



Status of Federally Listed
Plant Taxa in
Washington State
2018

Prepared for
U.S. Fish and Wildlife Service, Region 1

Prepared by
Walter Fertig
June 12, 2019



Status of Federally Listed Plant Taxa in Washington State

2018

Award Number F18AF01216

Report Date: June 12, 2019

Prepared for
U.S. Fish and Wildlife Service
Western Washington Fish and Wildlife Office
Region 1

Section 6 funding

by
Walter Fertig
Botanist

Washington Natural Heritage Program
Washington Department of Natural Resources
PO Box 47014
Olympia, WA 98504-7014

Cover: White Bluffs bladderpod (*Physaria douglasii* ssp. *tuplashensis*). Photo by Walter Fertig, WNHP, 24 May 2018.

Acknowledgements: Thanks to the following individuals for sharing data, providing reviews, or otherwise helping with this project:

Jane and Keith Abel, Joe Arnett, Molly Boyter, Paula Brooks, Tom Brumbelow, Natalie Cadoret, Tara Calloway, Jeff Chan, Alex Chmielewski, Karen Colson, Julie Conley, Kelly Cordell, Ernie Crediford, Darcy Dauble, Vicki Demetre, Peter Dunwiddie, Matt Fairbarns, Nathan Fisk, Kim Frymire, John Gamon, Mike Gregg, Wendy Gible, Rod Gilbert, Jamie Hanson, Anthony Hatcher, Jasa Holt, Betsy Kaiser, Tom Kaye, Stacy Kinsell, Terri Knoke, Sarah Krock, Peter Lesica, Laurie Malmquist, Amber Martens, Adam Martin, Heidi Newsome, Rebecca Niggemann, Von Pope, Tynan Ramm-Granberg, James Rebholz, Nathan Reynolds, Randi Riggs, James Riser, Joe Rocchio, Mike Rule, Sarah Shank, Mark Sheehan, Pene Speaks, George Thornton, Andrea Thorpe, Mary Water, Karen Weida, Dave Wilderman, and David Woodall.

My apologies (and thanks!) to anyone I may have omitted.

Table of Contents

Contents

Introduction.....	1
Discussion and Recommendations.....	3
References.....	4
<i>Arenaria paludicola</i> - Swamp sandwort (Caryophyllaceae).....	5
2018 Research, Monitoring, and Updates.....	5
Current Status Summary	5
<i>Castilleja levisecta</i> - Golden paintbrush (Orobanchaceae).....	8
2018 Research, Monitoring, and Updates.....	8
Current Status Summary	23
<i>Eriogonum codium</i> - Umtanum desert buckwheat (Polygonaceae).....	28
2018 Research, Monitoring, and Updates.....	28
Current Status Summary	33
<i>Hackelia venusta</i> - Showy stickseed (Boraginaceae).....	36
2018 Research, Monitoring, and Updates.....	36
Current Status Summary	37
<i>Howellia aquatilis</i> - Water howellia (Campanulaceae).....	40
2018 Research, Monitoring, and Updates.....	40
Current Status Summary	44
<i>Lomatium bradshawii</i> - Bradshaw's lomatium (Apiaceae).....	47
2018 Research, Monitoring, and Updates.....	47
Current Status Summary	49
<i>Lupinus oreganus</i> var. <i>kincaidii</i> - Kincaid's lupine (Fabaceae).....	52
2018 Research, Monitoring, and Updates.....	52
Current Status Summary	54
<i>Physaria douglasii</i> ssp. <i>tuplashensis</i> - White Bluffs bladderpod (Brassicaceae).....	57
2018 Research, Monitoring, and Updates.....	57
Current Status Summary	59
<i>Sidalcea nelsoniana</i> - Nelson's checker-mallow (Malvaceae).....	61
2018 Research, Monitoring, and Updates.....	61
Current Status Summary	62

<i>Sidalcea oregana</i> var. <i>calva</i> - Wenatchee Mountain checker-mallow (Malvaceae).....	65
2018 Research, Monitoring, and Updates.....	65
Current Status Summary	66
<i>Silene spaldingii</i> - Spalding's catchfly (Caryophyllaceae).....	69
2018 Research, Monitoring, and Updates.....	69
Current Status Summary	75
<i>Spiranthes diluvialis</i> - Ute ladies' tresses (Orchidaceae)	79
2018 Research, Monitoring, and Updates.....	79
Current Status Summary	81

Figures

Figure 1. Global population counts for <i>Castilleja levisecta</i> between 2004 and 2017.....	14
Figure 2. Change in abundance of the 12 largest <i>Castilleja levisecta</i> populations in Oregon and Washington over time	16
Figure 3. Estimated number of flowering plants of <i>Physaria douglasii</i> ssp. <i>tuplashensis</i> , 1997-2018.....	58
Figure 4. <i>Silene spaldingii</i> occurrences and Key Conservation Areas in Washington.....	74

Tables

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.....	6
Table 4. 2018 count of extant native and out-planted populations of <i>Castilleja levisecta</i> in Washington...9	
Table 5. Counted and extrapolated totals for all extant native <i>Castilleja levisecta</i> populations between 2006 and 2018.....	11
Table 6. 2018 counts of extant native and out-planted populations of <i>Castilleja levisecta</i> in British Columbia and Oregon.....	12
Table 7. Native and out-planted populations of <i>Castilleja levisecta</i> in Washington, British Columbia, and Oregon with status uncertain, abandoned, historical, or extirpated.....	13
Table 8. Minimum, maximum, long-term average, and 5-year average population counts for all extant and native outplanted <i>Castilleja levisecta</i> populations.....	20
Table 9. <i>Eriogonum codium</i> PVA monitoring and census data from 1995-2018.....	29
Table 10. Change in size and condition of mature <i>Eriogonum codium</i> plants in monitoring transects from 2016 to 2018.....	30
Table 11. Seed viability of unburned and burned <i>Eriogonum codium</i> seed following the 2017 Silver Dollar Fire.....	32
Table 12. Location data for <i>Howellia aquatilis</i> in Washington.....	41
Table 13. Monitoring and census data for <i>Lomatium bradshawii</i> at Lacamas Prairie NAP, Washington, from 1998-2018.....	48
Table 14. Summary of Washington populations of <i>Lupinus oreganus</i> var. <i>kincaidii</i>	53

Table 15. Location data for *Sidalcea oregana* var. *calva* in Washington.....66
Table 16. Location data for *Silene spaldingii* in Washington.....70
Table 17. *Silene spaldingii* Key Conservation Areas in Washington.....73
Table 18. Summary of *Spiranthes diluvialis* monitoring on the Rocky Reach Reservoir, 2000-2018.....80

Introduction

The Washington Natural Heritage Program (WNHP) was established in 1977 to provide a scientific approach for setting conservation priorities in the state. 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 information on the conservation status and distribution of rare plant and animal species and representative plant community types in Washington. Presently, 352 vascular plant and 59 non-vascular plant taxa are listed as state Endangered, Threatened, or Sensitive in Washington (WNHP 2018).

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, Fertig 2018). The following report contains a review of new information from 2018 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 name	Common Name	Family Name	Global Rank	State Rank	Status	
					WA	FWS
<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	S1	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. This table includes the status and rank values used in Table 1.

<p>Global Rank characterizes the relative rarity or endangerment of the element world-wide.</p> <p>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.</p> <p>G2 = Imperiled - At high risk of extinction or elimination due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>? = Inexact Numeric Rank - Denotes inexact numeric rank.</p> <p>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.</p>
<p>State Rank characterizes the relative rarity or endangerment within the state of Washington.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>A numeric range rank (e.g., S2S3 or S1S3) is used to indicate any range of uncertainty about the status of the species.</p>
<p>State 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.</p> <p>E = Endangered. In danger of becoming extinct or extirpated from Washington.</p> <p>T = Threatened. Likely to become endangered within the near future in Washington if the factors contributing to population decline or habitat loss continue.</p> <p>X = Possibly extinct or Extirpated. Documented to have previously occurred within Washington, but no longer thought to be present here.</p>
<p>FWS (Federal) Status under the U.S. Endangered Species Act as published in the Federal Register.</p> <p>E = Endangered. The plant is in danger of extinction throughout all or a significant portion of its range.</p> <p>T = Threatened. The plant is likely to become Endangered within the near future throughout all or a significant portion of its range.</p> <p>C = Candidate species. 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.</p>

Discussion and Recommendations

The status of the twelve listed Endangered and Threatened vascular plant species in Washington ranges from possibly extirpated to potentially recovering. Swamp sandwort (*Arenaria paludicola*) has not been observed in the state since 1976 and is considered extirpated, though no surveys have been undertaken to locate historical populations since 2006. Umtanum wild buckwheat (*Eriogonum codium*) numbers declined sharply in 2018 as a result of a large wildfire in July 2017 that burned about 60% of its limited habitat. Long-term monitoring data suggest that native populations of Golden paintbrush (*Castilleja levisecta*) and Ute ladies'-tresses (*Spiranthes diluvialis*) are declining. Other species, such as Water howellia (*Howellia aquatilis*) may be declining in Washington, but recent monitoring information is needed from many populations to determine if these are short term events or a long term pattern. The remaining seven listed species in Washington currently follow a stable or modest upward trend (such as Showy stickseed, *Hackelia venusta*).

The population sizes of several listed species have increased due to the success of out-plantings to create new occurrences or augment existing ones. The most successful out-planting effort has been for Golden paintbrush, which has exhibited a six-fold increase in population numbers since 2012, almost entirely due to newly established populations. Other species, such as Nelson's checkermallow (*Sidalcea nelsoniana*) and White Bluffs bladderpod (*Physaria douglasii* ssp. *tuplashensis*) have increased due to out-plantings, but the increase in abundance has been more moderate.

All of the state's listed Endangered or Threatened plant species would benefit from a regular schedule of population monitoring. For those species that are considered extirpated, site revisits might be scheduled less frequently, but ought to continue periodically 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, with selected sites revisited every 3-5 years. Annual monitoring should be implemented for species with significant management concerns, like *Eriogonum codium*, to ensure that trends are adequately detected or the species is responding to management changes. Species close to recovery, such as *Castilleja levisecta* and *Howellia aquatilis*, should also be monitored to ensure that delisting goals are being met (including post-delisting monitoring when appropriate). All of this monitoring activity should be a high priority for federal land management agencies and partner organizations, such as WNHP, the University of Washington's Rare Care program, and the Washington Native Plant Society. All organizations and agencies involved in Threatened and Endangered species management, recovery, and monitoring, should be encouraged to share their information with the state natural heritage program so that the cumulative dataset can be made available to all.

References

- Arnett, J. 2014. Monitoring federally listed and candidate plant taxa in Washington State 2011-2013. Prepared for the U.S. Fish and Wildlife Service, Region 1. Washington Natural Heritage Program, Department of Natural Resources. Natural Heritage Report 2014-09. November 20, 2014.
- Arnett, J. 2015. Monitoring federally listed and candidate plant taxa in Washington State 2014. Prepared for the U.S. Fish and Wildlife Service, Region 1. Washington Natural Heritage Program, Department of Natural Resources. Natural Heritage Report 2015-01. 64 pp.
- Arnett, J. 2016. Monitoring federally listed and candidate plant taxa in Washington State 2015. Prepared for the U.S. Fish and Wildlife Service, Region 1. Washington Natural Heritage Program, Department of Natural Resources. Natural Heritage Report 2016-01. January 26, 2016.
- Arnett, J. and A. Goldner. 2017. Monitoring federally listed and candidate plant taxa in Washington State 2016. Prepared for the U.S. Fish and Wildlife Service, Region 1. Washington Natural Heritage Program, Department of Natural Resources. Natural Heritage Report 2016-01. July 6, 2017.
- Fertig, W. 2018. Status of federally listed plant taxa in Washington state 2017. Natural Heritage Report 2018-02. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 77 pp.
- 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.
- Washington Natural Heritage Program. 2018. 2018 Washington vascular plant species of special concern. Natural Heritage Report 2018-04.1 Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 29 pp.

***Arenaria paludicola* - Swamp sandwort (Caryophyllaceae)**

2018 Research, Monitoring, and Updates

In August 2018, I conducted a brief survey for *Arenaria paludicola* in freshwater marsh and shrub riparian habitat in the Chehalis River Surge Plain Natural Area Preserve in southern Grays Harbor County. This preserve, managed by the Washington Department of Natural Resources, contains the largest and best quality tidal surge wetland in the state and is about 22 miles southwest of the historical Carlisle Bog occurrence. I was unable to locate any populations of *A. paludicola* at the site. The area may be too densely vegetated with *Phalaris arundinacea* (reed canarygrass) and other herbaceous and woody species to provide suitable habitat for *A. paludicola*, or the survey was done too late in the season for it to be readily located. To my knowledge, this was the first attempt to relocate *A. paludicola* since 2006, when the Carlisle Bog site was last surveyed (unsuccessfully).



Arenaria paludicola. Photo is a detail from Parish s.n., 1892, San Bernardino, CA (WS)

Arenaria paludicola is currently ranked SX (state extirpated) in Washington. Only one population has been confirmed for the state with an authenticated herbarium voucher (*Flett s.n.*, GH) collected in 1896 from “swamps near Tacoma” (Pierce County). According John Gamon (Natural Heritage Conservation Director at DNR, former WNHP state botanist and program manager), the Fletts had a dairy along Flett Creek in the Lakewood area, south of Tacoma. Although much of this area has been developed in the past 120 years, a few patches of marshy or swampy habitats are preserved in the area, including Seeley Lake Park and Wards Lake Park. Similar wetlands may also be present at the north end of nearby Joint Base Lewis-McChord. These and other boggy wetlands near the Pacific Coast in Grays Harbor and Pacific counties should be a high priority for future surveys of *Arenaria paludicola*.

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

Key Characteristics: *Arenaria paludicola* is a perennial herb characterized by opposite, linear to lance-shaped leaves, and glabrous, often shiny, stems up to 70 cm long (28 inches) that trail over the ground. Flowers occur singly on long, slender stalks and have 5 white, unlobed petals. Other Washington species in the Caryophyllaceae differ in having more egg-shaped leaves, hairy stems, flowers with 4 petals, or flowers with deeply bilobed petals.

Range: Central Mexico to Guatemala, with disjunct populations along the coast of central California and western Washington (Hartman et al. 2005). In the United States, it is presently known only from San Luis Obispo County, California. One verified occurrence is known from Washington (“swamps near Tacoma”) in Pierce County and the Puget Trough Ecoregion. Two other reports from Carlisle Bog in Grays Harbor County and Mud Mountain Dam in King County (Pacific Northwest Coast and North Cascades ecoregions) are based on observations and have not been relocated since 1976.

Number of Occurrences in WA: Known from 3 historical (and presumed extirpated) occurrences in Washington (Table 3). Seven other occurrences from Grays Harbor, Pacific, Pierce, San Juan, and Snohomish counties have been reported but are based on misidentified specimens (Gamon 1991; Consortium of Pacific Northwest Herbarium records, March 2019).

Abundance: Considered extirpated in Washington. Efforts to relocate populations in Washington occurred in 1981, 1987, 1990, 2005, 2006, and 2018 and have all been unsuccessful.

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

Table 3. Location data for *Arenaria paludicola* (Swamp sandwort) 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, Flett Creek? (EO # 008)	Pierce	Puget Trough	Private	1896	Presumed extirpated

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 impacted by competition from other wetland plants due to enhanced productivity from increased nutrient inputs (US Fish and Wildlife Service 2008).

Trends: Downward; probably extirpated in the state. One of two known native populations in California is now considered extirpated (last observed in 1985) and the other has declined by nearly 75% since 1998 (US Fish and Wildlife Service 2008). There have been three attempts to introduce this species into suitable habitat within its historical range in California, only one of which has been successful (Ventura Fish and Wildlife Office 2018). The taxonomic status and abundance of populations in Mexico and Central America is poorly known (Hartman et al. 2005).

Managed Areas and Ownership: Carlisle Bog Natural Area Preserve and private.

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)**

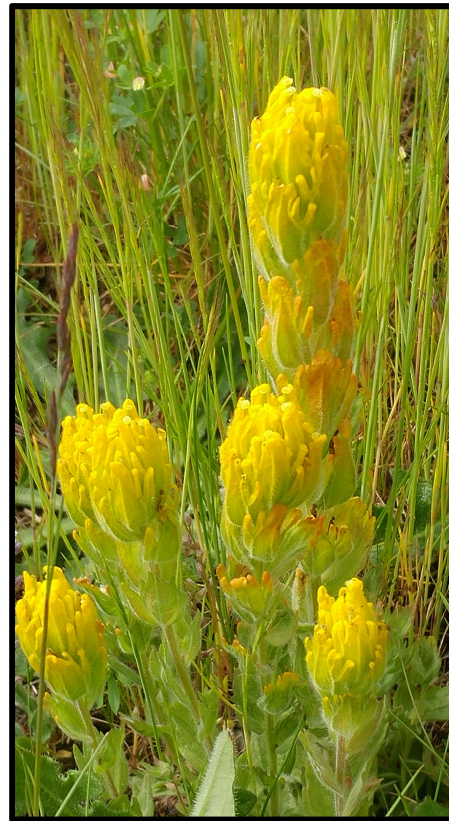
2018 Research, Monitoring, and Updates

Washington Surveys: In 2018, nine of the state's 10 extant naturally occurring populations of *Castilleja levisecta* were monitored by members of the Golden paintbrush technical team and citizen volunteers. A total of 4686 flowering individuals were observed at 8 of these sites (plants were present, but not counted at the ninth site) (Tables 4, 5). This was an increase of 2327 flowering plants from the count made in 2017 (Fertig 2018). Based on extrapolated population estimates for two other native extant occurrences (an additional 696 plants), the total number of naturally-occurring *C. levisecta* plants in Washington in 2018 is estimated at 5382 individuals (Tables 4, 5).

Twelve out-planted populations of *Castilleja levisecta* were monitored in 2018 and contained an estimated total of 190,638 flowering plants (Table 4). Nine of these are introduced populations and three are augmented native occurrences. The total number of flowering plants derived from out-planting increased by 12% from the 174,417 plants recorded in 2017 (Fertig 2018). 2018 marked the first time since out-planting began in 2001 in which all flowering plants were derived from established plugs (over three-years old) or seeds – making all of the observed flowering individuals eligible for recovery.

Including both naturally-occurring and introduced populations, the total number of flowering plants of *Castilleja levisecta* in Washington was estimated to be 195,324 in 2018 (Table 4). This is the highest number of *C. levisecta* plants ever reported for the state. Native occurrences represent 2.6% of the total population, while out-plantings contribute 97.4%.

Due to problems with hybridization between *Castilleja levisecta* and *C. hispida*, out-planted populations at Steigerwald National Wildlife Refuge, Tenalquot, and West Rocky Prairie do not meet recovery objectives for Golden paintbrush, and annual counts are no longer being conducted at these sites (Table 7). A fourth introduction site (Scatter Creek South) has been abandoned as management is shifting towards planting *C. hispida* to promote Taylor's checkerspot butterflies. In total, 13 native occurrences of *C. levisecta* from Washington are now considered extirpated and another 12 introduced populations have failed to become established or been abandoned (Table 7).



Castilleja levisecta at Smith Prairie, Whidbey Island, May 2018.

Table 4: 2018 counts of extant native and out-planted populations of *Castilleja levisecta* in Washington. Out-plants applicable to recovery are those grown on site from seed, from a plug persisting on the site for 3 or more years, or reproduction from out-plantings. Extirpated native populations and failed or abandoned out-plantings are listed in Table 7.

