washington. Washington Natural Heritage Program, Department of Natural Resources. Olympia, WA.
- Caplow, F. 2004. Annual report for Spalding's Catchfly (*Silene spaldingii*) on Fairchild AFB, Washington. Washington Natural Heritage Program, Department of Natural Resources. Olympia, WA.
- Colson, K. 2018. *Silene spaldingii* (Spalding's catchfly) Interim Tech team Meeting, Washington State call. January 11, 2018 Meeting Notes. US Fish and Wildlife Service. 4 pp.
- Conley, J.L. 2017. *Silene spaldingii* (Spalding's catchfly) fiscal year 2017 site monitoring report Fairchild Air Force Base, Spokane County, Washington. US Fish and Wildlife Service, Mid-Columbia River NWR Complex Land Management Research Demonstration Program, Burbank, WA. 18 pp + app.
- Fertig, W., J. Arnett, R. Niggemann, and A.S. Thorpe. 2017. Inventory for priority plant species in the East Cascades and Columbia Plateau ecoregions. Natural Heritage Report 2017-07. Washington Natural Heritage Program, Olympia, WA. 74 pp.
- Gamon, J. 1991. Report on the status of *Silene spaldingii* in Washington. Washington Natural Heritage Program, Department of Natural Resources. Olympia, WA.
- Heidel, B. 1980. *Silene spaldingii* Wats. (Spalding's catchfly). Compilation of reports by Kennison and Taylor (1979), the Washington Natural Heritage Program (1980), Sieeall (1979), and the compiler (Heidel 1979, 1980). On file at the Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.
- Heidel, B. 1995. Preliminary status report update for *Silene spaldingii* (Spalding's catchfly), a candidate species. Montana Natural Heritage Program, Helena MT.
- Hill, J. 2017. Spalding's catchfly: A monitoring challenge. Sage Notes 39(3):1, 4-8.
- Hill, J.L. and K.L. Gray. 2004. Conservation strategy for Spalding's Catchfly (*Silene spaldingii*). Conservation Data Center, Idaho Department of Fish and Game, Boise, ID.
- Hohn, J.E., P. Stine, W. White, and S. Wilbur. 1980. Panel session summary report, Spalding's silene (*Silene spaldingii* Wats.). Status recommended: Threatened. Report on file at Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.
- Lesica, P. 1987. A technique for monitoring nonrhizomatous, perennial plant species in permanent belt transects. Natural Areas Journal 7(2): 65-68.
- Lesica, P. 1992. The effects of fire on *Silene spaldingii* at Dancing Prairies Preserve. The Nature Conservancy, Helena, Montana.
- Lesica, P. 1993. Loss of fitness resulting from pollinator exclusion in *Silene spaldingii* (Caryophyllaceae). Madrono 40(4): 193-201.
- Lesica, P. 1997. Demography of the endangered plant, *Silene spaldingii* (Caryophyllaceae) in northwest Montana. Madrono 44(4): 347-358.

- Lesica, P. 1998. Spalding's catchfly: a regional endemic. Sage Notes 20(4): 10-11.
- Lesica, P., B. Adams, and C.T. Smith. 2016. Can physiographic regions substitute for genetically-determined conservation units? A case study with the threatened plant, *Silene spaldingii*. Conservation Genetics.
- Lesica, P. and B. Heidel. 1996. Pollination biology of *Silene spaldingii*. Prepared for The Nature Conservancy Montana Field Office.
- Lichthardt, J. and K. Gray. 2003. Development and implementation of a monitoring protocol for Spalding's catchfly (*Silene spaldingii*). Conservation Data Center, Idaho Department of Fish and Game, Boise, Idaho.
- Menke, C.A. and P.S. Muir. 2004. Short-term influence of wildfire on canyon grassland plant communities and Spalding's catchfly, a threatened plant. Northwest Science 78(3): 192-2003.
- Schassberger, L.A. 1988. Report on the conservation status of *Silene spaldingii*, a candidate threatened species. Montana Natural Heritage Program, Helena, MT.
- Siddall, J.L. and K.L. Chambers. 1978. Status Report for *Silene spaldingii*. Oregon rare and endangered plant project, Lake Oswego, OR and Oregon State University, Corvallis OR.
- Smith, C. and B. Adams. 2014. Population genetic structure of Spalding's Catchfly AFTC interim report. Abernathy Fish Technology Center, USFWS. In collaboration with Peter Lesica, Division of Biological Sciences, University of Montana, and Karen Colson, Idaho Fish and Wildlife Office, USFWS.
- U.S. Fish and Wildlife Service. 2001. Endangered and threatened wildlife and plants; final rule to list *Silene spaldingii* (Spalding's Catchfly) as threatened. Federal Register 66(196): 51598-51606.
- U.S. Fish and Wildlife Service. 2007. Recovery Plan for *Silene spaldingii* (Spalding's Catchfly). U.S. Fish and Wildlife Service, Portland, Oregon. xiii + 187 pages.
- Wentworth, J. 1996. Conservation recommendations for *Silene spaldingii* in Washington. Washington Natural Heritage Program, Department of Natural Resources. Olympia, WA.