Population	County	Out-Planted	Naturally-Occurring	Applicable to Recovery
Cavness	Thurston	121,550	0	121,550
Glacial Heritage Preserve	Thurston	40,724	0	40,724
Mima Mounds Natural Area Preserve	Thurston	6,314	0	6,314
Rocky Prairie NAP (EO #011)	Thurston	0	3,183	3,183
San Juan Island, American Camp	San Juan	15	0	15
San Juan Island, Cady Mountain	San Juan	30	0	30
San Juan Island, False Bay Middle (EO #020)	San Juan	95	4	99
San Juan Island, False Bay South (EO #024)	San Juan	0	38	38
San Juan Island, San Juan Valley (no EO #)	San Juan	0	96	96
San Juan Island, West Side Preserve	San Juan	7	0	7
USFWS Headquarters, Dungeness	Clallam	1,304	0	1,304
Whidbey Island, Admiralty Inlet NAP, Naas Prairie Unit and North Bluff (EO #009a)	Island	1,123	364	1,487
Whidbey Island, Admiralty Inlet NAP, South Bluff Prairie Unit (EO #009b)	Island	386	29	415
Whidbey Island, Ebey's Landing	Island	373	0	373
Whidbey Island, Forbes Point (EO #016)	Island	75	19	94
Whidbey Island, Fort Casey (EO #005)	Island	72	953	1,025
Whidbey Island, Hill Road – Ebey's Landing (EO #021)	Island	0	Present (no data)	0
Whidbey Island, Smith Prairie, PRI	Island	9,458	0	9,458
Whidbey Island, West Beach (EO #012)	Island	0	No data	0
Wolf Haven, Tenino	Thurston	9,112	0	9,112
TOTAL		190,638	4,686	195,324

British Columbia Surveys: The three extant occurrences of *Castilleja levisecta* in Canada were re-surveyed in 2018. Matt Fairbarns of Aruncus Consulting counted 131 mature flowering individuals on Alpha Islet and 801 flowering plants on Trial Island (Table 5). Both counts represent a decrease of 20-35% from the long-term average for these native populations (Table 8). Only four plants were found at the experimental out-planting on Mini D'Arcy Islet established in 2009 (Table 5). This population was re-seeded in October 2018 to boost recovery (Nathan Fisk of Parks Canada, personal communication to Jamie Hanson of USFWS, 2018). Eight other historical populations are known from the province and were last observed between 1887 and 1991 (Table 7).

Oregon Surveys: Tom Kaye of the Institute for Applied Ecology and others monitored 25 of 26 established out-planted populations in Oregon and estimated 364,811 flowering individuals (Table 6). This total represented an increase of 189% from the 126,002 plants documented in 2017 (Fertig 2018). Counts from just four populations (Pigeon Butte, Fern Ridge, Howell Savanna, and Bellfountain Prairie) accounted for 95.7% of the total population in 2018. As in Washington, all of the out-planted individuals counted in 2018 represented plants eligible for recovery based on their origin from direct seeding or plugs planted more than three years earlier. Oregon formerly contained at least five native populations of *Castilleja levisecta*, all of which were last seen in 1936 and are considered extirpated. Another three out-plantings in the state are considered to have failed and the status of four recently established introductions has not been verified (Table 7).

Rangewide Population Totals and Trends: The total, range-wide population of *Castilleja levisecta* reached a new high of an estimated 561,071 flowering stems in 2018. This represents an increase of 90% from the 294,469 flowering stems reported in 2017 (Figure 1). Since 2011, the range-wide population has increased by 535,557 from 25,502 flowering plants. Individuals derived from out-plantings (either in introduced populations or augmented wild occurrences) represented 98.8% of the total population in 2018 (555,432 flowering plants). The eleven largest out-plantings in Oregon and Washington (Figure 2) contained 538,161 flowering plants, or 96.8% of the total number of introduced plants.

Counts of native occurrences in Washington and British Columbia increased from 2359 flowering plants in 2017 to 5618 in 2018 (Table 5). Part of this increase may be due to using census data in 2018 vs. estimated population size in 2017 for the populations from Alpha Islet, Trial Island, and Rocky Prairie. Arnett and Goldner (2017) derived a system for estimating population numbers for missing years based on the average incremental difference between pairs of years with census data (Table 5). 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 downward trend from 2012-2018 for the 12 extant naturally-occurring populations of *Castilleja levisecta* in Washington and British Columbia (Table 5, Figure 1). The highest count of native populations occurred in 2008 with an estimated 20,921 flowering plants; since then the abundance of native plants has decreased by 231%.

Table 5. Counted and Extrapolated Totals for all extant native *Castilleja levisecta* populations between 2006 and 2018. Extrapolations are shown in [] and are derived from incrementally averaged changes in population numbers between years with actual count data. Totals do not include augmentation from out-planted individuals.

British Columbia													
Population	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Alpha Islet	165	155	[153]	[151]	[149]	[147]	[144]	[142]	[140]	[138]	[136]	[134]	131
Trial Island	3192	[3089]	[2985]	[2881]	[2777]	[2673]	[2569]	2465	[2132]	[1800]	[1468]	[1135]	801
Washington													
Population	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rocky Prairie NAP (EO# 11)	[7834]	[8613]	9392	[8322]	[7252]	6183	8910	[7240]	5569	[4583]	3597	[3390]	3183
San Juan Isl. False Bay Middle (EO#20)	54	40	42	33	32	20	11	22	16	6	5	28	4
San Juan Isl, False Bay South (EO#24)	312	401	453	407	319	430	193	245	321	232	134	171	38
San Juan Isl., San Juan Valley (no EO#)	[6296]	[5676]	[5056]	[4436]	[3816]	[3196]	[2576]	[1956]	1336	477	664	466	96
Whidbey Isl., Admiralty Inlet NAP, Naas Prairie (EO#9a)	94	86	148	241	274	347	1128	841	658	537	404	550	364
Whidbey Isl., Admiralty Inlet NAP, South Bluff (EO# 9b)	[80]	[80]	[80]	[80]	80	71	67	103	109	94	57	46	29
Whidbey Isl., Forbes Point (EO#16)	260	105	201	56	50	18	54	84	108	60	40	27	19
Whidbey Isl., Fort Casey (EO#5)	760	1544	1713	1497	1538	2471	2534	1196	227	952	1004	375	953
Whidbey Isl., Hill Road - Ebey's Landing (EO#21)	214	747	601	[1044]	1487	1984	2656	4612	2191	883	766	687	[687]
Whidbey Isl., West Beach (EO#12)	189	69	97	75	47	65	20	14	18	24	11	9	[9]
WA & BC Counted Total	5240	3147	12647	2309	3827	11589	15573	9582	10553	3265	6682	2359	5618
WA & BC Extrapolated Total []	14210	17458	8274	16914	13994	6016	5289	9338	2272	6521	1604	4659	696
Counted & Extrapolated Grand Total	19450	20605	20921	19223	17821	17605	20862	18920	12825	9786	8286	7018	6314

Table 6: 2018 counts of extant native and out-planted populations of *Castilleja levisecta* in British Columbia and Oregon. Out-plants applicable to recovery are those grown on site from seed, from a plug persisting on the site for 3 or more years, or reproduction from out-plantings. Table does not include out-planted populations that have failed to become established or are extirpated (see Table 7)

Population	Land District/ County	Out-Planted	Naturally-Occurring	Applicable to Recovery
British Columbia				
Alpha Islet	Victoria	No data	131	131
Mini D'Arcy Islet, Gulf Islands National Preserve	Victoria	4	0	4
Trial Island	Victoria	No data	801	801
Total # of Flowering Plants in BC in 2018		4	932	936
Oregon				
Ankeny National Wildlife Refuge (NWR)	Marion	256	0	256
Bald Hill Park	Benton	4	0	4
Bald Top (Bluebird Strip) Finley NWR	Benton	3,411	0	3,411
Baskett Butte East, Baskett Slough NWR	Polk	1,468	0	1,468
Baskett Butte West, Baskett Slough NWR	Polk	2,375	0	2,375
Beazell Memorial Forest	Benton	1,369	0	1,369
Bellfountain Prairie, Finley NWR	Benton	24,263	0	24,263
Carnine	Lane	144	0	144
Cooper Mountain Nature Park	Washington	250	0	250
Coyote Prairie	Lane	220	0	220
Dorena Lake	Lane	4	0	4
Fern Ridge	Lane	50,820	0	50,820
Field 1, Finley NWR	Benton	390	0	390
Field 29, Finley NWR (includes large east and west plots from previous years)	Benton	3,333	0	3,333
Fitton Green	Benton	856	0	856
Graham Oaks	Clackamas	32	0	32
Herbert Farm	Benton	3	0	3
Holyer	Lane	19	0	19
Heritage Jefferson	Marion	3	0	3
Howell Savanna	Multnomah	49,208	0	49,208
Lupine Meadows Preserve	Benton	579	0	579
Peach Cove	Clackamas	No data	0	0
Pearcy-Schoener Caldwell Hill	Benton	353	0	353
Pigeon Butte, Finley NWR (includes Fender's Prairie from previous years)	Benton	224,814	0	224,814
Tualatin River NWR	Washington	605	0	605
Wild Iris Ridge	Lane	32	0	32
Total # Flowering Plants in OR in 2018		364,811	0	364,811

Table 7: Native and out-planted populations of *Castilleja levisecta* in Washington, British Columbia, and Oregon with status uncertain, abandoned, historical, or extirpated.

Population	Land District/ County	Year Last Observed	Status
British Columbia			
Beacon Hill	Victoria	1991	Presumed Extirpated, not relocated in 1993
Cedar Hill	Victoria	1887	Extirpated
Dallas Cliffs	Victoria	1887	Extirpated
Foul Bay/Clover Point	Victoria	1918	Extirpated
Lost Lake (Blenkinsop Lake)	Victoria	1945	Extirpated
Oak Bay	Victoria	1900	Extirpated
Sidney	North Saanich	1927	Extirpated
Wellington	Nanaimo	1898	Extirpated
Oregon			
Bonneville	Multnomah	1905	Extirpated
Brownsville	Linn	1922	Extirpated
Field 31, Finley NWR	Benton	2014	Failed out-planting
Fort Hoskins	Benton	2017	Status uncertain
Kingston Prairie Preserve	Marion	2010	Failed out-planting
Lebanon	Linn	1929	Extirpated
Noble Oaks	Polk/Yamhill	2017	Status uncertain
Oak Creek	Benton	2011	Failed out-planting
Peterson Butte	Linn	1938	Extirpated
Salem	Marion	1916	Extirpated
Willow Creek Hayfield	Lane	2017	Status uncertain
Yamhill Oaks South	Yamhill	2017	Status uncertain
Washington			
Alki Point (EO #22)	King	1906	Extirpated
Cedar Rock Reserve, Shaw Island	San Juan	2007	Failed out-planting
Davis Point (EO #23)	San Juan	1995	Presumed Extirpated; not relocated in surveys in 1999, 2002, or 2008
Kah Tai Prairie	Jefferson	2016	Abandoned
Long Island (EO #27)	San Juan	2002	Presumed extirpated
Lopez Island, Flint Beach	San Juan	2015	Abandoned
Lopez Island, Iceberg Point	San Juan	2017	Abandoned
Mill Plain (Ft. Vancouver) (EO #10)	Clark	1889	Extirpated (type locality)
Port Ludlow (EO #19)	Jefferson	1890	Extirpated
Port Townsend (EO #13)	Jefferson	1900	Extirpated
Protection Island	Jefferson	2017	Failed out-planting; to be reinitiated
Roy (EO #18)	Pierce	1889	Extirpated
San Juan Island, Cattle Point (EO #3)	San Juan	1936	Extirpated
San Juan Island, False Bay North (EO #25)	San Juan	2004	Presumed Extirpated
San Juan Island, Friday Harbor (EO #2)	San Juan	1923	Extirpated
San Juan Island, Kanaka Bay (EO #1)	San Juan	1917	Extirpated

Population	Land District/ County	Year Last Observed	Status
Scatter Creek South	Thurston	2017	Abandoned; site will be managed for <i>Castilleja hispida</i> (Taylor's checkerspot habitat) in future
Steigerwald National Wildlife Refuge (O)	Clark	2018	Out-planting contains hybrid plants; needs to be re-started once hybrids are removed
Tenalquot (O)	Thurston	2017	Out-planting with high percentage of hybrid plants; abandoned as a recovery site in 2017
Waldron Island, Bitte Baer Preserve	San Juan	2015	Failed out-planting
West Rocky Prairie (O)	Thurston	2017	Out-planting with high percentage of hybrid plants; abandoned as a recovery site in 2017
Whidbey Island, Deception Pass & Lighthouse Point (EO #14)	Skagit	1980	Presumed extirpated; could not be relocated in 1982 or 1983
Whidbey Island, NPS Ebey Overlook	Island	2010	Failed out-planting
Whidbey Island, Oak Harbor (EO #17)	Island	1929	Extirpated
Whidbey Island, Perego's Bluff	Island	2016	Failed out-planting
Whidbey Island, Sherman Farm Field	Island	2015	Abandoned

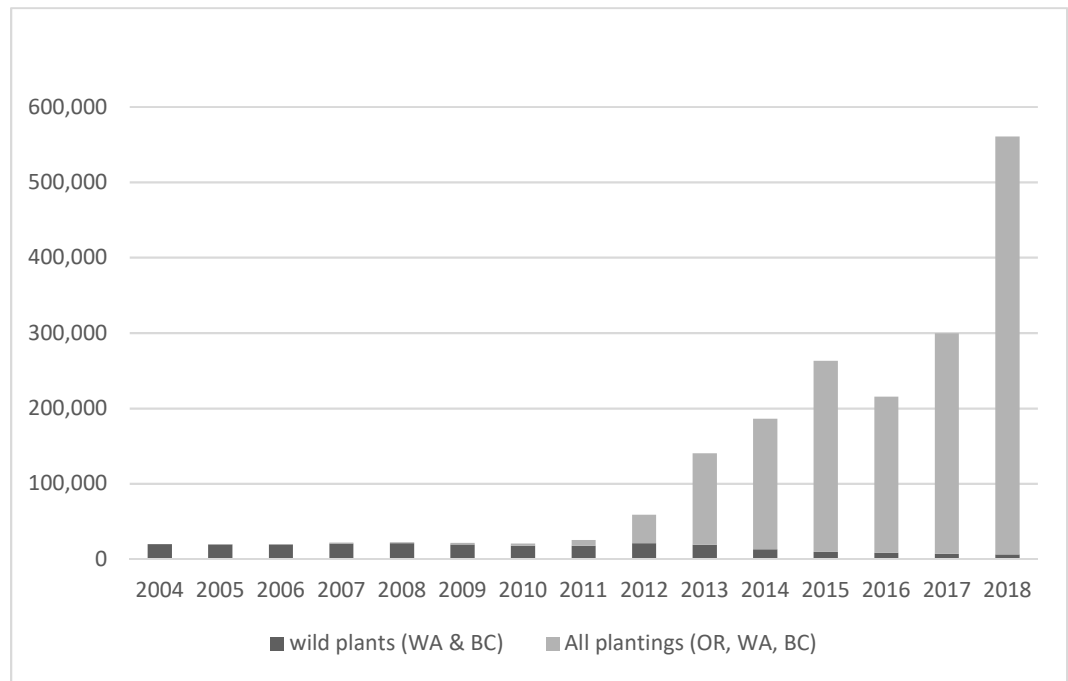


Figure 1. Global population counts (wild, planted, and total) for *Castilleja levisecta* between 2004 and 2018. Wild population numbers include census and extrapolated estimates (see Table 5).

Population size can vary markedly from year to year in monitored populations, depending on climatic conditions and survivorship of out-planted individuals. These fluctuations are summarized in Table 8, 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 (2014-2018).

There is great variability in population size both between populations and between years within a population. The five- and ten-year average population size is typically 1/3 to 1/2 smaller than the maximum count (Table 8). For 10 of the 12 native occurrences, the average numbers over the last five years are smaller than the long-term average, suggesting these populations are declining. The large native occurrence at Rocky Prairie NAP has been in an overall decline since 1983, punctuated by intermittent periods of oscillation (Figure 2). The two native occurrences that have increased (Admiralty Inlet Naas Prairie and Bluff units) have both been augmented by out-plantings that are now more abundant than the native patches (Table 4). By contrast, 33 of 37 introduced populations have 5-year averages equaling or exceeding the long-term average. This appears to be driven primarily by the initial exponential growth of relatively recent introductions (Table 8, Figure 2). When population change is plotted over time five of the 11 largest out-plantings exhibit a sharp decline over the past 1-3 years after attaining a maximum abundance (Figure 2). Six out-plantings still exhibit exponential growth, with their maximum abundance to date being recorded in 2018 (Figure 2). These populations may continue to grow in the short-term, or begin to experience a decline like other large out-plantings. Peter Dunwiddie and Adam Martin (personal communication, 2018) have noted that the large out-planted population at Glacial Heritage steadily declined since attaining its population maximum in 2014, but appears to be stabilizing at about 2 flowering plants per square meter.

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 been confirmed at the Steigerwald National Wildlife Refuge, Tenalquot, and West Rocky Prairie out-planted sites and could become a problem at some other sites in Washington (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 (Kaye & Blakely-Smith 2008). Differentiating hybrid plants from their parent species can be difficult in the field, complicating monitoring efforts. Because of the threat of hybridization to other native or out-planted occurrences, the Steigerwald, Tenalquot, and West Rocky Prairie populations have been dropped as recovery populations for *C. levisecta* (though Steigerwald may be re-planted again with verified pure *C. levisecta* seed).

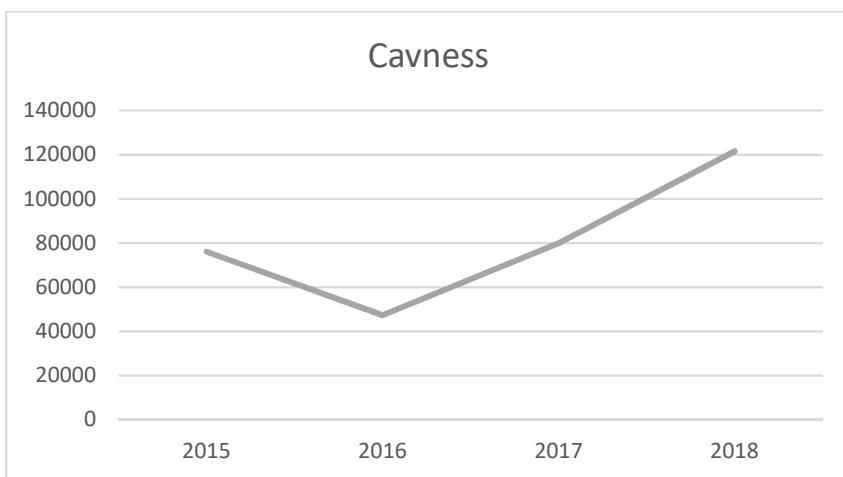
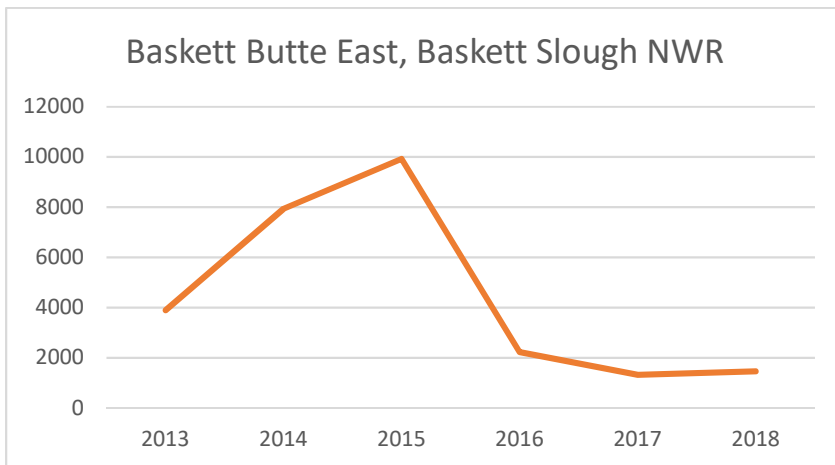
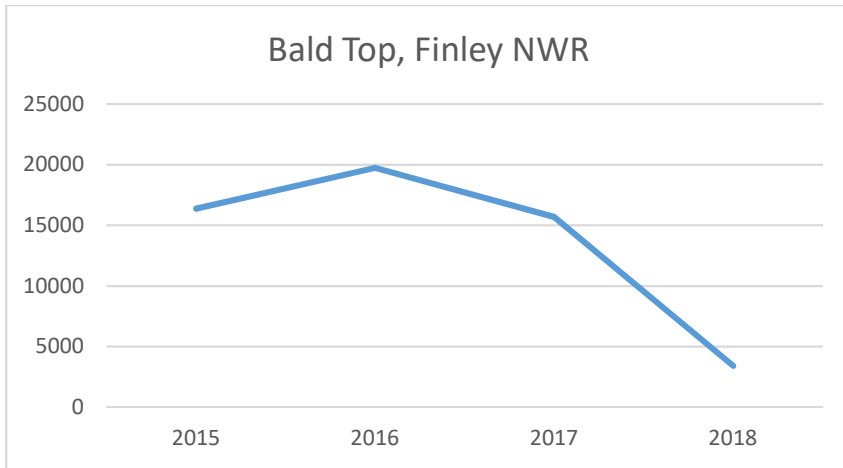


Figure 2. Change in abundance of the 12 largest *Castilleja levisecta* populations in Oregon and Washington over time. Only Rocky Prairie NAP is a native population; the remaining have been introduced.

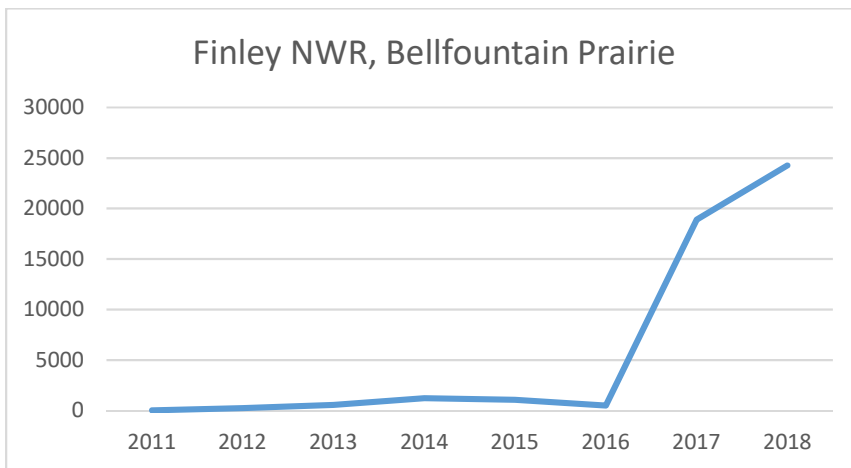
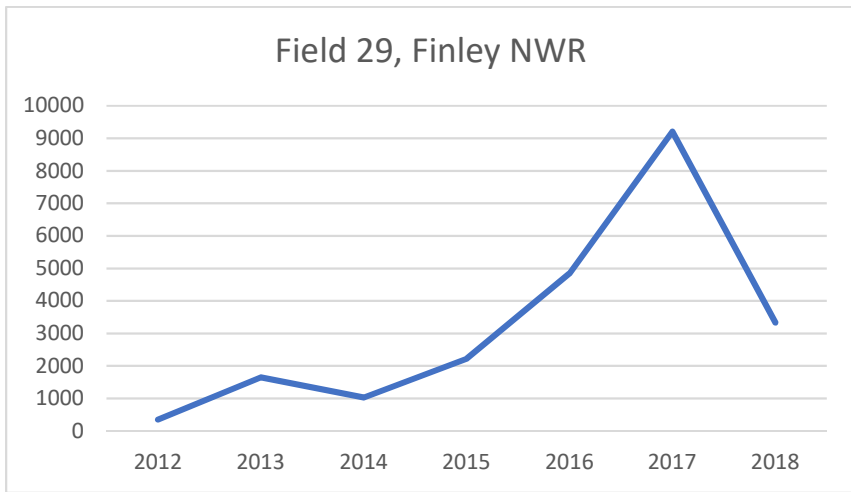
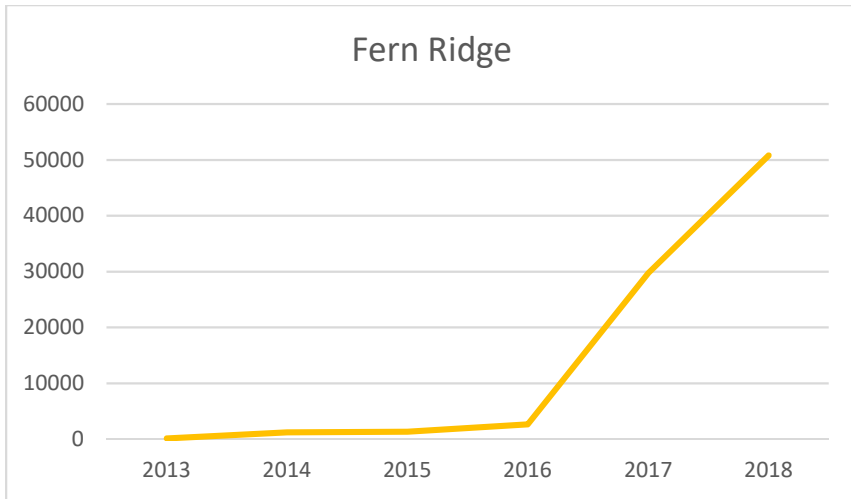


Figure 2. Continued.

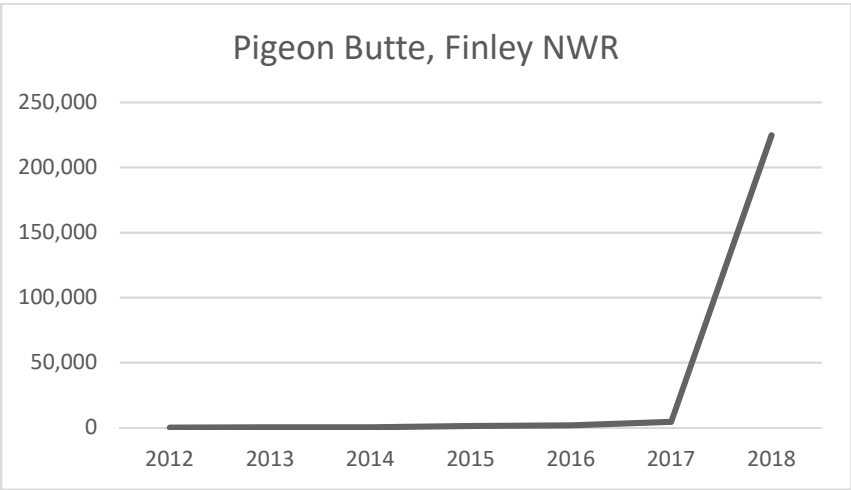
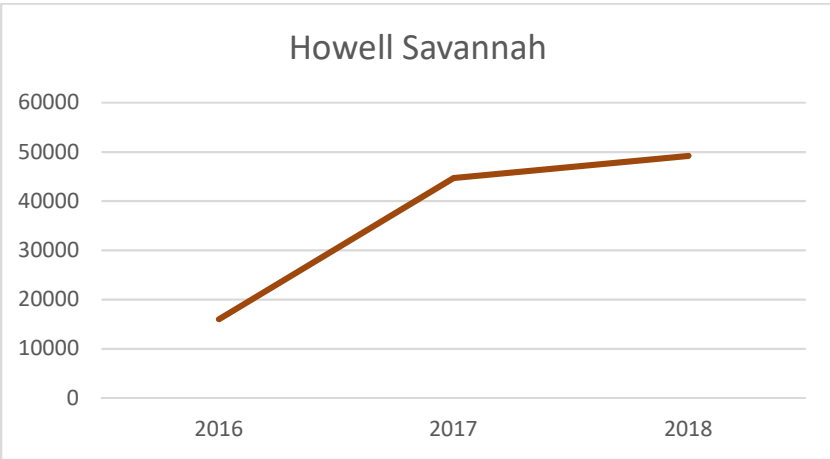
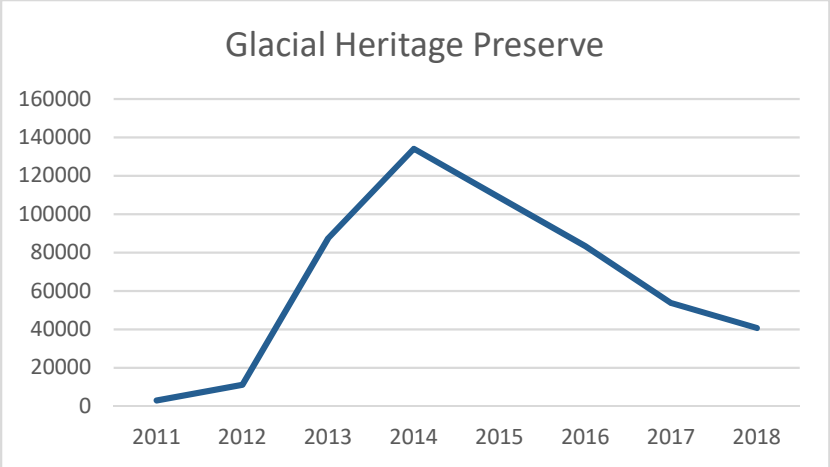


Figure 2. Continued.

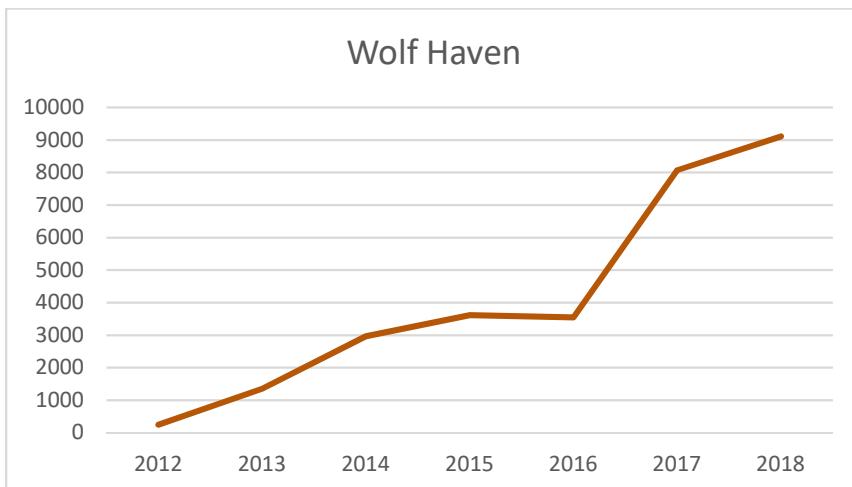
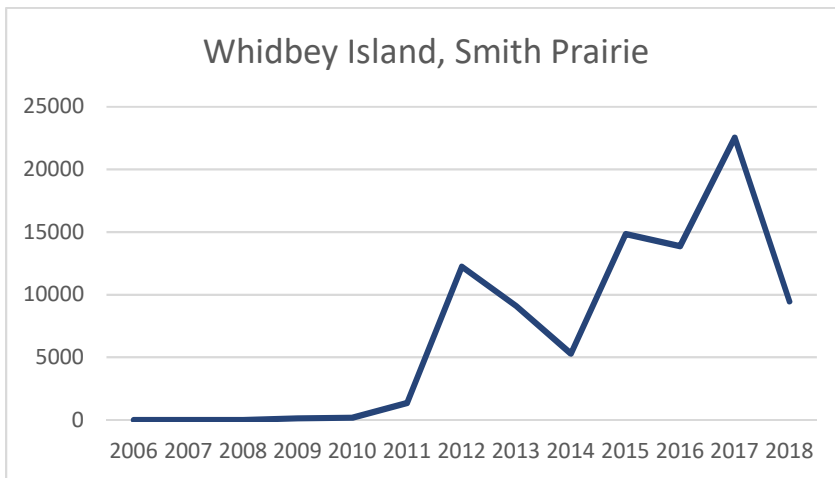
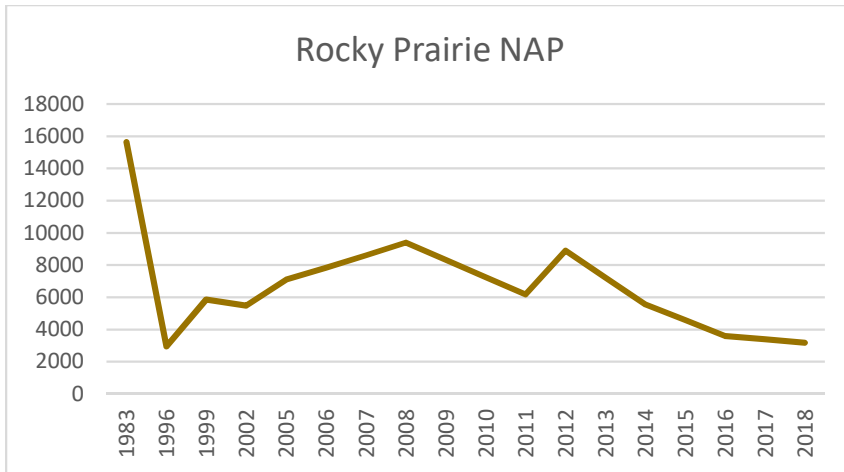


Figure 2. Continued.

Table 8. 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 (OP) status are indicated in columns 3 and 4. “Formal protect.” 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. USFWS condition refers to expert assessment of habitat and management conditions (USFWS 2018). Table excludes populations that are no longer eligible for recovery due to hybridization issues, or which have failed or been abandoned

Population	Min Pop	Max Pop	Long-term Avg	5 year Avg (2014-18)	<i>r</i>	CV	Viability Index	Formal Protect.	USFWS Cond
British Columbia									
Alpha Islet (N)	155	1,333	648	131	na	na	0		Mod
Mini D’Arcy Islet, Gulf Islands Nat. Preserve (O)	4	243	46	15	-0.879	0.936	1	x	Low
Trial Island (N)	801	3,192	2,234	801	na	na	0		Mod
Oregon									
Ankeny NWR (O)	194	256	225	225	1.0	0.195	2	x	Mod
Bald Hill Park (O)	3	4	4	4	-0.289	0.152	1		Low
Bald Top (Bluebird Strip), Finley NWR (O)	3	19,744	9,218	13,801	-0.775	0.518	2	x	High
Baskett Butte East, Baskett Slough NWR (O)	1321	9,925	4,462	4,576	-0.841	0.886	2	x	High
Baskett Butte West, Baskett Slough NWR (O)	136	2,796	875	1,313	0.773	0.896	3	x	High
Beazell Memorial Forest (O)	74	3,299	1,407	1,039	-0.223	0.479	2	x	High
Bellfountain Prairie, Finley NWR (O)	45	24,263	5,859	9,198	0.881	1.246	2	x	High
Carnine (O)	56	144	90	90	0.775	0.521	2		Mod
Cooper Mountain Nature Park (O)	5	250	71	71	0.546	1.444	1		Mod
Coyote Prairie (O)	83	220	128	128	0.734	0.447	2	x	Mod
Dorena Lake (O)	4	4	4	4	na	na	0		Low
Fern Ridge (O)	172	50,820	14,334	17,166	0.901	1.305	2	x	High
Field 1, Finley NWR (O)	32	1,120	576	576	-0.803	0.815	1	x	Mod
Field 29 (includes large East & West plots), Finley NWR (O)	352	9,210	3,234	4,128	0.578	0.768	3	x	High
Fitton Green (O)	38	856	382	450	0.923	0.713	2	x	Mod
Graham Oaks (O)	32	132	86	86	-0.578	0.592	1		Low
Herbert Farm (O)	4	4	4	4	na	na	0		Low
Holyer (O)	19	76	44	44	-0.974	0.670	1		Low
Heritage Jefferson	3	3	3	3	na	na	0		Low
Howell Savannah (O)	16,007	49,208	36,638	36,638	0.922	0.492	3		High
Lupine Meadows Preserve (O)	186	689	462	499	0.790	0.305	2	x	High
Peach Cove (O)	74	116	95	95	-1.00	0.313	1		Low
Pearcy-Schoener Cardwell Hill (O)	317	678	487	483	-0.831	0.350	1	x	Mod
Pigeon Butte (includes Fender’s Prairie), Finley NWR (O)	24	224,814	33,317	46,583	0.717	2.139	2	x	High
Tualatin River NWR Field 5S (O)	2	605	1	303	1.00	1.405	1	x	Mod
Wild Iris Ridge (O)	17	32	25	25	1.00	0.433	2		Low
Washington									
Cavness (O)	47,343	121,550	81,195	81,195	0.715	0.377	3	x	High
Glacial Heritage Preserve (O)	97	134,098	58,016	84,088	-0.994	0.457	2		Mod
Mima Mounds Natural Area Preserve (O)	78	6,314	1,073	1,935	0.706	1.266	2	x	High
Rocky Prairie NAP (EO 011) (N)	2,942	15,634	6,714	4,116	-0.936	0.310	2	x	High
San Juan Island, American Camp (O)	15	185	80	80	-0.954	0.967	1	x	Low

Population	Min Pop	Max Pop	Long-term Avg	5 year Avg (2014-18)	r	CV	Viability Index	Formal Protect.	USFWS Cond
San Juan Island, Cady Mountain (O)	20	30	25	25	1.00	0.283	2		Low
San Juan Island, False Bay Middle (EO 020) (N, O)	15	128	49	45	0.710	0.721	2		Low
San Juan Island, False Bay South (EO 024) (N, O)	12	506	262	184	-0.938	0.608	1		Low
San Juan Island, San Juan Valley (no EO #) (N)	96	7,528	2,084	608	-0.863	0.751	1	x	Low
San Juan Island, West Side Preserve (O)	7	12	9	9	-0.949	0.272	1	x	Low
USFWS Headquarters, Dungeness (O)	1,304	1,304	1,304	1,304	na	na	na	x	High
Whidbey Island, Admiralty Inlet NAP, Naas Prairie Unit (EO 009a) (N, O)	59	2,987	978	2,013	-0.806	0.335	2	x	High
Whidbey Island, Admiralty Inlet NAP, Bluff Unit (EO 009b) (N, O)	67	415	184	267	0.934	0.587	2	x	Mod
Whidbey Island, Ebey's Landing (O)	373	4,308	1,849	1,261	-0.876	1.031	1		Mod
Whidbey Island, Forbes Point (EO 016) (N, O)	78	2,700	629	152	-0.853	0.556	1	x	Low
Whidbey Island, Ft. Casey (EO 005) (N, O)	109	2,936	855	813	0.217	0.502	2	x	High
Whidbey Island, Hill Road - Ebey's Landing (EO 21) (N)	214	7,627	1,989	1,132	-0.841	0.628	2	x	Mod?
Whidbey Island, Smith Prairie, PRI (O)	4	22,544	6,852	13,202	0.392	0.489	3		High
Whidbey Island, West Beach (EO 012) (N)	9	1,255	230	16	-0.753	0.442	1		No data
Wolf Haven (O)	32	9,112	3,618	5,464	0.916	0.529	3		High

Progress Towards Recovery: According to the *Recovery Plan for Golden Paintbrush* (US Fish and Wildlife Service 2000), *C. levisecta* 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 on 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 be exhibiting a sharp decline (even if technically meeting the 1000 plant threshold) (US Fish and Wildlife Service 2007).

In 2018, de-listing criteria for all taxa listed under the Endangered Species Act were modified (Zinke and Ross 2018). De-listing will be based on whether species are no longer meeting the definition of an Endangered or Threatened species based on the Service’s five listing factors: (1) present or threatened destruction, modification or curtailment of habitat or range; (2) overutilization for commercial, recreational, scientific, or educational purposes; (3) disease or predation; (4) inadequacy of existing regulatory mechanisms; (5) other natural or manmade factors affecting continued existence. Existing recovery criteria are useful for identifying whether the threats identified in the five listing factors are being addressed, but will not be the sole criteria for assessing if a species warrants de-listing.

Table 8 summarizes several lines of evidence that may be informative in assessing the present status of *Castilleja levisecta* at each of the extant populations across its range. Long-term and five-year averages (2014-2018) are provided to document which populations are attaining the original recovery goal of a population over 1000 individuals. Populations with formal protection through binding land management policies or conservation easements are also identified.

At the suggestion of Tom Kaye, the golden paintbrush technical team developed a “viability index” for each population (Table 8). This is a composite score of the correlation between population change and time (measured by Pearson’s r), the degree of variability in population numbers over time (Coefficient of Variance or CV), and overall population abundance. A viability index score of 3 (the maximum score) indicates that the population has a positive correlation between population increase and time ($r > 0$), relatively stable changes in numbers over time ($CV < 1$), and a population of over 1000 flowering individuals for 5 consecutive years. Viability scores of 0, 1, or 2 indicate that none, one, or two of these three benchmarks are being met.