Spiranthes diluvialis – Ute ladies' tresses (Orchidaceae)

Current Status Summary

Legal Status

USFWS Threatened (US Fish and Wildlife Service 1992).

Natural Heritage Rank

G2G3/S1; WA Endangered

Range

Occurs from northern Washington and southern British Columbia to southwest Montana, eastern Idaho, eastern Nevada, northern and central Utah, eastern Wyoming, western Nebraska, and central Colorado (Fertig et al. 2005). Washington populations are found in Chelan, Grant, and Okanogan counties in the Columbia Plateau, East Cascades, and Okanogan ecoregions (Figure 7).



Figure 7. Distribution of *Spiranthes diluvialis* (red dots) in Washington.

Number of Occurrences in Washington

Known from three extant occurrences in Washington. The site in Okanogan County was first discovered in 1997 and was relocated several times from 1998-2000. The population was considered extirpated before being relocated again in 2011. A larger population occurs at six sites along the Rocky Reach Reservoir of the Columbia River (Chelan County) and has been monitored each year from 2000-2017. In 2017, a new population was discovered east of the Columbia River near the Vantage substation (Grant County).

Abundance

The Okanogan occurrence was estimated to contain about 200 plants in 1998-2000, but the most recent cursory survey in 2011 documented 15 plants. At Rocky Reach, the population has ranged from a minimum of 959 plants in 2007 to 35 plants in 2015 (Over 90% of the population was burned by the Reach Fire in August 2015). Population numbers fluctuate at this site depending on the amount and duration of seasonal flooding along the river and impacts of late summer drought. The Grant County population contained approximately 23 plants in 2017. As a perennial geophyte with long-term dormancy, an unknown subset of plants may remain below ground each year, making trend data difficult to determine.

Habitat

In Washington, found in alkaline flats around lakeshores, seasonally flooded shorelines of large reservoirs along the Columbia River, and shallow depressions associated with storm runoff.

Threats

Changes in hydrology (permanent inundation under reservoirs or water withdrawal), loss of habitat to development or agriculture, herbicides, and vegetation succession.

Trends

Downward recently due to impacts of wildfire and high flood waters, but populations tend to be variable or oscillate in response to climate conditions.

Managed Areas and Ownership

Spokane Bureau of Land Management, Chelan County Public Utility District, Colockum Wildlife Area, Grant County Public Utility District.

2017 Research, Monitoring, and Updates

New Occurrence Discovered

On 24 August, 2017, Ken McDonald discovered a new population of *Spiranthes diluvialis* while conducting a survey of the Vantage to Pamona Heights Transmission line east of Wanapum Dam. This population is just the third to be documented in Washington and extends the known range of the species by about 65 miles (105 km) from the next nearest occurrence at Rocky Reach. The Vantage substation population is located in a densely vegetated depression below a culvert within a matrix of disturbed upland vegetation. Associated species include saltgrass (*Distichlis spicata*), rushes (*Juncus* sp.), giant helleborine (*Epipactis gigantea*) and purple loosestrife (*Lythrum salicaria*). By contrast, the other Washington occurrences are found along lakeshores or seasonally flooded terraces along the Columbia River. Across its range, *S.*

Table 18. Summary of *Spiranthes diluvialis* Monitoring on the Rocky Reach Reservoir, 2000-2017.

Adapted from Pope and Cordell (2017).