Table 8 also includes results of a Current Condition Assessment conducted by USFWS as part of the *Castilleja levisecta* Species Status Assessment (SSA) (USFWS 2018). Current condition (labeled USFWS Cond in Table 8) measures five criteria: degree of management, site quality, threats, population abundance, and protection status as determined by a panel of experts familiar with each site. Based on an averaged score, each site is placed into one of three condition categories: low, moderate, or high (USFWS 2018).

Using 2018 monitoring data, 19 of the 49 extant native and introduced populations of *Castilleja levisecta* (38.8%) have a five-year average of at least 1000 flowering individuals (Table 8). Twenty-one populations have a positive Pearson's r , (42.9%) indicating there is a positive correlation between population growth and time over the past 5 years. At least 35 of 49 sites (71.4%) have a Coefficient of Variance <1, indicating that annual population counts have been relatively stable from 2014-2018. Only six populations have a Viability Index score of 3 (Baskett Butte West, Field 29, and Howell Savanna in Oregon and Cavness, Smith Prairie, and Wolf Haven in Washington), while another 21 sites have a score of 2 (Table 8). Twenty-eight populations are formally protected (57.1%). Lastly, 18 populations have a "high" score for their USFWS Condition Assessment (36.7%) and another 14 are rated moderate (28.6%).

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

Key Characteristics: Golden paintbrush can be distinguished from other *Castilleja* species in its range by its combination of bright yellow floral bracts that are shallowly 3-5 lobed at the tips, corolla tubes 20-23 mm long with the upper lobe 3-4 x longer than the stubby lower lobes, and pubescence of the stems, leaves, and bracts that is soft and slightly sticky. Yellow-flowered forms of *Castilleja hispida* have more deeply divided bracts and upper leaves and longer corollas with the tubular upper lobes 4-5 x longer than the stubby lower lobe. Hybrid individuals between these species can be recognized by flowers of intermediate proportions.

Range: Historically, golden paintbrush 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. Additional populations have been out-planted in Clark and Clallam counties, but these have not been present long enough to be considered established. Golden paintbrush is extirpated in King, Kitsap, Pierce, and Skagit counties.

Number of Occurrences in WA: Golden paintbrush is currently known from 10 extant and 10 established 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.) Thirteen additional native populations, including the type occurrence at Mill Plain/Fort Vancouver, are historical or extirpated.

Abundance: As of 2018, there were an estimated 5382 flowering plants in 10 extant native occurrences and 190,638 flowering individuals in established out-plantings or augmentation sites. The total state population is currently estimated at 195,324 flowering 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 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, the number of native occurrences has been decreasing, but this trend has reversed in recent years with the successful establishment of new introduced populations. 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 declined since 2012. The state's five largest native populations have decreased by 52-85% during this time span. The overall number of populations in the state has 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/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; County Government: Thurston County. Private NGOS: Center for Natural Lands Management, San Juan Preservation Trust, Whidbey-Camano Land Trust, Wolf Haven.

References:

- Arnett, J. 2010. *Castilleja levisecta* (golden paintbrush). Monitoring and reporting methodology. Prepared for the U.S. Fish and Wildlife Service, Region 1, by the Natural Heritage Program, Washington Department of Natural Resources. Natural Heritage Report 2011-07. Olympia, WA. December 2, 2011.
- Arnett, J. and A. Goldner. 2017. Monitoring federally listed and Candidate plant taxa in Washington State, 2016. 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*). Prepared for the U.S. Fish and

- Wildlife Service, Region 1, by the Natural Heritage Program, Washington Department of Natural Resources. Natural Heritage Report 2010-02. April, 2010. Olympia, WA. 77 pp.
- Arnett, J. and T. Thomas. 2007. Golden paintbrush (*Castilleja levisecta*) Five-year review: summary and evaluation. Prepared for the U.S. Fish and Wildlife Service, Region 1, by the Natural Heritage Program, Washington Department of Natural Resources. Natural Heritage Report 2007-08. Olympia, WA. Original report date September 30, 2007; reformatted January, 2008.
- 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*). Prepared for the U.S. Fish and Wildlife Service, Region 1, by the Natural Heritage Program, Washington Department of Natural Resources. Natural Heritage Report 2004-01. Olympia, WA. 77 pp.
- Caplow, F. and C. Chappell. 2005. South Puget Sound Site Evaluations for Reintroduction of Golden Paintbrush. Prepared for the U.S. Fish and Wildlife Service, Region 1 by the Natural Heritage Program, Washington Department of Natural Resources. Natural Heritage Report 2005-07. Olympia, WA.
- Chappell, C. and F. Caplow. 2004. Site Characteristics of Golden Paintbrush Populations. Prepared for the U.S. Fish and Wildlife Service, Region 1, by the Natural Heritage Program, Washington Department of Natural Resources. Natural Heritage Report 2004-03. 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.
- Fertig, W. 2018. *Castilleja levisecta* – Golden paintbrush. Pp 9-23. In: Status of federally listed plant taxa in Washington state, 2017. Natural Heritage Report 2018-02. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 77 pp.
- Fessler, M. and B. Kohler. 2015. Fort Casey 2015 *Castilleja levisecta* count. Monitoring report on file at the Washington Natural Heritage Program, Olympia, WA.
- 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. Unpublished report, Washington Natural Heritage Program, Dept. 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.
- Heckard, L.R. 1962. Root parasitism in *Castilleja*. *Bot. Gaz.* 124:21-29.
- 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.
- Hersch-Green, E.I. 2012. Polyploidy in Indian paintbrush (*Castilleja*; Orobanchaceae) species shapes but does not prevent gene flow across species boundaries. *American Journal of Botany* 99(10): 1-11.
- Kaye, T.N. 2001. Restoration research for golden paintbrush (*Castilleja levisecta*), a threatened species. Report date September 19, 2001; last modified on web site January 20, 2002. <http://www.appliedeco.org/Reports>
- Kaye, T.N. 2002. Preliminary notes on the breeding system of *Castilleja levisecta*. Institute for Applied Ecology, Corvallis, OR. September 19, 2002.
- 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.
- Lawrence, B.A. and T.N. Kaye. 2005. Growing *Castilleja* for restoration and the garden. *Rock Garden Quarterly* 63: 128-134.
- 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. (first published on-line in June 30, 2009).
- 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. Final Report, September 2003.
- Pischalko, M. and R. Holmes. 2005 Population Census of *Castilleja levisecta* at Rocky Prairie. Natural Area Program, Washington Department of Natural Resources
- 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.

- 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*. Unpublished report submitted to the U.S. Fish and Wildlife Service, Portland, Oregon. 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. June 11, 1997.
- 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.
- U.S. Fish and Wildlife Service. 2018. Species status assessment report for golden paintbrush (*Castilleja levisecta*). Version 1.0. Washington Fish and Wildlife Service Office, Lacey, WA.
- 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. Unpublished report, Washington Department of Natural Resources, Natural Heritage Program. 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.
- Zinke, R.K. and W. Ross. 2018. Endangered and Threatened wildlife and plants; Revision of the regulations for listing species and designating critical habitat. Federal Register 83(143):35193-35201.

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

2018 Research, Monitoring, and Updates

Seedling Monitoring: Annual Population Viability Analysis (PVA) monitoring of *Eriogonum codium* seedlings in three permanent belt transects along Umtanum Ridge took place on 11 April 2018 following the methodology of Arnett (2013). Monitoring was conducted by Heidi Newsome of the US Fish and Wildlife Service, and I with the help of volunteers Jane Abel, Natalie Cadoret, Ernie Crediford, Terri Knoke, and Karen Weida. Only 9 seedlings were observed in the 24 permanent plots (Table 9), a decrease of nearly 98% from the 333 observed in the same plots in April 2017 (the 2017 seedling count was incorrectly cited as 69 in Fertig 2018). No seedlings were found in transects 1 or 3, both of which burned in the July 2017 Silver Dollar fire. The 9 seedlings observed in transect 2 (which did not burn in 2017) represented a decrease of 92% from the 118 seedlings observed in 2017. None of the 2018 cohort of seedlings in the plots appeared to have survived when the plots were revisited on 12 July 2018.



Eriogonum codium from Umtanum Ridge, Benton County, Washington, July 2018.

Live Plant Monitoring: Summer PVA monitoring of mature *E. codium* plants took place on 12 July 2018 at the three belt transects on Umtanum Ridge. Monitoring was done by H. Newsome, J. Abel, Keith Abel, E. Crediford, K. Weida, and me. Fifty-five live plants were observed in the 24 survey plots (Table 10). Unburned transect #2 contained 26 living plants (including 4 new recruits into the population since 2016) and 3 dead individuals. Lightly burned transect #1 had 26 living plants, including 7 new recruits since 2016. This transect also contained 20 mature plants that died from 2016 to 2018 and 8 new recruits that also died (Table 10). Severely burned transect #3 had only three living plants, no new recruits, and 10 newly dead plants. Of the 68 plants that were alive in 2016, 41 were still alive in 2018, a survival rate of 60.3%.

Mature plants that survived from 2016 through the fire of 2017 to 2018 tended to become smaller and produce fewer inflorescences. Of 40 plants that survived this transition, 19 (47.5%) were more than 10 percent smaller in area and 12 (30%) were about the same size ($\pm 5\%$ in area). Of the nine plants that increased more than 10% in area, 8 (89%) were from unburned transect #2. Fourteen of 19 plants (73.7%) that were smaller in area came from the lightly to severely burned transects. Of 38 plants with data, 21 (55%) had 5% fewer inflorescences in 2018, while only four (11%) had significantly more flowering stalks (Table 10). Reduction in size and reproductive output might be expected for plants that are highly stressed, such as those that experienced the worst impacts from the Silver Dollar Fire.

Table 9. *Eriogonum codium* PVA monitoring and census data from 1995-2018. 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 PVA count			Total Population Census
		New Adult Dead	Persisting Adult	Newly	
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	333*	No data (monitoring cancelled due to Silver Dollar Fire)			Estimated 1906-2921 survived the Silver Dollar Fire
2018	9	11	39**	35	2515

*Erroneously reported as 69 in Fertig (2018) report.

**Includes 6 surviving plants that had been reported as dead in 2016.

Table 10. Change in Size and Condition of Mature *Eriogonum codium* plants in monitoring transects from 2016 to 2018

Trans #	Tag #	2016			2018		
		Dimensions	# Inflor	Condition	Dimensions	# Inflor	Condition
1	75	19 x 14	3	Alive (3)	10 x 3	1	Alive (6)
1	70	28 x 16	0	Alive (5)			Dead (5)
1	71	16 x 11	0	Alive (5)			Dead (3)
1	New				12 x 9	0	Alive (5)
1	New				24 x 9	0	Alive (6)
1	New?				35 x 25	0	Dead (3)
1	New?				20 x 24	0	Dead (3)
1	New?				29 x 10	0	Dead (3)
1	52	9 x 8	2	Alive (4)	9 x 5	0	Dead (3)
1	82	22 x 11	29	Alive (3)	19 x 9	0	Dead (3)
1	80	24 x 21	61	Alive (3)	23 x 10	29	Alive (3)
1	85	21 x 21	41	Alive (2)	16 x 15	0	Dead (3)
1	78	26 x 23	54	Alive (3)	29 x 22	36	Alive (3)
1	1	63 x 45	133	Alive (2)	30 x 46	0	Dead (3)
1	3	17 x 13	0	Alive (3)	14 x 11	0	Dead (3)
1	New? (mostly out of plot)				34 x 27	0	Dead (3)
1	New				na	0	Dead (5)
1	11	35 x 21	18	Alive (3)	20 x 20	0	Dead (3)
1	8	29 x 27	38	Alive (2)	30 x 17	24	Alive (3)
1	9	28 x 21	0	Alive (4)	24 x 18	0	Dead (3)
1	7	41 x 30	30	Alive (3)	35 x 21	22	Alive (4)
1	New				na	0	Dead (5)
1	14	29 x 25	0	Alive (4)	23 x 24	0	Dead (1)
1	16	37 x 25	104	Alive (3)	35 x 19	0	Dead (1)
1	34	29 x 23	21	Alive (4)	10 x 13	2	Alive (5)
1	New				16 x 13	34	Alive (3)
1	35	26 x 14	5	Alive (3)	21 x 6	12	Alive (6)
1	New				16 x 13	0	Alive (5)
1	33	33 x 21	3	Alive (5)	3 x 4	0	Alive (6)
1	New				13 x 14	1	Alive (6)
1	New				26 x 27	10	Alive (3)
1	New				7 x 6	0	Alive (5)
1	32	24 x 24	32	Alive (3)	3 x 6	0	Alive (6)
1	54	6 x 6	1	Alive (1)	5 x 6	0	Alive (5)
1	38	40 x 37	182	Alive (3)	35 x 35	0	Alive (4)
1	39	23 x 17	21	Alive (2)	20 x 15	0	Alive (6)
1	24	21 x 14	25	Alive (3)	24 x 17	20	Alive (2)
1	25	31 x 26	0	Alive (5)	22 x 12	0	Dead (3)
1	23	63 x 58	20	Alive (4)	30 x 29	0	Alive (5)
1	22	31 x 26	29	Alive (3)	30 x 24	7	Dead (2)
1	20	23 x 23	15	Alive (3)	25 x 12	15	Alive (3)
1	18	17 x 11	24	Alive (3)	12 x 13	5	Alive (4)
1	17	13 x 10	0	Alive (4)	7 x 7	2	Alive (4)
1	New				6 x 6	1	Alive (1)
1	New				8 x 7	0	Alive (2)
1	New	13 x 12	17	Alive (1)	10 x 12	0	Dead (2)
2	New				2 x 2	0	Alive (1)
2	99	42 x 35	49	Alive (3)	45 x 35	26	Alive (1)
2	New				2 x 2	0	Alive (1)
2	New				1 x 0.5	0	Alive (1)
2	111	19 x 10	0	Alive (3)	19 x 11.5	0	Alive (1)
2	105	34 x 30	46	Alive (3)	30 x 25	46	Alive (1)
2	107	46 x 31	75	Alive (3)	45 x 44	90	Alive (3)
2	48	58 x 45	183	Alive (3)	82 x 41	173	Alive (2)
2	43	17 x 14	8	Alive (3)	17 x 15	4	Alive (2)
2	41	31 x 21	28	Alive (3)	30 x 18	24	Alive (2)
2	42	19 x 19	23	Alive (3)	40 x 20	68	Alive (4)
2	New	23 x 23	4	Alive (3)	21 x 17	2	Alive (2)
2	New	30 x 22	31	Alive (3)	31 x 19	24	Alive (3)

Trans #	Tag #	2016			2018		
		Dimensions	# Inflor	Condition	Dimensions	# Inflor	Condition
2	New	25 x 15	2	Alive (4)			Dead?
2	New	31 x 21	22	Alive (3)			Dead?
2	New	22 x 20	37	Alive (3)			Dead?
2	New				7 x 4	0	Alive (4)
2	86	48 x 39	173	Alive (3)	46 x 43	89	Alive (1)
2	87	52 x 41	115	Alive (4)	48 x 48	77	Alive (3)
2	88	42 x 23	48	Alive (3)	39 x 21	26	Alive (3)
2	53	42 x 38	110	Alive (3)	44 x 39	82	Alive (2)
2	54	27 x 16	0	Alive (4)	27 x 12	2	Alive (3)
2	55	26 x 19	35	Alive (3)	27 x 23	20	Alive (2)
2	62	23 x 19	3	Alive (4)	27 x 20	9	Alive (4)
2	New				14 x 14	22	Alive (3)
2	57	33 x 23	54	Alive (3)	39 x 24	41	Alive (2)
2	60	40 x 29	3	Alive (5)	6 x 3	0	Alive (6)
2	61	31 x 25	61	Alive (3)	30 x 22	48	Alive (2)
2	67	67 x 54	197	Alive (4)	81 x 47	171	Alive (4)
3	53	5 x 4	0	Alive (1)			Dead (1)
3	109	33 x 28	45	Alive (3)			Dead (1)
3	95 (?)	65 x 44	43	Alive (3)			Dead (1)
3	90	35 x 20	62	Alive (2)			Dead (1)
3	100 (c)	35 x 18	24	Alive (4)	na	0	Dead (6)
3	47	19 x 21	4	Alive (3)			Dead (3)
3	99	37 x 31	60	Alive (3)			Dead (3)
3	98	21 x 16	1	Alive (2)			Dead (3)
3	101	54 x 30	191	Alive (1)			Dead (3)
3	100a	29 x 23	25	Alive (3)	28 x 22	0	Dead (3)
3	100b	30 x 18	22	Alive (4)	4 x 5)	6	Alive (6)
3	93	42 x 40	56	Alive (3)	40 x 34	0	Alive (6)
3	94	na	0	Alive (5)	60 x 46	5	Alive (3)

Transect 1 was lightly burned, transect 2 was unburned, and transect 3 was severely burned in July 2017 Silver Dollar Fire. Dimensions are in cm.
Condition classes for Alive plants are: 1 (0-1% of plant is dead), 2 (2-5% of plant is dead), 3 (6-25% of plant is dead), 4 (26-50% of plant is dead), 5 (51-75% of plant is dead), 6 (76-100% of plant is dead).
Condition classes for Dead plants are: 1 (attempted to leaf out in present year before dying), 2 (leaves and inflorescence visible), 3 (leaves fragmentary, no inflorescences visible), 4 (stems and trunks visible), 5 (only trunk visible), 6 (plant completely gone)

Seed Germination Study: Sarah Shank, a graduate student at the University of Washington and Rare Care nursery volunteer, conducted a study on the potential impacts of the 2017 Silver Dollar Fire on germination of seeds collected from burned and unburned *Eriogonum codium* plants. Heidi Newsome and Jane Abel collected three envelopes of seed from unburned plots and two envelopes from lightly to partially burned plots in August 2017.

Shank reported the following results: “testing with tetrazolium chloride indicate changes in viability following fire, notably a significant decrease in viability for partially burned seeds. Total viability for the three unburned envelopes of seed was between 20% and 62% (Table 11). For lightly burned seed, viability was 25-28%, and for partially burned seed viability was 5-8%. Initial results of germination testing are consistent with results of viability testing. To date, germination is between 15% and 20.6% for unburned seed, 10.6% for lightly burned seed, and 2.6% for partially burned seed” (S. Shank, personal communication 2019).

Table 11. Seed viability of unburned and burned *Eriogonum codium* seed following the 2017 Silver Dollar Fire. Results from research by Sarah Shank, graduate student, University of Washington.

Envelope	Viability	Germination (to date)
Unburned 1	61-62%	20.6%
Unburned 2	41-43%	18.6%
Unburned 3	20-23%	15%
Lightly burned	25-28%	10.6%
Partially burned	5-8%	2.6%

2018 Out-planting Monitoring: No monitoring of Umtanum buckwheat out-plantings was conducted in 2018 (Heidi Newsome, personal communication, April 2019). The introduction on Yakima Ridge is currently inaccessible due to road damage resulting from the Silver Dollar Fire in 2017. That population was down to three individuals in 2016 and has probably failed to become established (Goldie and Newsome 2017). The second out-planting on Saddle Mountain burned in the summers of 2017 and 2018 and is presumed extirpated. Forty new plugs were planted at Saddle Mountain in the Fall of 2018, but their current condition is not known (H. Newsome, personal communication).

2018 Census: The last full census of Umtanum buckwheat was done in 2011, at which time the four main subpopulations contained 5,169 plants (Arnett and Goldner 2017, Newsome 2017). On July 12-13, 2018, the entire population was re-censused for the first time after the Silver Dollar Fire of 2017. The western-most subpopulation contained 555 mature plants in 2018, of which over 90% were flowering. A small subpopulation immediately to the east on the ridgeline contained 100 individuals. Another 374 plants were counted at the far eastern end of Umtanum Ridge. Finally, 1486 mature plants were counted within the vicinity of the three permanent monitoring transects. The total number of plants censused in 2018 was 2515, a decrease of 105% from 2011.

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

Key Characteristics: *Eriogonum codium* is a densely matted perennial herb with lemon yellow flowers borne in ball-like clusters at the tips of leafless branches. The basal leaves are elliptic and densely white or gray woolly. The perianth is comprised of 6 equal tepals that are hairy on the outside. The flowers do not taper to a stipe-like base. *Eriogonum douglasii* and *E. caespitosum* have yellow or dirty whitish flowers with stipe-like bases. *E. ovalifolium* var. *ovalifolium* has glabrous yellow flowers with the outer 3 tepals broader than the inner 3 and leaves that are oval.

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

Number of Occurrences in WA: Known from a single occurrence first discovered in 1993 (Fertig 2018) and last visited in 2018.

Abundance: 2515 plants were counted in the entire Umtanum Ridge population in 2018, down from 5169 in the 2011 census.

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: This species is trending 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, resulting in a decrease of the population from 5169 to 2515 from 2011 to 2018.

Managed Areas/Ownership: Hanford Site (DOE).

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. Prepared for the U.S. Fish and Wildlife Service, Natural Heritage Report 2012-01. Washington Natural Heritage Program, Department of Natural Resources, Olympia. January 17, 2012
- Arnett, J. 2013. Hanford Endemic Plants Population Monitoring: Umtanum desert-buckwheat (*Eriogonum codium*) and White Bluffs bladderpod (*Physaria douglasii* ssp. *tuplashensis*). Prepared for the U.S. Fish and Wildlife Service, Natural Heritage Report 2013-07. Washington Natural Heritage Program, Department of Natural Resources, Olympia. April 18, 2013.
- 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. March 2003.
- 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). Prepared for the U.S. Fish and Wildlife Service under Section 6 funding. Natural Heritage Report 2007-04, Washington Natural Heritage Program, Washington Department of Natural Resources, Olympia, Washington. June 30, 2007.
- 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, Washington.
- Dunwiddie, P.W., K.A. Beck, and F.E. Caplow. 2001. Demographic studies of *Eriogonum codium* Reveal, Caplow & Beck (Polygonaceae) in Washington. In Conservation of Washington's Rare Plants and Ecosystems: Proceedings from a conference of the Rare Plant Care and Conservation Program of the University of Washington. Washington Native Plant Society, Seattle, Washington.
- Fertig, W. 2018. *Eriogonum codium* - Umtanum desert buckwheat. Pp. 24-30. In: Status of federally listed plant taxa in Washington state 2017. Natural Heritage Report 2018-02. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 77 pp.
- Kaye, T.N. 2007. Draft population viability analysis for *Eriogonum codium* (Umtanum buckwheat). Prepared for the Washington Natural Heritage Program, Washington Department of Natural Resources, Olympia, WA by Thomas N. Kaye, Institute for Applied Ecology, Corvallis, Oregon. January 2007.
- 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. October 2016.
- 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. October 2016.
- 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. May 15, 2012.
- 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. April 23, 2013.
- 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. December 20, 2013.

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

2018 Research, Monitoring, and Updates

Monitoring of Out-plantings: On 23 May 2018, Wendy Gibble and Stacy Kinsell (Washington Rare Care), Randi Riggs (USFWS), and I 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 2018, dropping from an average of 83% in year one (2016) to 51% in year two (2017) and 26% in year 3 (2018) (Gibble 2018). Only 44 of the original cohort of out-planted individuals in Tumwater Canyon were still present in 2018, with no site containing more than 15. On the positive side, 8-10 second generation seedlings were documented for the first time in one of the plots, indicating that some recruitment is potentially occurring (Gibble 2018).



Hackelia venusta from out-planting in Tumwater Canyon, June 2018.

Previous out-plantings in Tumwater Canyon and Icicle Canyon from 1994-1996 have apparently failed. The last plants at the Tumwater Canyon out-planting were observed in 2003. Two plants were still present at Icicle Canyon in 2012, and a single plant was observed by Gibble, Kinsell, and Riggs in 2018 (Gibble 2018). 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: No formal census was undertaken at the naturally-occurring population in Tumwater Canyon in 2018. The area was inspected cursorily as part of the effort to monitor nearby outplantings and found to be present and thriving. 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.

Ex-situ Propagation Work: Wendy Gibble collected 200-300 seeds from the Tumwater population in July 2018 to augment the seed bank at the University of Washington. Rare Care staff continued work in 2018 on growing additional *H. venusta* plugs for future out-planting and apparently resolved issues with damping off caused by the horticultural sand previously used in the potting mix (Gibble 2018). Plans are to continue nursery propagation and have plugs available for augmentation planting in the field in Fall 2019 (Gibble 2018).

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

Key Characteristics: *Hackelia venusta* is a multi-branched perennial herb with leafy stems 20-40 cm tall. Stem leaves are 2.5-5 cm long x 3-7 mm wide and lance-shaped to narrowly elliptic with spreading hairs and coarse ciliate margins. Flowers are white (occasionally washed with blue) and 18-22 mm wide. Raised knobs (fornices) at the mouth of the corolla are squared-off or slightly lobed. Fruits are comprised of 4 nutlets 3.8-4.3 mm long with a warty surface and broadly winged margin lined by rough prickles. *Hackelia taylori* differs in having deep blue flowers only 3-5 mm wide and shorter stems. *H. diffusa* var. *arida* has taller stems, longer leaves, and white flowers with rough-warty or hairy fornicies.

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

Number of Occurrences in WA: 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. The augmented Tumwater Canyon populations contained 44 surviving plants in 2018 (down from an initial population of 228) and the first evidence of second generation seedlings (Gibble 2018).

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 competing vegetation cover. 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 has increased in recent years. Some of the population increase may be due to the discovery of additional satellite populations beyond the original core sites.

Managed Areas/Ownership: Tumwater Special Interest Area, Wenatchee National Forest.

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. June 2007.
- Arnett, J. 2011a. Inventory of potential outplanting sites for *Hackelia venusta* (showy stickseed). Prepared for the U.S. Fish and Wildlife Service, Natural Heritage Report 2011-01. Washington Natural Heritage Program, Department of Natural Resources, Olympia. March 21, 2011.
- Arnett, J. 2011b. *Hackelia venusta* (showy stickseed). Monitoring and Inventory, 1968-2011. Prepared for the U.S. Fish and Wildlife Service, Natural Heritage Report 2011-03. Washington Natural Heritage Program, Department of Natural Resources, Olympia. September 9, 2011.
- Arnett, J. 2012. Review of endemic plants of the Wenatchee Mountains and adjacent areas. Prepared for the U.S. Fish and Wildlife Service, Natural Heritage Report 2012-06. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. September 10, 2012.
- Arnett, J. 2014. *Hackelia venusta*, Tumwater Canyon. Monitoring Layout and Summary Washington Natural Heritage Program, Washington Department of Natural Resources. March 2015.
- 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. January 31, 1985
- Caplow, F. 2004. Summary of *Hackelia venusta* fieldwork, May 11 and 12, 2004. In files of the 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. October-December.
- Fertig, W. 2018. *Hackelia venusta* - showy stickseed. Pp. 31-34. In: Status of federally listed plant taxa in Washington state 2017. Natural Heritage Report 2018-02. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 77 pp.
- 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. March, 1988.
- Gamon, J.G. 1988. Report on the status of *Hackelia venusta* (Piper) St. John. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. March 31, 1988.
- 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.

- Gibble, W. 2018. Progress report for October 1, 2017 through September 30, 2018 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. February 6, 2002.
- 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. Western Washington University, Bellingham, WA.
- 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)**

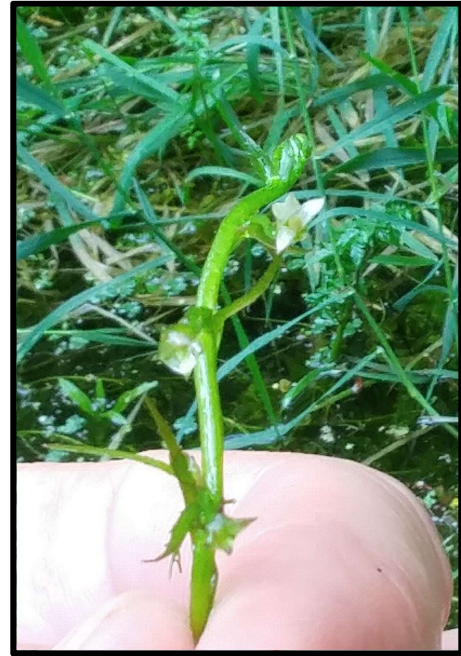
2018 Research, Monitoring, and Updates

2018 Site visits: Rod Gilbert, Sarah Krock, and Amber Martens of Joint Base Lewis McChord (JBLM) and I surveyed 11 of the 21 known occurrences of *Howellia aquatilis* on JBLM in June 2018 (Table 12). These sites were last monitored in 2015. In 2018, these occurrences contained a total of 3929-4609 plants. The same areas had 2955-3205 plants in 2015. Five of the individual occurrences had a population increase, two were stable, and four decreased (the Roy occurrence had no plants in 2018). Three of the four decreasing occurrences were among the smallest populations, and none contained more than 80 plants in 2015.

Alex Chmielewski revisited the Blackwater Island RNA occurrence at Ridgefield National Wildlife Refuge in early June 2018 and observed *Howellia* in all four ponds. No other *Howellia aquatilis* occurrences in Washington were re-surveyed in 2018.

Post De-listing Monitoring: In 2013, the US Fish and Wildlife Service issued a five-year review of the status of water howellia. The Service concluded that *Howellia 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 recovery plan was written in 1996 (though never formally adopted) that focused on implementing management plans for *Howellia* 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).

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 the species' range (US Fish and Wildlife Service 2017). The goal of the monitoring plan is to revisit a minimum of 60 of the 307 known water howellia 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 howellia should remain de-listed or be placed



Howellia aquatilis at Joint Base Lewis McChord, Pierce County, Washington, June 2018.

Table 12. Location data for *Howellia aquatilis* (Water howellia) in Washington.

Population	County	Ecoregion	Ownership	Year last Obs	Status
Dishman Hills (EO #1)	Spokane	Columbia Plateau	Dishman Hills NRCA	2011	2011: 50 plants observed; 2002: 217
Blackwater Island RNA (EO #2)	Clark	Puget Trough	Blackwater Island RNA, Ridgefield NWR	2018	2018: observed in all 4 ponds; 2014: 100s of plants observed (highest count yet recorded). 1980: abundant
Cheney-Spangle & Curtis roads (EO #3)	Spokane	Columbia Plateau	unknown	1986	1986: Hundreds to thousands estimated
Curtis Road (EO #4)	Spokane	Columbia Plateau	unknown	1986	1986: Hundreds reported
Bretz Pothole (EO #5)	Spokane	Columbia Plateau	unknown	1990	1990: observed; 1986: several 100 to 1000; not relocated in 1991 or 1992
Cameron Road (EO #6)	Spokane	Columbia Plateau	unknown	1987	No data
Jennings Road (EO #7)	Spokane	Columbia Plateau	Private	1987	No data
Cross Tracks I (EO #8)	Spokane	Columbia Plateau	Private	1987	1987: noted as "small population"
Cross Tracks II (EO #9)	Spokane	Columbia Plateau	unknown	1987	No data
Cross Tracks III (EO #10)	Spokane	Columbia Plateau	Private	1987	1987: "very few plants" observed
Turnbull NWR, E of Findley Lake (EO #11)	Spokane	Columbia Plateau	Turnbull NWR	2007	2007: 100s observed; 1996: 402 plants
E of Kepple Lake (EO #12)	Spokane	Columbia Plateau	unknown	1987	No data
Pond E of Campbell Lake (EO #13)	Spokane	Columbia Plateau	Turnbull NWR	2008	2008: 6 plants
Squirrel View (EO #14)	Spokane	Columbia Plateau	Turnbull NWR	2008	2008: 105+ plants; 1996: 16 plants
Lily Pond (EO #15)	Spokane	Columbia Plateau	unknown	1987	1987: "small population"
Anderson Road (EO #16)	Spokane	Columbia Plateau	unknown	1987	1987: "scattered"
N of West Tritt Lake (EO #17)	Spokane	Columbia Plateau	Turnbull NWR	1990	1990: "very few"; Not relocated in 2008, 2009, 2012
Pond 10, Pine Creek RNA S pond (EO #18)	Spokane	Columbia Plateau	Turnbull NWR	2007	2007: 60-120 plants; 1996: 156 plants; 1993: 2 plants
S of West Blackhorse Lake (EO #19)	Spokane	Columbia Plateau	Turnbull NWR	2010	2010: 2 small clusters; 1997-2009: not found; 1990: "fair" population
Pond 85 Turnbull NWR (EO #20)	Spokane	Columbia Plateau	Turnbull NWR	2009	2009: observed but not censused, 1996: 57 plants
Pond 21A Turnbull NWR (EO #21)	Spokane	Columbia Plateau	Turnbull NWR	2009	2009: 2 plants; 1997: 0; 1993: 1 plant
Pond 77 Turnbull NWR, Findley Lake NE (EO #22)	Spokane	Columbia Plateau	Turnbull NWR	2007	2007: 1 plant
Pond 72 Turnbull NWR (EO #23)	Spokane	Columbia Plateau	Turnbull NWR	2010	2010: 240 plants; 1993: 2 plants
Pond 55 Turnbull NWR (EO #24)	Spokane	Columbia Plateau	Turnbull NWR	2008	2008: 10 plants; 1996: 150 plants; 1993: 2 plants

Table 12. continued

Population	County	Ecoregion	Ownership	Year last Obs	Status
Pond 39 Turnbull NWR (EO #25)	Spokane	Columbia Plateau	Turnbull NWR	2008	2008: 23 plants
Pond 21C Turnbull NWR (EO #26)	Spokane	Columbia Plateau	Turnbull NWR	2009	2009: observed, but not censused; 2007: 200+ plants; 1993: 1 plant
Pond 61 Turnbull NWR (EO #28)	Spokane	Columbia Plateau	Turnbull NWR	2007	2007: 250+ plants; 1997: 50-75 plants; 1996: 46 plants
Pond 18 Turnbull NWR (EO #29)	Spokane	Columbia Plateau	Turnbull NWR	2008	2008: 1 plant, 1993: 1 plant
Pond 21B Turnbull NWR (EO #30)	Spokane	Columbia Plateau	Turnbull NWR	2009	2009: observed; 1993: 2-3 plants
Pond 31 Turnbull NWR (EO #31)	Spokane	Columbia Plateau	Turnbull NWR	2008	2008: 297 plants; 1993: 3 plants
Pond 29 Turnbull NWR (EO #32)	Spokane	Columbia Plateau	Turnbull NWR	2007	2007: 15 plants; 1997: 2 plants; 1996: 18 plants; 1993: 50+ plants
Pond 12 Turnbull NWR (EO #33)	Spokane	Columbia Plateau	Turnbull NWR	2007	2007: 40-70 plants
Pond 1A Stubblefield Lake Turnbull NWR (EO #34)	Spokane	Columbia Plateau	Turnbull NWR	1993	1993: 1 plant; Could not be relocated in 2010, 2011, or 2012
Pond 112 Turnbull NWR (EO #35)	Spokane	Columbia Plateau	Turnbull NWR	1993	Could not be relocated in 2011 Rare Care search; 1993: 3 plants
Pond 96 Turnbull NWR (EO #36)	Spokane	Columbia Plateau	Turnbull NWR	2007	2007: 110+ plants; 1996: 15 plants
NW of Hog Lake (EO #37)	Spokane	Columbia Plateau	BLM	2012	2012: ca 50 plants; monitored almost yearly; no plants found in 2017; 1993: 50
Pond 107 Turnbull NWR (EO #38)	Spokane	Columbia Plateau	Turnbull NWR	2009	2009: scattered throughout pond; 1996: 30 plants; 1993: 2 plants
Foot Lake (EO #39) JBLM wetland #1	Pierce	Puget Trough	Joint Base Lewis McChord	2018	2018: 516 plants. 2015: 120-170 plants. 1998: 338 plants
S of Bentsen (EO #40) JBLM wetland #3	Pierce	Puget Trough	Joint Base Lewis McChord	1998	1998: 4 plants; 2015: 0 plants observed
Bentsen wetland (EO #41) 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 #42) JBLM wetland #15	Pierce	Puget Trough	Joint Base Lewis McChord	2015	2015: 7 plants; 1998: 90 plants
Shaver Kettle (EO #43) JBLM wetland #7	Pierce	Puget Trough	Joint Base Lewis McChord	2018	2018: 805-1235 plants. 2015: 200 plants. 2001: 80-140 plants; 1998: estimated 800 plants
Trench Wetland (EO #44) JBLM wetland #6	Pierce	Puget Trough	Joint Base Lewis McChord	2018	2018: 255-355 plants; 2015: 230-330 plants. 1998: 20 plants
NE Chambers Satellite (EO #45) 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 #46) JBLM wetland #9	Pierce	Puget Trough	Joint Base Lewis McChord	2015	2015: 107-182 plants. 1998: 706 plants

Table 12. continued

Population	County	Ecoregion	Ownership	Year last Obs	Status
West Shaver Pond (EO #47) JBLM wetland # 8	Pierce	Puget Trough	Joint Base Lewis McChord	2018	2018: 558 plants; 2015: 148-198 plants. 1998: 804 plants
Crone Marsh (EO #48) JBLM wetland # 4	Pierce	Puget Trough	Joint Base Lewis McChord	2018	2018: 416 plants (Crone West) and 685-785 plants (Crone East); 2015: 105 plants (Crone West) and 1200 plants (Crone East). 1998: 1000+ plants
Joseph Marsh (EO #49) JBLM wetland # 5	Pierce	Puget Trough	Joint Base Lewis McChord	2018	2018: 455-505 plants; 2015: 202 plants; 1999: ca 500 plants
Middle East Chambers (EO #50) JBLM wetland # 10	Pierce	Puget Trough	Joint Base Lewis McChord	1998	1998: 53 plant; 2015: 0 plants observed
Dailman Lake (EO #51) JBLM wetland # 14	Pierce	Puget Trough	Joint Base Lewis McChord	2015	2015: 8 plants. 1998: 39 plants; 1997: 100s of plants
Hamilton Lake (EO #52) JBLM wetland # 16	Pierce	Puget Trough	Joint Base Lewis McChord	2015	2015: 16 plants. 1998: 13 plants; 1997: 4 plants
Chambers East (EO #53) JBLM wetland # 13	Pierce	Puget Trough	Joint Base Lewis McChord	2018	2018: 45 plants; 2015: 144-194 plants. 1998: 91 plants
Turnbull NWR Pond 13 South RNA (EO #54)	Spokane	Columbia Plateau	Turnbull NWR	2008	2008: 32-35 plants; 1993: 9 plants
Turnbull NWR Pond 82 (EO #55)	Spokane	Columbia Plateau	Turnbull NWR	2008	2008: 25 plants; 1993: 1 plant
Turnbull NWR Pond 63 (EO #56)	Spokane	Columbia Plateau	Turnbull NWR	1993	Not relocated in 1997, 2008, 2009, 2012 visits; 1993: 3 plants
Turnbull NWR pond 32 (EO #57)	Spokane	Columbia Plateau	Turnbull NWR	2008	2008: ca 1000; 1996: 39
Turnbull NWR pond 138 (EO #58)	Spokane	Columbia Plateau	Turnbull NWR	2009	2009: observed but not censused; 1997: 10-20 plants; 1993: 100+ plants
Turnbull NWR pond 139 (EO #59)	Spokane	Columbia Plateau	Turnbull NWR	2009	2009: 1 patch; 1996: 9 plants; 1993: 1 plant
Turnbull NWR pond 117 (EO #60)	Spokane	Columbia Plateau	Turnbull NWR	2009	2009: observed but not censused; 1996: 1 plant; 1993: 3 plants
Turnbull NWR pond 18 (EO #61)	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 #64)	Thurston	Puget Trough	Scatter Creek Wildlife Area	2008	2008: observed but not censused; 1995: "small population"
Turnbull NWR, NW of Campbell Lake (EO #65)	Spokane	Columbia Plateau	Turnbull NWR	1997	1997: 7 plants
Willow Kettle, 13th Div Prairie (EO # 66) JBLM wetland # 17	Pierce	Puget Trough	Joint Base Lewis McChord	2018	2018: <50 plants; 2015: 80 plants. 1998: scattered and in clusters
Smythe Rd North (EO #67)	Spokane	Columbia Plateau	WA DNR	2011	2011: 85-120 plants; 999: 1260-1860 plants
Burnett Rd (EO #68)	Spokane	Columbia Plateau	WA DNR	2013	2013: observed but not censused; 2010: 1000+; 1999: ca 1100

Table 12. continued

Population	County	Ecoregion	Ownership	Year last Obs	Status
N of S Luke Rd (EO #69)	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	2018	2018: >400 plants; 2015: 485 plants
Roy (EO #72) JBLM wetland # 20	Pierce	Puget Trough	Joint Base Lewis McChord	2015	2018: 0 plants; 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	2018	2018: 14 plants; 2015: 30 plants

back on the Endangered Species list (US Fish and Wildlife Service 2017). A formal proposal for de-listing *Howellia aquatilis* is expected in 2019, but had not been issued as of 1 May.