Year	PUD Pond	Gallagher Flat	Stocker	BLM	WDFW	PUD Beebe	Total
2000	185	7	60				252
2001	71	0	0				71
2002	128	1	46				175
2003	178	19	58				255
2004	193	15	172				380
2005	217	29	72	20			318
2006	180	18	173	25			396
2007	177	48	398	336			959
2008	193	43	182	135			553
2009	145	29	220	235	42	1	672
2010	153	43	168	280	109	1	754
2011	149	92	320	247	8	0	816
2012	64	64	177	150	2	0	439
2013	46	65	299	138	6	0	554
2014	39	78	392	149	7	0	665
2015	16	0	5	14	0	0	35
2016	33	11	182	134	36	0	396
2017	15	0	14	20	23	0	72

diluvialis is occasionally found in urban or other human-influenced environments, such as reclaimed gravel quarries, roadside barrow pits, levees, and irrigation ditches (Fertig et al. 2005).

McDonald (2017) included a high-quality image of *Spiranthes diluvialis* in his summary report that has been confirmed by experts. Only 23 individuals in flower and fruit were observed in two patches within the subirrigated depression.

Annual Monitoring at Rocky Reach

The Rocky Reach occurrence was monitored for the eighteenth consecutive year in 2017 by staff of Public Utility District Number 1 of Chelan County (Pope and Cordell 2017). Only 72 plants were observed in 2017, a decrease of 82% from 396 plants in 2016 (Table 18). *Spiranthes diluvialis* plants were found in just four of the six main subpopulations (none were observed at the Gallagher Flats and PUD Beebe sites). Individual subpopulations ranged from 14 plants at Stocker to 23 at Beebe Springs (WDFW site). 2017 marked the second year in the past three in which fewer than 100 plants were counted and continues a long-term decline since peak numbers were observed in 2007-2011. The 2017 count was the third lowest ever recorded for Rocky Reach since the population was first censused in 2000.

Unusual hydrologic conditions may account for the sharp decline in *Spiranthes diluvialis* numbers observed in 2017 (Pope and Cordell 2017). Flows of the Columbia River were significantly higher and lasted longer than the 10-year average from January through June, then were below average from July through September (DART 2017). As a result, emergence and flowering of *S. diluvialis* was delayed at many sites, and when plants did emerge, they were subject to drier conditions than normal. Pope and Cordell (2017) noted that surveys had to start later in August than usual and continued into September (later than usual) in order to record

flowering and fruiting. Plants are more difficult to observe in fruit, thus late-season surveys could have resulted in under-counting. Ute ladies' tresses also is capable of prolonged dormancy (Arft 1995) and so the number of emergent plants might have been lower than expected due to the longer than normal period of spring and early summer inundation.

In 2017 surveyors discovered two individuals of a second species of *Spiranthes* at the BLM subpopulation at Rocky Reach. Based on a photograph provided by Pope and Cordell (2017), these specimens are probably Hooded ladies tresses (*S. romanzoffiana*), a species that has previously been found at the Gallagher Flat site. Hooded ladies' tresses is more commonly found in the mountains to the north and west of the Columbia River. The plants might also be Western ladies' tresses (*S. porrifolia*), a rare species in Washington known from other locations downstream on the Columbia River and along Lake Chelan.

This year's large decline in Ute ladies' tresses at Rocky Reach is similar to 2015, when only 35 plants were observed in three of the six subpopulations (Pope and Cordell 2015). The state was in the middle of an extreme drought in 2014-15 and the flows of the Columbia River were well below average, resulting in drier habitat conditions than normal. A large wildfire also burned much of the area in 2015. The Rocky Reach population may still be recovering from the extreme events of 2014-15 and 2017. Other long-term monitoring studies of Ute ladies' tresses have found populations to oscillate when counts are based on flowering and fruiting individuals only, but to be relatively stable when dormant plants are considered (Fertig et al. 2005).