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

Key Characteristics: *Howellia aquatilis* is an annual herb with slender stems 10-60 cm long that are rooted in mud or free-floating on the surface of water. Leaves are linear or thread-like and 10-45 mm long x 1.5 mm wide and mostly alternate to occasionally opposite or whorled. Flowers above the water surface are 2-2.7 mm long, white, irregular, and borne singly in leaf axils, while those produced below the water surface remain closed at maturity. Both flowers develop fruiting capsules 5-13 mm long. *Callitriche* species differ in having opposite leaves, apetalous green flowers, and heart-shaped fruits.

Range: *Howellia aquatilis* occurs sporadically across Washington, northern Idaho, western Montana, western Oregon, and northern California. In Washington, it is found in Clark, Mason, Pierce, Spokane, and Thurston counties in the Columbia Plateau and Puget Trough ecoregions.

Number of Occurrences in WA: In Washington, *H. aquatilis* is known from 73 occurrences (Table 12). Ten of these occurrences have not been relocated since 1987 and their present status is unknown; another two have not been relocated in several repeat visits and may be extirpated. Two additional historical records are known from Mason and Thurston counties (Mincemoyer 2005). Fifty-five occurrences have been discovered or relocated since 2000, with 20 revisited as recently in 2015. 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 (for an average of 137-769 plants per site). 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 10).

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.

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 survey efforts. 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 11 of 21 known populations are declining (populations are stable to increasing at 8 locations on JBLM).

Managed Areas/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.

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.
- Fertig, W. 2018. *Howellia aquatilis* - water howellia. Pp. 35-41. In: Status of federally listed plant taxa in Washington state 2017. Natural Heritage Report 2018-02. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 77 pp.
- 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. March 16, 1998.

- Gamon, J. 2002. Endangered species management plan for the water howellia (*Howellia aquatilis*), Fort Lewis, Washington. Washington Natural Heritage Program, Department of Natural Resources. June 30, 2002.
- 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. July 22, 1998.
- 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. Prepared for the Idaho Department of Parks and Recreation, with Section 6 funding from U.S. Fish and Wildlife Service, Region 1. 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. July 2005.
- 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. January 1998.
- 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. January 30, 1996.
- 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. July 14, 1994.
- 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. September 24, 1996.
- 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)**

2018 Research, Monitoring, and Updates

Monitoring at Lacamas Prairie NAP: Approximately 111 acres of Bradshaw's lomatium 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 was monitored based on subsampling quadrats within two large macroplots, with these results then extrapolated across the entire NAP. This protocol was discontinued following the 2013 field season, after the number of plants within the quadrats declined precipitously and a full census within the macroplots was done instead (Wilderman 2017). In 2018, DNR counted 387 plants within macroplot number 2, which represented a decrease of 28% from 2017 (Table 13). The entire NAP contained 658 plants in 2018, which was down from 804 in 2017 (a decrease of 22%) (Wilderman 2018). The Lacamas Prairie NAP population has fluctuated since 2000, but the overall trend is down sharply since 2007 and from the highest estimate of 13,829 plants when monitoring started in 1998 (Wilderman 2018).

Population status outside of Lacamas Prairie NAP: on 31 May, 2018, Dave Wilderman and I made a brief site visit to the golf course south of Alexandra Lane to inspect the portion of the Bradshaw's lomatium occurrence outside the current area of the Lacamas Prairie NAP in state ownership. We found this population to be locally abundant, often contributing 50% of the total vegetation cover. Although we did not attempt to quantify population numbers, this site appeared to be considerably denser with *Lomatium* than the areas within the existing NAP.



Lomatium bradshawii (above) in flower from Lacamas Prairie NAP (photo by Tynan Ramm-Granberg, WNHP); in fruit (below) by W. Fertig.



Table 13. Monitoring and census data for *Lomatium bradshawii* at Lacamas Prairie NAP, Washington from 1998-2018. Numbers include both reproductive (flowering and fruiting) and vegetative plants. Data from Wilderman (2018).

Year	1998	1999	2000	2001	2002	2003	2004	2007	2013	2015	2016	2017	2018
Total number of plants in quadrats (Macroplot 2)	1608	1360	842	300	645	810	1109	593	20	N/A	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	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	N/A
Census data Macroplot 2										420	520	496	387
Census Data for rest of Lacamas Prairie NAP											447	308	271
Total Population Census Lacamas Prairie NAP											967	804	658

Restoration Monitoring at Lacamas Prairie NAP: Ramm-Granberg and Rocchio (2018) assessed changes in vegetation condition and the response of *Lomatium bradshawii* following controlled burning and herbicide application to invasive plant species at Lacamas Prairie NAP using Ecological Integrity Assessment methodology. Prescribed fire and targeted herbicide use have produced short term improvements in site conditions (especially through reducing the cover of invasives and increasing the cover of native species). In the absence of sustained management actions, however, invasive species cover began to increase. Burning and herbicide treatments may be needed every 1-3 years to promote *L. bradshawii* reproduction and contain the spread of invasive plants. Management actions do not have to target *L. bradshawii* specifically to have a positive effect; efforts to promote the restoration of wet prairies in general seem to achieve complementary results. Residential development surrounding the NAP unfortunately continues to consume existing and potentially restorable wet prairie habitat and is likely to impact hydrological conditions within the natural area (Ramm-Granberg and Rocchio 2018).

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

Key Characteristics: *Lomatium bradshawii* is a glabrous perennial herb from a woody caudex topping a slender taproot. Stems are short or almost completely below-ground. Leaves are 10-30 cm long and ternate-pinnately dissected into numerous linear or thread-like segments 3-10 mm long x 1 mm wide. The inflorescence is a compound umbel of 5-14 smaller umbels of yellow flowers subtended by deeply 3-lobed and toothed involucre bractlets and borne on unequal branches (rays). Fruits are glabrous, flattened schizocarps (splitting in two halves) lacking raised dorsal ribs but with the rim strongly inflated and corky-thickened, resembling an inner-tube or horse-collar. *Lomatium utriculatum* differs in having involucre bracts that are wedge-shaped and toothed on the margins, but not deeply 3-lobed and fruits with raised dorsal ribs and inflated margins.

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

Number of Occurrences in WA: 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 was estimated at 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 at more than 22 million individuals. Arnett (2010) identified relatively homogeneous polygons that excluded unsuitable Bradshaw's lomatium 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 entire 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 (which represents a subset of the entire occurrence) indicate that populations can oscillate from year to year, but overall trend appears downward since 1998 (Wilderman 2018).

Managed Areas/Ownership: Lacamas Prairie Natural Area Preserve (WA DNR), private.

References:

- Arnett, J. 2010. Recovery Actions for *Lomatium bradshawii* (Bradshaw's lomatium). Prepared for the U.S. Fish and Wildlife Service Western Washington Fish and Wildlife Office. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. October 5, 2010.
- Arnett, J., K. Birkhauser, and T. Kemper. 2007. Southwestern Washington Prairies: Inventory and Conservation Planning for Rare Plants of Southwestern Washington Grasslands. Prepared for the U.S. Fish and Wildlife Service, Region 1. Washington Natural Heritage Program, Department of Natural Resources, Olympia, Washington. June 30, 2007.
- Camp, P. and J.G. Gamon. 2011. Field Guide to the Rare Plants of Washington. University of Washington Press, Seattle, WA. 392 pp.
- Fertig, W. 2018. *Lomatium bradshawii* - Bradshaw's lomatium. Pp. 42-46. In: Status of federally listed plant taxa in Washington state 2017. Natural Heritage Report 2018-02. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 77 pp.
- 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.
- Ramm-Granberg, T. and F.J. Rocchio. 2018. Assessment of potential recovery actions for *Lomatium bradshawii* within the Lacamas Prairie Natural Area Preserve and vicinity. Natural Heritage Report 2018-10. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 56 pp. + appendices.
- 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.
- 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.
- Wilderman, D. 2017. *Lomatium bradshawii* monitoring, Lacamas Prairie NAP 2017. Natural Areas Program, Department of Natural Resources, Olympia, WA. 1 pp
- Wilderman, D. 2018. *Lomatium bradshawii* monitoring, Lacamas Prairie NAP 2018. Natural Areas Program, Department of Natural Resources, Olympia, WA. 1 pp

***Lupinus oreganus* var. *kincaidii* - Kincaid's lupine (Fabaceae)**

2018 Research, Monitoring, and Updates

2018 Monitoring: On 22 June 2018, Joe Arnett and I revisited the Boistfort Prairie occurrence of *Lupinus oreganus* var. *kincaidii*. The subpopulation at Cemetery Hill was inspected from the road. According to Arnett, this area has become densely vegetated and is becoming unsuitable for this species. The Boistfort dairy subpopulation is still robust and contains at least 2000 individual plants. We did not measure the foliar cover of the entire population but did note that lupine cover averaged 20% of total vegetation cover in the two main subpopulations. Some plants were as large as 1 m². Four other WNHP plant species of concern co-occur with *Lupinus oreganus* at this site: *Carex densa*, *Delphinium leucophaeum*, *Lathyrus holochlorus*, and *Wyethia angustifolia*.



Lupinus oreganus var. *kincaidii* from Boistfort Prairie, Lewis County, Washington, June 2018

Arnett and I also revisited the Toledo school subpopulation. We observed 100-200 plants along the fencerow bordering the ball fields. Lupine plants provided about 10% of the total vegetation cover.

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 2018. Reynolds' team measured lupine cover and the number of inflorescences, rather than estimating the number of individual plants. In 2018, total Kincaid's lupine cover was 41.52 m², which was nearly the same as in 2017 (41.63 m²) (Table 14). The number of inflorescences in 2018 declined from 2146 in 2017 to 1022 (a drop of 52%). Despite the decrease in flowering stems, the 2018 count was still the third highest since monitoring began in 2011 (Reynolds personal communication).

Other known occurrences in the state were not revisited in 2018. The current status of the Washington populations is summarized in Table 14.

Table 14. Summary of Washington populations of *Lupinus oreganus* var. *kincaidii*

Element Occurrence Number	Location (year last observed in parentheses)	Lupine cover in square meters (year) or estimated # of stems	Comments
1	Boistfort – Dairy (2018)	1040 m ² (2016 – data from Ottombrino-Haworth et al. 2016); 4,000 m ² (2006)	2018: Several 1000 plants, lupines make up to 20% of total cover. Locally common in 2 main patches.
	Boistfort – Cemetery Hill (2018)	150 (2008); appears to be declining (2016)	2018: plants not observed in ocular search from roadside; habitat becoming increasingly over-grown
3	Cowlitz Prairie-adjacent to School District property (2008)	286 m ² , ca 250-300 stems (2008)	
	Cowlitz Prairie-Lozier Preserve (2018)	41.52 m ² (2018), 41.63 m ² (2017), 34.48 m ² (2016), 28.89 m ² (2015), 15.4 m ² (2014), 20.7 m ² (2013), 33.22 m ² (2012), 21.82 m ² (2011)	Inflorescence counts: 1022 (2018), 2146 (2017), 475 (2016), 643 (2015), 570 (2014), 753 (2013), 1096 (2012), 980 (2011)
	Cowlitz Prairie-School District property (2018)	100-200 stems, cover ca 10% (2018), 100 – 150 m ² ; ca 333 stems (2016)	
4	Drews Prairie (2016)	1	
5	Cowlitz Prairie, eastern end- south parcel of (2016)	1,040 (2010), appears to be declining (2016)	Apparent decline may be due to increased competition associated with the elimination of grazing
	Cowlitz Prairie, eastern end-middle parcel (2012)	Not estimated-access has not been obtained.	
	Cowlitz Prairie, eastern end-north parcel (2012)	Small patches	

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

Key Characteristics: *Lupinus oregonus* var. *kincaidii* is a perennial herb with multiple stems to 50 cm tall covered by white to brown appressed silky hairs. Leaves are palmately compound with 9-11 oblanceolate leaflets that are glabrous on the upper surface and taper to a point. Basal leaves are present at flowering. Numerous (but not crowded) purple to light bluish (rarely yellowish) pea-like flowers are in a terminal raceme 10-18 cm long. Flowers are 9-12 mm long and borne on stalks 4-10 mm long. The banner petal is only slightly reflexed from the wing petals, leaving a small opening. *Lupinus sulphureus* differs in having pubescent leaflets, yellow to blue flowers, and occurs mostly east of the Cascades. *L. polyphyllus* has flowers 10-16 mm long with banners that are widely divergent from the wing petals. *L. bicolor* is an annual with flower stalks 1-3 mm long.

Range: Endemic to a small area near Canyonville, Oregon, the Willamette Valley of western Oregon, and the southern Puget Trough in southwestern Washington (Lewis County). Historically, it was also known from southern British Columbia.

Number of Occurrences in WA: 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 2018).

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).

Managed Areas/Ownership: All 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.

Comments: Kincaid's lupine is the primary host plant for the federally Endangered Fender's blue butterfly (*Icaricia icaricioides fenderi*).

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. 2010. Recovery of Kincaid's Lupine (*Lupinus sulphureus* ssp. *kincaidii*). Natural Heritage Report 2010-10. Prepared for U.S. Fish and Wildlife Service Region 1. November 22, 2010. 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. Prepared for U.S. Fish and Wildlife Service Western Washington Fish and Wildlife Office. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. August 7, 2014.
- 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. Prepared for U.S. Fish and Wildlife Service Region 1. 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.
- Fertig, W. 2018. *Lupinus oregonus* - Kincaid's lupine. Pp. 47-50. In: Status of federally listed plant taxa in Washington state 2017. Natural Heritage Report 2018-02. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 77 pp.
- 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)**

2018 Research, Monitoring, and Updates

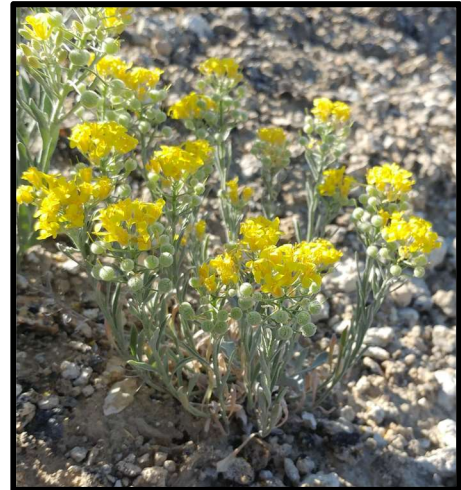
2018 Population Monitoring: On 24 May, 2018, Heidi Newsome of the US Fish and Wildlife Service Mid-Columbia River National Wildlife Refuge Complex and a team of 8 volunteers (including me) conducted annual monitoring of White Bluffs bladderpod in 20 permanent transects at the north end of the White Bluffs. The group counted 14,634 flowering plants (Newsome 2018a). This sum is less than half the number of 30,026 plants noted in 2017 (Newsome 2017a), but about 16% higher than the long-term average of 12,536 plants per year from 1997-2018.

Based on an extrapolation formula used for the past 21 years (Beck 1999, Caplow 2003), the total population for the White Bluffs area is estimated at 33,367 (Newsome 2018a). This is a decrease of 75% from the 58,472 plants estimated in 2017, but higher than the 16-year average of 24,322 plants (Figure 3). The observed and estimated number of flowering plants fluctuates widely from year to year and is probably affected by drought, fire, winter precipitation, and spring temperatures (Newsome 2018a), though the exact combination of factors remains poorly understood.

Individual transects also vary in abundance from year to year. Counts in 2018 ranged from 69 to 1682 individuals. The average number of flowering plants per transect in 2018 was 732, with a standard deviation of 406.7, down from the average of 1580 plants per transect in 2017 (Newsome 2018a).

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). Since 2017, however, the population has increased significantly and the 2017-18 average is now 45,919 plants, well above Caplow's critical threshold.

2018 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 soils that are similar to the native population 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



Physaria douglasii var. *tuplashensis*
from White Bluffs, Franklin County,
Washington, May 2018.

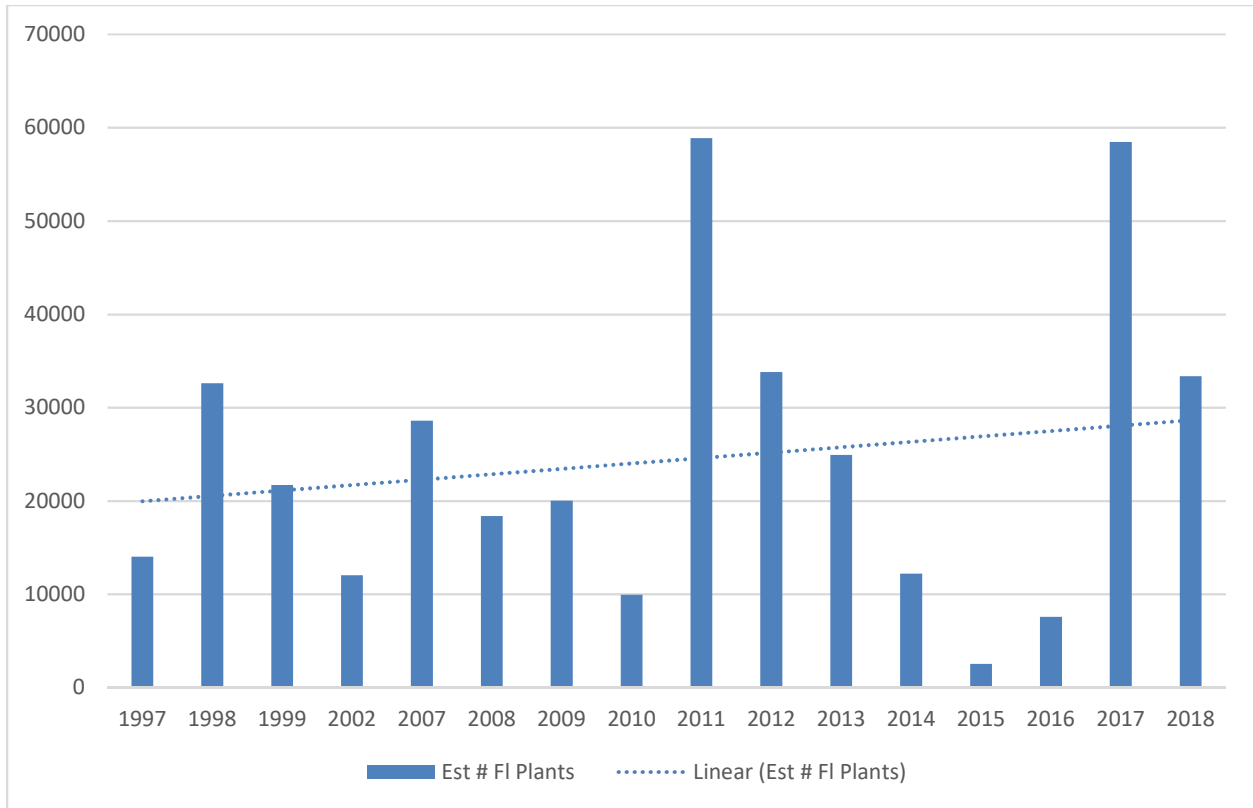


Figure 3. Estimated number of flowering plants of *Physaria douglasii* var. *tuplashensis* from 1997-2018. Derived from Newsome (2018a).

additional cohorts in fall 2014, spring 2015, and fall 2015. In all, 893 plants were installed from 2013-15 (no additional out-plantings have been done since).

In May 2018, all nine out-planting transects were revisited. Newsome (2018b) reports that only 5 of the original cohort of out-planted individuals was still alive in 2018, down from 65 survivors in 2017. Another 201 plants were present in the plots, all of which are first or second generation progeny of the original out-planted individuals. Of these, 102 were flowering or fruiting in 2018. Results of this study indicate that the likely longevity of *P. douglasii* ssp. *tuplashensis* is 3-4 years and that out-planting in appropriate habitat in spring or fall is a viable option for increasing the abundance and range of this taxon (Newsome 2018b).