References

- Arft, A.M. 1995. The genetics, demography, and conservation management of the rare orchid *Spiranthes diluvialis*. PhD dissertation. University of Colorado, Boulder, CO.
- Arft, A.M., and T. Ranker. 1998. Allopolyploid origin and population genetics of the rare orchid *Spiranthes diluvialis*. *American Journal of Botany* 85:110-122.
- Arnett, J. 2012. *Spiranthes diluvialis* and other rare plants in Columbia River riparian habitats. Natural Heritage Report 2012-07. Washington Natural Heritage Program, Department of Natural Resources.
- Arnett, J. and A. Goldner. 2017. Monitoring federally listed and candidate plant taxa in Washington state 2016. Natural Heritage Report 2017-03. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 63 pp + app.
- Beck, K. 2004. *Spiranthes diluvialis* Survey, Rocky Reach, Washington, Chelan County PUD. Beck Botanical Services, Bellingham, WA 98225.
- Björk, C. 1997. *Spiranthes diluvialis* in Washington state (Okanogan County). Report prepared for the US Fish and Wildlife Service.
- DART. 2017. Columbia Basin Research, Columbia River Data Access Real Time (DART). University of Washington, Seattle, WA. (<http://www.cbr.washington.edu/dart/dart.html>).
- Fertig, W., R. Black, and P. Wolken. 2005. Rangewide status review of Ute Ladies'-Tresses (*Spiranthes diluvialis*). Prepared for the U.S. Fish and Wildlife Service and Central Utah Water Conservancy District. 101 pp.

- McDonald, K. 2017. Memorandum to Bureau of Land Management. Vantage to Pomona Heights Transmission Line Project- Floral Survey – orchid observation. Power Engineers, Anaheim, CA.
- McGonigle, T. and P. Sheridan. 2004. A study of root associated fungi of *Spiranthes diluvialis* in Idaho. Report prepared by Biological Sciences, Idaho State University.
- Pope, V.R. and K. Cordell. 2015. Rocky Reach Reservoir Ute Ladies' Tresses (*Spiranthes diluvialis*) Monitoring Report, 2015: Annual summary and weed control. Public Utility District No. 1 of Chelan County, Fish and Wildlife Department, Wenatchee, Washington.
- Pope, V.R. and K.A. Cordell. 2017. Rocky Reach Reservoir Ute Ladies' Tresses (*Spiranthes diluvialis*) Monitoring Report, 2017: Annual summary and weed control. Public Utility District No. 1 of Chelan County, Fish and Wildlife Department, Wenatchee, Washington. 25 pp.
- Sheviak, C.J. 1982. Biosystematic study of the *Spiranthes cernua* complex. New York State Museum Bulletin 448. 73 pp.
- Sheviak, C.J. 1983. United States terrestrial orchids – patterns and problems. In: Plaxton, E.D., ed. North American Terrestrial Orchids: Symposium II Proceedings and Lectures. Michigan Orchid Society.
- Sheviak, C.J. 1984. *Spiranthes diluvialis* (Orchidaceae), a new species from the western United States. *Brittonia* 36(1): 8–14.
- Sheviak, C.J. and P.M. Brown. 2002. *Spiranthes*. Pp. 530-545. In: Flora of North America Editorial Committee. Flora of North America North of Mexico. Volume 26. Magnoliophyta: Liliidae: Liliales and Orchidales. Oxford University Press, New York. 723 pp.
- Sipes, S.D., and V.J. Tepedino. 1995. Reproductive biology of the rare orchid, *Spiranthes diluvialis*: breeding system, pollination and implications for conservation. *Conservation Biology* 9(4): 929–938.
- Szalanski, A.L., G. Steinauer, R. Bischof, and J. Petersen. 2001. Origin and conservation genetics of the Threatened Ute ladies'-tresses, *Spiranthes diluvialis* (Orchidaceae). *American Journal of Botany* 88: 177-180.
- U.S. Fish and Wildlife Service. 1992. Endangered and threatened wildlife and plants; final rule to list the plant *Spiranthes diluvialis* as a Threatened species. *Federal Register* 57(12): 2048–2054.
- U.S. Fish and Wildlife Service. 1995. Ute ladies'-tresses (*Spiranthes diluvialis*) recovery plan. U.S. Fish and Wildlife Service, Denver, CO. 46 pp.
- U.S. Fish and Wildlife Service. 2004. Endangered and Threatened wildlife and plants; 90-day finding on a petition to delist the Ute ladies'-tresses orchid and initiation of a 5-year review. *Federal Register* 69(196):60605-60607.