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?T1/S1; WA Endangered

Key Characteristics: *Physaria douglasii* var. *tuplashensis* is a short-lived, grayish-pubescent perennial herb with numerous erect to spreading stems 10-35 cm tall. Basal leaves form a rosette and are 2-4 cm long x 1-1.5 cm wide and have rounded tips. Stem leaves are more slender and oriented in a tight spiral. The inflorescence is 3-6 cm long and densely packed with yellow flowers. The 4 petals are yellow, narrowly spoon-shaped, and 4.5-5 mm long. Fruits are slightly inflated, spherical pods 3-4.5 mm long on spreading to ascending stalks. The wall of the fruit is covered by stalked star-shaped hairs. *Physaria douglasii* var. *douglasii* differs in having stem leaves that are more loosely arranged (not strongly overlapping), and has fruits with sessile star-like hairs.

Range: Endemic to the White Bluffs area along a 17 km band on the east bank of the Columbia River in Franklin County, Washington (Columbia Plateau ecoregion).

Number of Occurrences in WA: 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 of abundance in 2011 with an estimated 58,887 plants. In 2016, the population had declined to an estimated 7591 (Arnett and Goldner 2017, Newsome 2016). Following a cool and wet winter in 2016/17, the population rebounded to 58,472 in 2017 (Newsome 2017a), before declining again in 2018. Another 200-376 plants have been established in an experimental out-planting west of the native population.

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 24,300 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: Hanford Reach National Monument, South Columbia Wildlife Area.

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. January 17, 2012.
- Arnett, J. 2013. Hanford Endemic Plants Population Monitoring: Umtanum desert-buckwheat (*Eriogonum codium*) and White Bluffs bladderpod (*Physaria douglasii* ssp. *tuplashensis*). Prepared for The US Fish and Wildlife Service Western Washington Fish and Wildlife Office. Washington Natural Heritage Program Washington Department of Natural Resources. Olympia, WA. April 18, 2013.
- 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. March 2003.
- Fertig, W. 2018. *Physaria douglasii* ssp. *tuplashensis* - White Bluffs bladderpod. Pp. 51-54. In: Status of federally listed plant taxa in Washington state 2017. Natural Heritage Report 2018-02. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 77 pp.
- 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. 2016. Annual update of the current status of *Physaria douglasii* ssp. *tuplashensis* on the Hanford Reach National Monument (2016). US Fish and Wildlife Service Mid-Columbia River NWRC, Burbank, WA.
- Newsome, H. 2017b. White Bluffs bladderpod experimental out-planting monitoring report 2017. U.S. Fish and Wildlife Service Mid-Columbia River NWRC, Burbank, WA. 9 pp.
- Newsome, H. 2018a. Annual update of the current status of *Physaria douglasii* ssp. *tuplashensis* on the Hanford Reach National Monument (2018). U.S. Fish and Wildlife Service Mid-Columbia River NWRC, Burbank, WA. 15 pp.
- Newsome, H. 2018b. White Bluffs bladderpod experimental out-planting monitoring report 2018. U.S. Fish and Wildlife Service Mid-Columbia River NWRC, Burbank, WA. 15 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.

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

2018 Research, Monitoring, and Updates

2018 Site Visits: Joe Arnett and I revisited the Lewis County population of *Sidalcea nelsoniana* on 22 June 2018. We observed 42 plants in two main patches in an overgrown meadow adjacent to a plowed field. Many of the plants were infested with weevils and had aborted flower buds or signs of foliar herbivory. The population was last surveyed in 2014 and contained approximately 245 plants at that time. The second native occurrence in Clark County has not been resurveyed since 2014 when it contained 13-23 plants.

Monitoring of Out-Planted Populations: As part of the recovery effort for Nelson's checker-mallow (US Fish and Wildlife Service 2010), two new populations were established on suitable wet prairie habitat in Ridgefield National Wildlife Refuge (NWR) in 2007 and Steigerwald Lake NWR in 2011. Both sites were monitored in 2018 by Alex Chmielewski and other refuge staff.

Ridgefield NWR contains four out-planted subpopulations. The Smith Lake subpopulation initially contained 1846 plugs and had grown to 3871 plants in 2016. In 2017, the population was monitored based on percent cover and frequency within 16 100m belt transects. That year *Sidalcea nelsoniana* contributed an average of 8.5% cover within these transects and had a frequency of 51% occupancy of sub plots. Unfortunately, the monitoring window was missed in 2018, and no data are available (Chmielewski 2018).

The other subpopulations at Ridgefield NWR have declined from their original out-planted numbers. The One Hundred Acre North subpopulation began with 160 plugs and was down to 47 flowering plants in 2018. One Hundred Acre South has declined from 400 plugs in 2007 to 75 flowering plants in 2018. This number has been relatively stable over the past three years. Texas Island has decreased from 100 plugs in 2007 to 2 in 2018, both of which were browsed by deer and did not flower (Chmielewski 2018).

The three subpopulations at Steigerwald Lake National Wildlife Refuge showed a population increase from 2016 to 2017, but declined in 2018. The Straub Field out-planting dropped from 163 plants to 27, Office Road Field declined from 114 to 16, and the Trail head subpopulation had 0 plants in 2018 (Chmielweski 2018) .



Sidalcea nelsoniana (above) from vicinity of Boistfort Prairie, Lewis County, Washington

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

Key Characteristics: *Sidalcea nelsoniana* is a perennial herb with stems 40-100 cm tall from a stout taproot and short, lateral rhizomes. Stems are glabrous or have short, appressed, simple hairs at the base. Basal leaf blades are rounded and shallowly 5-7 lobed and borne on elongate petioles, while stem leaves are more deeply divided into 5-7 linear leaflets and have short petioles. The inflorescence is an open, many-flowered spike with flowers on stalks about 3 mm long. The calyx is 4-6 mm long, purplish, and nearly glabrous to uniformly pubescent with star-shaped hairs. Petals are 5-15 mm long and pinkish lavender. Fruits are mericarps that split into wedge-like segments that are faintly reticulated on the inner edges and have a short beak (0.5 mm) at the tip. *Sidalcea hirtipes* differs in having larger flowers, stiff, spreading hairs on the stems, and fruit segments with more prominent reticulations and a longer beak-like tip. *S. hendersonii* is distinctive in having hollow stems, branched inflorescences, and a larger calyx.

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

Number of Occurrences in WA: 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, but declined in 2018.

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 has been stable to increasing (Arnett and Goldner 2017), though it appeared to be in decline in 2018.

Managed Areas/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.

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. Prepared for The U.S. Fish and Wildlife Service Western Washington Fish and Wildlife Office. Natural Heritage Report 2010-04. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. October 8, 2010
- 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. Prepared for U.S. Fish and Wildlife Service Region 1. Natural Heritage Report 2004-02. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.
- Chmielewski, A. 2018. Monitoring report: Ridgefield NWRC *Sidalcea nelsoniana* plantings. US Fish and Wildlife Service Ridgefield NWRC. 7 pp.
- Dillon, J. 2007. Introduction of *Sidalcea nelsoniana* on the Ridgefield National Wildlife Refuge, Clark County, Washington. December 2007.
- Dillon, J. 2011. Introduction of *Sidalcea nelsoniana* on the Steigerwald Lake National Wildlife Refuge, Clark County, Washington. March 29, 2011.
- Fertig, W. 2018. *Sidalcea nelsoniana* - Nelson's checkermallow. Pp. 55-59. In: Status of federally listed plant taxa in Washington state 2017. Natural Heritage Report 2018-02. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 77 pp.
- 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.
- Silvernail, I., A. Ottombrino-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. February 12, 1993.
- 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.

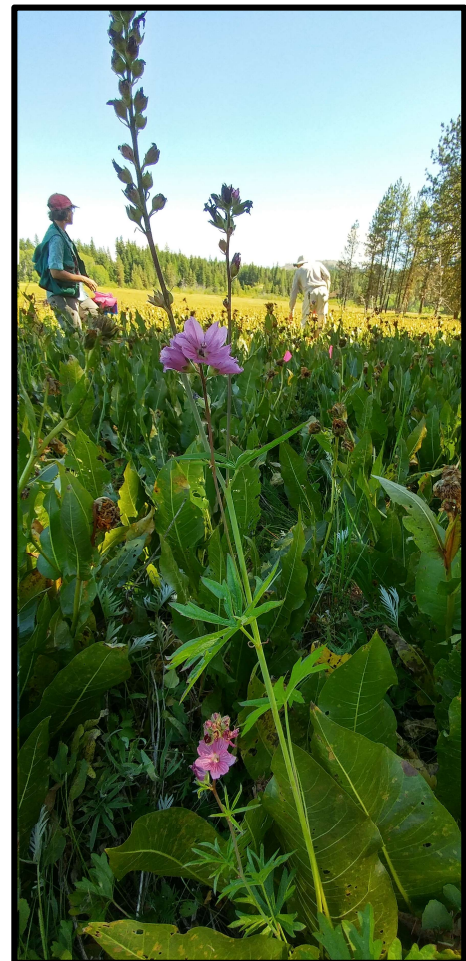
***Sidalcea oregana* var. *calva* - Wenatchee Mountain checker-mallow (Malvaceae)**

2018 Research, Monitoring, and Updates

2018 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 123 discrete patches. Since 2012, a subset of polygons have been mapped and counted each year. In 2018, Dave Wilderman, Wendy Gibble, Stacy Kinsell, Tara Calloway, Randi Riggs, several Rare Care volunteers, DNR staff, and me observed 4628 flowering plants in 26 polygons. The cumulative total of flowering plants observed at Camas Meadows from 2012-2018 is 13,515 plants in 215 polygons (Table 15). Approximately 90 polygons remain to be monitored and re-mapped, although there are plans to complete this work in 2019.

Tara Calloway and Lauri Malmquist monitored the Mountain Home occurrence in 2018 and documented 1375 flowering plants. This figure represents a decrease of almost 50% since 2011. The out-planting on Mountain Home Ridge was found to have 100 surviving flowering plants from the 161 planted (T. Calloway, personal communication). The Poison Canyon sub-population (which is part of the Lacamas Meadows occurrence on adjacent US Forest Service lands) was visited in April, but only seedlings were present. The area will be monitored again in Spring 2019.

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



Sidalcea oregana var. *calva* from Camas Meadows, Chelan County, Washington, June 2018.

Table 15. Population data for Native and Out-Planted Occurrences of *Sidalcea oregana* var. *calva* in Washington. Populations indicated by a * may be based on misidentified specimens.

Population	County	Ecoregion	Ownership	Year 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) includes Poison Meadows	Chelan	East Cascades	Camas Meadows NAP, Wenatchee NF	2018	Largest known population, Estimated at 13,515 flowering plants in 215 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	2018	2018: 1375 flowering plants observed. 2017: estimated at >100 plants. 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)
Mountain Home Ridge (out-planting)	Chelan	East Cascades	Private	2018	2018: 100 of 161 out-planted individuals surviving

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 Endangered3

Key Characteristics: *Sidalcea oregana* var. *calva* is a perennial herb with several stems from a branched rootcrown, but lacks spreading rhizomes or an enlarged fleshy taproot. Stems are 20-150 cm tall and glabrous at the base and sparsely pubescent with appressed, star-like hairs and bluish-green (glaucous) higher on the stem. The thick, fleshy, glabrous leaves have long petioles and rounded blades that are shallowly to deeply lobed into palmate segments. The inflorescence is a loosely-flowered raceme. The calyx is less than 6 mm long and has sparse cover of star-shaped hairs on the back and stiff ciliate hairs along the margins. Petals are light to dark pink. Fruits are dry mericarps that split into numerous wedge-shaped segments with prominent

reticulate veins. *Sidalcea oregana* var. *oregana* differs in having stems with simple to forked hairs and calyces lacking ciliate margins and having dense star-shaped hairs covering the back. *Iliamna longisepala* has larger, maple-like leaves and fruit edges that are hairy on the back.

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

Number of Occurrences in WA: 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/Ownership: Camas Meadows Natural Area Preserve, Colockum Wildlife Area (may be a false report), Wenatchee National Forest, Chelan-Douglas Land Trust (Mountain Ridge introduction), private. The Mountain Home Lodge is in the Washington Register of Natural Areas.

References:

- Arnett, J. 2011. *Sidalcea oregana* var. *calva* (Wenatchee Mountains checker-mallow) Monitoring and Inventory Prepared for The U.S. Fish and Wildlife Service Western Washington Fish and Wildlife Office. Washington Natural Heritage Program, Department of Natural Resources. Olympia, WA September 27, 2011.
- Arnett, J. 2012. Review of endemic plants of the Wenatchee Mountains and adjacent areas. Prepared for the U.S. Fish and Wildlife Service, Natural Heritage Report 2012-06. Washington Natural Heritage Program, Department of Natural Resources, Olympia. September 10, 2012.
- Arnett, J. and K. Birkhauser. 2008. Monitoring Seed Predation of *Sidalcea oregana* (Nutt.) Gray var. *calva* C.L. Hitchcock (Wenatchee Mountain checker-mallow). Report prepared for the U.S. Fish and Wildlife Service Region 1. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. February, 2008.
- 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.
- Fertig, W. 2018. *Sidalcea oregana* var. *calva* - Wenatchee Mountain checker-mallow. Pp. 42-46. In: Status of federally listed plant taxa in Washington state 2017. Natural Heritage Report 2018-02. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 77 pp.
- 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. December 31, 1987.
- 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. December 22, 1999.
- 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. July 22, 2004.
- 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. December, 2015.
- 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. July, 2005.

***Silene spaldingii* - Spalding's catchfly (Caryophyllaceae)**

2018 Research, Monitoring, and Updates

2018 Site Visits and Monitoring: Eleven known occurrences of *Silene spaldingii* were relocated in 2018 and one new extant occurrence was discovered through field surveys.

David Woodall of the Washington Department of Fish and Wildlife (WDFW) discovered a new occurrence of *S. spaldingii* along Tam Tam Ridge in the Asotin Creek State Wildlife Area (Table 16). This population is the first to be recorded from Garfield County, WA and extends the range of the species into the Blue Mountains ecoregion. Woodall observed 10-12 plants growing in the middle of a sparsely-used two track road. Additional surveys are needed to establish the full extent and abundance of this occurrence.

Volunteers from the University of Washington Rare Care program relocated two occurrences on DNR and BLM lands in 2018. Darcy Dauble and Betsy Kaiser revisited the BLM Rock Creek occurrence (EO #83) and found 235 plants, a sizeable increase from 66 observed in 2010 (Table 16). Mary Water successfully relocated the Downs Lake occurrence (EO #29) on DNR property and estimated the population at 50 plants. This occurrence had a single plant when last monitored in 2007 and only 25 when discovered in 1993.

Paula Brooks and a crew from Umatilla National Forest established approximately 20 permanent demographic monitoring plots on Forest Service and WDFW lands in the foothills of the Blue Mountains in 2018. These plots were located within 9 subpopulations of the extensive Sourdough/Sheep Ridge occurrence (EO #49) in Asotin County following the protocol developed by Peter Lesica (Colson 2018).

Kim Frymire of the Spokane BLM discovered a new subpopulation of *S. spaldingii* with 5 plants in the large Telford occurrence (EO #85), within the Greater Telford Key Conservation Area (KCA) (Table 17, Figure 4). I found a second new subpopulation in this same occurrence in early August at the base of a small basalt knob adjacent to the Telford Rest Area along US Highway 2. This subpopulation contained only two plants.

I relocated 15 other small subpopulations in Sourdough Gulch in the Asotin State Wildlife Area (EO #49), the Swanson Lakes Wildlife Area (EO #85), Coal Creek ACEC (EO #48) and Crab Creek (EO #30) on Spokane BLM lands. These subpopulations ranged in size from 1 to 24 plants. In addition, Pene Speaks and I revisited the Cheney-Spangle eyebrow occurrence (EO



Silene spaldingii from newly discovered subpopulation south of Swanson Lakes, Lincoln County, Washington, August 2018.

Table 16. Location data for *Silene spaldingii* (Spalding's catchfly) in Washington.

Population	County	Ecoregion	Ownership	Year last Obs	Status
Pullman West (EO #2)	Whitman	Columbia Plateau	state	1951	Historical, probably extirpated
Hill S of Winona (EO #3)	Whitman	Columbia Plateau	unknown	1925	Historical; not relocated in 1990
Liberty Lake (EO #5)	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 #6)	Whitman	Columbia Plateau	Kramer Palouse BSA	2017	2017: ca 400 plants; 2000: 216 plants 1981: 147 plants
Berry Lake, SW of Lamont (EO #7)	Whitman	Columbia Plateau	unknown	1995	1995: 38 plants; 1980: ca 50; includes former EO 07 & 15
WSU Prairie preserve, Pullman (EO #8)	Whitman	Columbia Plateau	Campus Prairie BSA (WA State University)	2013	2014: no plants found, late in season, 2013: 3 plants; 1995: 18 plants; 1983: 33 plants
Upper Wawawai (EO #9)	Whitman	Columbia Plateau	DNR, private (registry)	2002	2002: 3 plants; 1990: 17 plants; 1981: 21 plants
Spaulding Road (EO #10)	Whitman	Columbia Plateau	Private	1990	1995: no plants found; 1990: 2 plants
Wawawai Eyebrows (EO #11)	Whitman	Columbia Plateau	Private	1995	1995: 11 plants; 1983: 51 plants
Upper Steptoe Canyon (EO #12)	Whitman	Columbia Plateau	DNR, private	1995	2013: no plants found; 1995: 18 plants; 1981: 34 plants
East Upper Steptoe Canyon (EO #13)	Whitman	Columbia Plateau	unknown	1990	1995: not found; 1990: 4 plants; 1981: 12 plants; 1980, ca 40
Pitts Cemetery (EO #14)	Whitman	Columbia Plateau	private	2017	2017: ca 50 plants. 2004: 41 plants; 1995: 62 plants; 1990: 60 plants; 1981: 12 plants
Gooseneck Steppe (EO #16)	Asotin	Columbia Plateau	Private	1990	1995: not found; 1990: 59 plants; 1980: 60+ plants
Smoot Hill BSA (EO #18)	Whitman	Columbia Plateau	Smoot Hill BSA (Washington State University)	1981	1981: 4 plants; not relocated in 1990, 1995, or 2014
Johnson-Pullman Rd (EO #19)	Whitman	Columbia Plateau	Private	1981	1981: 9 plants; 1990: not found
Steptoe Butte (EO #20)	Whitman	Columbia Plateau	Steptoe Butte State Park, private	2018	2018: 500 more plugs out-planted in 2 sites S of State Park by A. Hatcher; 2017: 500 plugs out-planted at 2 sites S of State Park by J. Riser; 2008: 10-20 plants; 1990: 15 plants
Cheney-Spangle Eyebrow (EO #21)	Spokane	Columbia Plateau	Private (DNR registry)	2018	2018: 59 plants; 2005: 3 plants; 1995: 5 plants
Strangland Road (EO #22)	Spokane	Columbia Plateau	Private	1990	1990: 29 plants; 1995: not found
Tucker Prairie (EO #23)	Spokane	Columbia Plateau	DNR	2002	2002: 9 plants; 1999: 12 plants; 1990: 46 plants
Armstrong (EO #25)	Whitman	Columbia Plateau	Private	1995	1995: 48 plants; 1990: 21 plants
Mohler (EO #26)	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
Sprague Parcel (EO #27)	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 #28)	Lincoln	Columbia Plateau	Private	1993	1993: 17 plants
Downs Lake (EO #29)	Lincoln	Columbia Plateau	WA DNR	2018	2018: 50 plants; 2007: 1 plant; 1993: 25 plants

Table 16. continued

Population	County	Ecoregion	Ownership	Year last Obs	Status
Crab Creek (EO #30)	Lincoln	Columbia Plateau	BLM	2018	2018: 24 plants observed in 5 subpops; 2016: 4 subpops visited with 61 plants 2014: observed; 2010: 1014 plants
Thorpe Steppe (EO #31)	Spokane	Columbia Plateau	Private	1995	1995: 3 plants; 1994: 7 plants
Miller Ranch acquisition, Fishtrap Lake, Hog Lake (EO #32)	Lincoln, Spokane	Columbia Plateau	BLM	2017	2017: 11 subpops visited with 73 plants. 2014: observed; 2010: 708 plants.
Fairchild AFB (EO #44)	Spokane	Columbia Plateau	Fairchild Air Force Base	2018	2018: 122 plants observed 2017: 134 plants observed. 2016: 141 plants; 2015; 91 plants 2013: 63 plants; 2004: 67 plants; 1994: 11 plants.
Watson Benchmark (EO #45)	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 #46)	Lincoln	Columbia Plateau	BLM	2016	2016: 2 subpops surveyed with 11 plants. 2014: observed; 2010: 580 plants
Coal Creek ACEC (EO #48)	Lincoln	Columbia Plateau	BLM, Coal Creek ACEC	2018	2018: 2017: two new subpops discovered. Total of 12 subpops visited, and 160 plants observed. 2015: observed; 2010: 770 plants.
Sourdough Ridge (EO #49)	Asotin	Columbia Plateau	Umatilla NF, Asotin Creek Wildlife Area	2018	2018: 13 pl in one patch; additional subpops monitored by USFS; 2017: observed & monitored. 2015: ca 1200 plants
Prune Orchard Road (EO #51)	Whitman	Columbia Plateau	private	1995	1995: 8 plants
Twin Lakes (EO #52)	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 #59)	Whitman	Columbia Plateau	BLM, private	2016	2016: 3 subpops visited with 84 plants. 2014: observed; 2010: 275 plants
Clear Lake area (EO #60)	Spokane	Columbia Plateau	WA DNR	2013	2013: 1 plant; 1999: 2 plants
Turnbull NWR/Pine Lakes (EO #61)	Spokane	Columbia Plateau	Turnbull NWR	2018	2018: seed collected by Rare Care; 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 #62)	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 #70)	Whitman	Columbia Plateau	Private	2001	2001: 1 plant
Rock Creek South (EO #71)	Whitman	Columbia Plateau	Private	2001	2001: 15 plants
Negro Creek West (EO #74)	Spokane	Columbia Plateau	Private	2001	2001: 9 plants
Negro Creek (EO #75)	Spokane	Columbia Plateau	Private	2001	2001: 70 plants
Swanson Lake WA (EO #78)	Lincoln	Columbia Plateau	WA DFW	2010	2010: 81 plants; 2002: 52 plants
Cheney (EO #80)	Spokane	Columbia Plateau	Private	1903	Historical and possibly extirpated
Rock Creek; Escure Ranch (EO #83)	Adams	Columbia Plateau	BLM	2018	2018: 235 plants; 2016: 57 plants. 2014: observed; 2010: 66 plants
Telford Parcel (EO #85)	Lincoln	Columbia Plateau	Swanson Lakes Wildlife Area	2018	2018: 2 new subpops found; 2015: observed; 2010: ca 3060 plants

Table 16. continued

Population	County	Ecoregion	Ownership	Year last Obs	Status
Blankinship Allotment (EO #86)	Asotin	Columbia Plateau	BLM	2016	2016: 3 plants. 2004: 2 plants
Smoothing Iron Ridge (EO #88)	Asotin	Columbia Plateau	Asotin Creek Wildlife Area	2018	2018: Monitoring plots established; 2009: 10000 estimated (6010 counted)
Whelan Cemetery (EO #89)	Whitman	Columbia Plateau	Private	2017	2017: ca 30 plants observed ;2005: 11 plants
Buffalo Eddy Nez Perce NHP, Snake River (EO #90)	Asotin	Columbia Plateau	Nez Perce NHP	2007	2007: observed; 2006: 11 plants
NW of Hatten Lake (EO #91)	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
2 miles N of Maccall (EO #93)	Adams	Columbia Plateau	WA DNR	1946	Historical
Tam Tam Ridge	Garfield	Blue Mountains/ Columbia Plateau	Asotin Creek SWA	2018	2018: 10-12 plants

#21) and found 59 plants in three main patches. This area had only 3 plants when last surveyed in 2005.

Julie Conley, James Rebolz, and Mike Gregg of the US Fish and Wildlife Service conducted annual monitoring of the Fairchild Air Force Base population in July 2018 (Conley and Rebolz 2018). Spalding’s catchfly was observed at 9 of 10 monitoring locations on the base and a total of 122 plants was observed, which represented a modest decrease from the 134 plants found in 2017 (the highest number was recorded in 2016 with 141 plants).

2018 Out-plantings: Beginning in 2017, Turnbull National Wildlife Refuge received funding through the Cooperative Recovery Initiative to establish new out-plantings of *Silene spaldingii* in the Stubblefield Lake and Philleo Lake areas of the refuge. Seed for the project came from collections made at Turnbull. In October 2017, 250 seedlings were planted in the Stubblefield Lake area to augment an existing occurrence. These were monitored in 2018 and plants grown in sites that had been previously burned had better survival than those planted in dense shrub/grassland. Additional seed was collected in 2018 by Rare Care volunteers and additional seedlings planted in 104 plots representing different vegetation types and treatments. Preliminary data suggest high survival of the 2018 out-plantings (Mike Rule, personal communication, 2019). Additional seeding will take place in 2019 to establish a new population at Philleo Lake.

Anthony Hatcher of the Palouse Conservation District continued out-planting *S. spaldingii* plugs at Steptoe Butte in the Fall of 2018, building on work initiated by James Risor in 2017. Two colonies of 250 plugs each were planted on north-facing slopes on private lands just south of the Steptoe State Park boundary on the northwest and northeast slopes of the butte. Hatcher (personal communication) noted poor survival of the 2017 cohort, due largely to herbivory of voles, but had better initial survival in 2018 when plugs were treated with Plantskydd granules to repel herbivores (A. Hatcher, personal communication).

At Fairchild AFB, the existing native population has been augmented by three sets of out-plantings. The most successful of these in 2018 contained just 6 surviving plants out of 85 that were planted in October 2017. Another outplanting had no survivors of the 85 that were planted, and the third had a single surviving plant. These 7 out-planted individuals were counted among the 122 *S. spaldingii* plants reported for Fairchild in 2018 (Conley and Rebholz 2018).

New Historical Occurrence: While researching historical records in the Consortium of Pacific Northwest Herbaria website, I noted a Washington State University specimen from “2 miles north of Macall” in Adams County that had not previously been documented in the WNHP database. The area is managed by the WA Department of Natural Resources (DNR) and has several hundred acres of potential *S. spaldingii* habitat that warrant additional survey.

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, private (DNR)	Palouse Grasslands	ca 10-20 native plants; out-plantings of 500 plugs made at two sites in 2017 and 2018

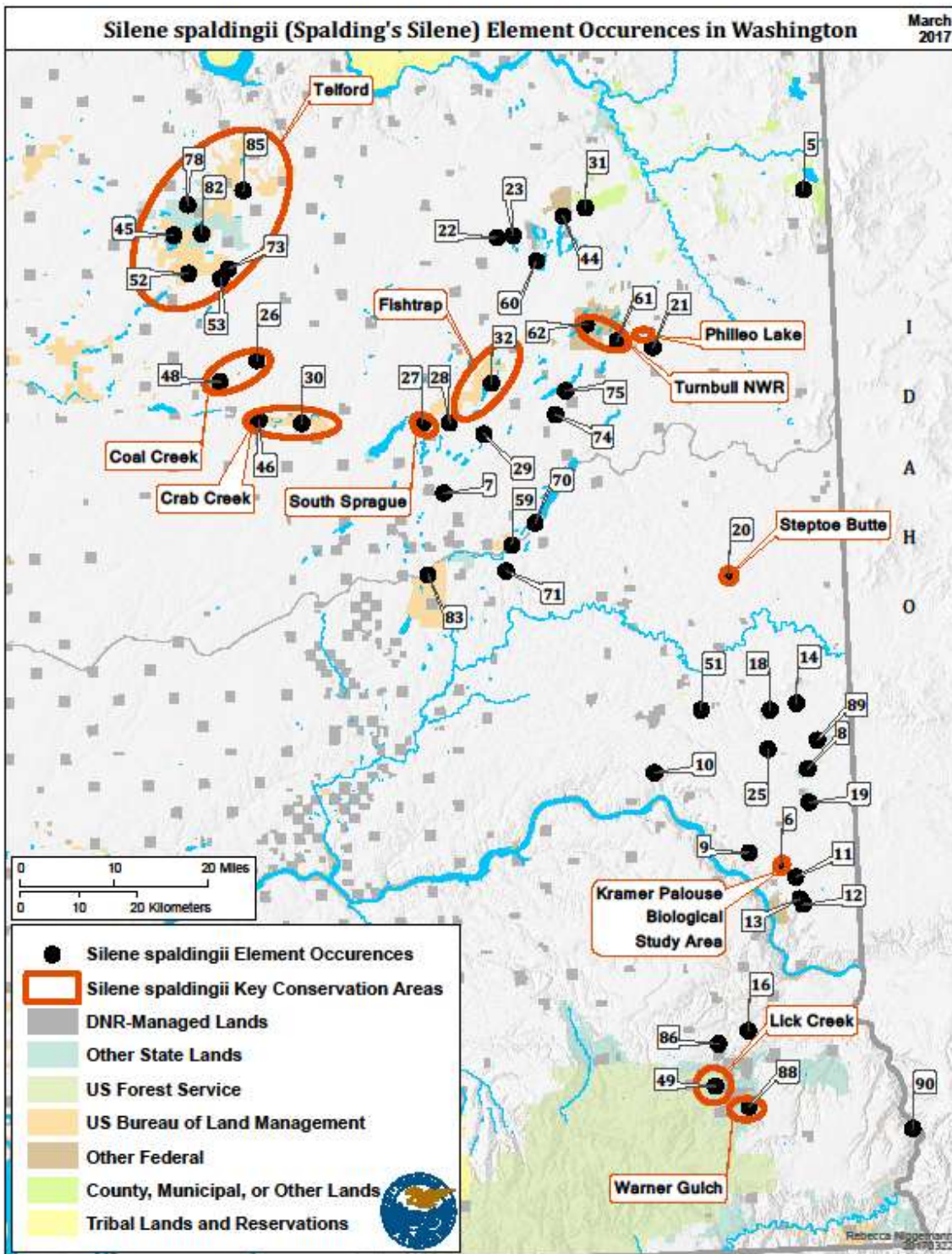


Figure 4. *Silene spaldingii* occurrences and Key Conservation Areas in Washington.

Silene spaldingii Observation Database: In 2017, WNHP received Section 6 funding from USFWS to develop an observation database to better record location and abundance data from monitoring of individual subpopulations of *S. spaldingii* in Washington. Rebecca Niggemann, former database manager with WNHP, and I developed an Arc-GIS database to record more than 80 biological and locational attributes for each sub-population and a system for aggregating site revisit data into “site” records, which in turn could be organized into higher hierarchical categories (sub-populations, element occurrences, and KCAs) (Niggemann and Fertig 2018). Data from existing element occurrences in WNHP’s Biotics database, the US Forest Service’s NRIS database, BLM’s GeoBOB database, and records from the Consortium of Pacific Northwest Herbaria were used to generate fields within the database. Ultimately, the *S. spaldingii* database could be used in other states within the species’ range, or be applied to other rare or common species (Niggemann and Fertig 2018).

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

Key Characteristics: *Silene spaldingii* is a perennial herb with 1 to several erect stems 20–60 cm tall. The stems and leaves are light yellowish-green and covered with soft, glandular hairs. Leaves are opposite, sessile, oblanceolate to lance-shaped, and 6–7 cm long. The pubescent calyx is green, tubular, 15 mm long, and 10-veined. Petals are greenish white and shallowly hour-glass shaped with a 2 mm entire or slightly notched blade above a 15 mm long obovate claw that tapers abruptly to a narrow base. Four short appendages are located at the junction of the blade and claw. Fruit capsules have 3 styles and open by 3–6 valves. *S. scouleri* differs in having deeply bi-lobed petals with terminal blades 4–8 mm long. *S. douglasii* has longer, bi-lobed white petals and mostly non-glandular pubescence.

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

Number of Occurrences in WA: Known from 46 extant, 4 potentially extirpated, and 4 historical occurrences in Washington (Table 17). Thirty-six occurrences have been relocated or discovered since 2000, with 12 documented in 2018. Two new occurrences were discovered in 2018: one extant and one historical that was not previously known. The 54 occurrences in Washington are comprised of over 500 discrete sub-populations (Niggemann and Fertig 2018). These are aggregated according to minimum distance criteria of 1–1.5 km (Arnett and Holt 2009). Element occurrences are aggregated into 11 “Key Conservation Areas” (KCA) divided among three main physiographic provinces: Canyon Grasslands, Channeled Scablands, and Palouse Grasslands (Table 16, 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). A population discovered in 2008 at Asotin Creek Wildlife Area contained at least 6000 plants. Most populations have been stable in recent years, suggesting that the total population in Washington is approximately 11,000-12,000 plants. Individual subpopulations 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).

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/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. The Cheney-Spangle Eyebrow occurrence is recognized in the Washington Register of Natural Areas.

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. April 2009.
- 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. October 19, 2011.
- 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. October 2001.
- 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. September 2002.

- 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. November 2003.
- 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. August 2005.
- 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.
- Conley, J.L. and J. Rebholz. 2018. *Silene spaldingii* (Spalding's catchfly) fiscal year 2018 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. 19 pp + app.
- Fertig, W. 2018a. *Silene spaldingii* - Spalding's catchfly. Pp. 64-72. In: Status of federally listed plant taxa in Washington state 2017. Natural Heritage Report 2018-02. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 77 pp.
- Fertig, W. 2018b. Cheney-Spangle Eyebrow Registry Site visit. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 6 pp.
- Gamon, J. 1991. Report on the status of *Silene spaldingii* in Washington. Washington Natural Heritage Program, Department of Natural Resources. Olympia, WA. June, 1991.
- 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. Published online: 18 April 2016.

- 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.
- Niggemann, R. and W. Fertig. 2018. Developing an observational database for Spalding's catchfly (*Silene spaldingii*). Natural Heritage Report 2018-11. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 13 pp.
- 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. Prepared for the U.S. Fish and Wildlife Service, Region 1. Washington Natural Heritage Program, Department of Natural Resources. Olympia, WA.

***Spiranthes diluvialis* - Ute ladies' tresses (Orchidaceae)**

2018 Research, Monitoring, and Updates

Annual Monitoring: The Rocky Reach occurrence was monitored for the nineteenth consecutive year in 2018 by staff of Public Utility District Number 1 of Chelan County (Pope and Cordell 2018). The number of flowering plants increased from 72 to 211 (Table 18). 2018 was the fifth straight year in which population numbers either increased or decreased from the previous year, illustrating the unstable nature of this occurrence. Numbers in 2018 are approximately one-half the long-term average of 420 plants for the site, and about 1/5 of the maximum number of 959 recorded in 2007. All 5 of the previously documented extant subpopulations experienced a population increase in 2017 (the PUD subpopulation again had 0 plants and has not been seen since 2010).

In 2018 Chelan PUD staff expanded their normal monitoring efforts to survey for additional potential *Spiranthes* habitat elsewhere in the Rocky Reach area. This effort resulted in the discovery of a new subpopulation at Hendricks Draw on the east bank of the Columbia River in Douglas County (a first report for that county). Only 4 plants were found at this privately-owned site (this number is included in the total for the entire occurrence). The population is located on an alluvial fan that was recently flooded and scoured following the 2015 Chelan Complex fire (Pope and Cordell 2018). This subpopulation could be threatened by future development, recreation activities, and impacts from invasive weeds. Although within a grazing allotment, the area is not being actively grazed (Pope and Cordell 2018).

In 2017 surveyors from Chelan PUD discovered two individuals of a putative hybrid between *Spiranthes diluvialis* and *S. romanzoffiana* at the Gallagher Flat subpopulation at Rocky Reach (Pope and Cordell 2017). These plants were relocated in 2018 and re-affirmed as likely hybrids based on the intermediate shape of the sepals and lip petal. The necessary genetic work to confirm their hybrid origin has not been done yet. *S. romanzoffiana* is the most common ladies'-tresses species in Washington, but is more commonly found in the mountains to the north and west of the Columbia River.

George Thornton revisited the Wannacut lake occurrence in Okanogan County observed 92 plants on 1 September 2018, most in late flower or fruit. This site had last been documented in 2011 when Thornton found only 15 plants in a brief visit to a subsection of the occurrence. The



Spiranthes diluvialis from Stocker subpopulation along Rocky Reach Reservoir, Chelan County, Washington, August 2018.

population had not been relocated in annual surveys from 2007-2009 and was once thought to be extirpated.

Vantage Substation: On 24 August, 2017, Ken McDonald discovered a new population of Ute ladies' tresses while conducting a survey of the Vantage to Pamona Heights Transmission line east of Wanapum Dam. This is just the third population 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 occurrence contained 23 plants in flower and fruit in 2017. It 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. 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).

Table 18. Summary of *Spiranthes diluvialis* monitoring on the Rocky Reach Reservoir, 2000-2018. From Pope and Cordell (2018).

Year	PUD Pond	Gallagher Flat	Stocker	BLM	WDFW	PUD Beebe	Hendricks	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
2018	25	35	67	55	25	0	4	211

Current Status Summary

Legal Status: USFWS Threatened (US Fish and Wildlife Service 1992).

Natural Heritage Rank: G2G3/S1; WA Endangered

Key Characteristics: *Spiranthes diluvialis* is a perennial herb with glandular-pubescent stems 12-60 cm tall from tuberous roots. Basal leaves are narrowly linear, up to 1 cm wide and 28 cm long. Leaves become progressively smaller up the stem and are alternate. The inflorescence is a sparsely pubescent 3-15 cm long spike of numerous white to ivory-colored flowers arranged in a gradual spiral. The lip petals are oval to lance-shaped and narrowed at the middle (fiddle-shaped) with wavy margins. Sepals are separate or fused only at the base and are often spreading at their tips. *S. romanzoffiana* has sepals fused for at least half of their length into a hood-like tube and short hairs on the stem and inflorescence. *S. porrifolia* has pale yellow flowers and strap-shaped lip petals with peg-like hairs on the upper surface (Fertig et al. 2005).

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, Douglas, Grant, and Okanogan counties in the Columbia Plateau, East Cascades, and Okanogan ecoregions.

Number of Occurrences: 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 and most recently in 2018. A larger population occurs at seven sites along the banks of the Rocky Reach Reservoir of the Columbia River (Chelan and Douglas counties) and has been monitored each year from 2000-2018. In 2017, a new population was discovered by Ken McDonald east of the Columbia River near the Vantage substation in Grant County (Fertig 2018).

Abundance: The Okanogan occurrence was estimated to contain about 200 plants in 1998-2000, but had 92 plants when revisited in 2018. At Rocky Reach, the population has ranged from a maximum 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. In 2018, the Rocky Reach occurrence contained 211 flowering plants, which is approximately half the 18-year average of 420 (Pope and Cordell 2018). 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 (Fertig et al. 2005).

Habitat: In Washington, found in alkaline flats around lakeshores where water levels may fluctuate widely between years, seasonally flooded shorelines of large reservoirs along the Columbia River, and shallow depressions associated with storm runoff in upland settings. Elevation ranges from 1830 ft (558 m)

Threats: Changes in hydrology (permanent inundation under reservoirs or water withdrawal), loss of habitat to development or agriculture, herbicides, competition from invasive weeds, and vegetation succession. One small subpopulation along Rocky Reach Reservoir appears to contain a few hybrid individuals with *S. romanzoffiana* (Pope and Cordell 2018)

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

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. Prepared for U.S. Fish and Wildlife Service, Region 1. Washington Natural Heritage Program, Department of Natural Resources. Natural Heritage Report 2012-07. December 7, 2012.
- 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. December 2004
- 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.
- Fertig, W. 2018. *Spiranthes diluvialis* - Ute ladies'-tresses. Pp. 73-77. In: Status of federally listed plant taxa in Washington state 2017. Natural Heritage Report 2018-02. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 77 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.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.
- Pope, V.R. and K.A. Cordell. 2018. Rocky Reach Reservoir Ute Ladies' Tresses (*Spiranthes diluvialis*) Monitoring Report, 2018: Annual monitoring summary, weed control, and 5-year survey effort. Public Utility District No. 1 of Chelan County, Fish and Wildlife Department, Wenatchee, Washington. 26 pp.

- 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. January 17, 1992.
- 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.