



## Status of Federally Listed Plant Taxa in Washington State

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

Prepared by  
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# **Status of Federally Listed Plant Taxa in Washington State**

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Cover: Ute ladies' tresses (*Spiranthes diluvialis*). Photo by Walter Fertig, WNHP, 22 August 2018.

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## 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, 356 vascular plant and 59 non-vascular plant taxa are listed as state Endangered, Threatened, or Sensitive in Washington (WNHP 2019).

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 (ESA) (Arnett and Goldner 2017; Fertig 2018, 2019). The following report contains a synthesis of new information from research and monitoring studies undertaken in 2020 for the twelve vascular plant species listed as Endangered or Threatened in Washington as of December 30, 2020 (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, 2020.** For 2020 Trend data, an \* indicates a long-term downward trend. See Table 2 for definitions.

Species name	Common Name	Heritage Rank	2020 Trend	Status	
				WA	USFWS
<i>Arenaria paludicola</i>	swamp sandwort	G1/SX	Extirpated	X	E
<i>Castilleja levisecta</i>	golden paintbrush	G2/S2	Upward*	T	To be delisted 2021
<i>Eriogonum codium</i>	Umatanum desert buckwheat	G1/S1	Downward*	E	T
<i>Hackelia venusta</i>	showy stickseed	G1/S1	Downward*	E	E
<i>Howellia aquatilis</i>	water howellia	G3/S2	Upward*	T	Delisted on 16 July 2021
<i>Lomatium bradshawii</i>	Bradshaw's lomatium	G2/S1	Upward	E	Delisted 2021
<i>Lupinus oregonus</i>	Kincaid's lupine	G4T2/S1S2	Stable	E	T
<i>Physaria douglasii</i> ssp. <i>tuplashensis</i>	White Bluffs bladderpod	G4?T2/S1	Stable*	T	T
<i>Pinus albicaulis</i>	whitebark pine	G3G4/S3	Downward*	S	propT
<i>Sidalcea nelsoniana</i>	Nelson's checker-mallow	G2G3/S1	Stable	E	T
<i>Sidalcea oregana</i> var. <i>calva</i>	Wenatchee Mountains checker-mallow	G5T1/S1?	Upward	E	E
<i>Silene spaldingii</i>	Spalding's catchfly	G2/S2	Stable	T	T
<i>Spiranthes diluvialis</i>	Ute ladies' tresses	G2G3/S1	Stable*	E	T

**Table 2. Key to Natural Heritage ranks and status.** This table includes the status and rank values used in Table 1.

<p><b>Heritage Rank</b> characterizes the Global (G for full species, T for varieties or subspecies) and State (S) rank assigned to each species based on its risk from extinction, range, abundance, trend, and threats.</p> <p><b>1 = Critically Imperiled</b> - 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><b>2 = Imperiled</b> - At high risk of extinction or elimination due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors.</p> <p><b>3 = Vulnerable</b> - 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><b>4 = Apparently Secure</b> - 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><b>5 = Secure</b> - 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><b>X = Presumed Extirpated</b> - Species is believed to be extirpated globally or 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><b>? = Inexact Numeric Rank</b> - Denotes inexact numeric rank.</p> <p>A numeric range rank (e.g., G1G2, S2S3) is used to indicate uncertainty about the exact status of a taxon or ecosystem type.</p>
<p><b>State Status</b> 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><b>E = Endangered.</b> In danger of becoming extinct or extirpated from Washington.</p> <p><b>T = Threatened.</b> Likely to become endangered within the near future in Washington if the factors contributing to population decline or habitat loss continue.</p> <p><b>X = Possibly extinct or Extirpated.</b> Documented to have previously occurred within Washington, but no longer thought to be present here.</p>
<p><b>USFWS (Federal) Status</b> under the U.S. Endangered Species Act as published in the Federal Register.</p> <p><b>E = Endangered.</b> Species is in danger of extinction throughout all or a significant portion of its range.</p> <p><b>T = Threatened.</b> Species is likely to become Endangered within the near future throughout all or a significant portion of its range.</p> <p><b>Prop = Proposed.</b> Species that has been formally proposed for listing as Endangered or Threatened in a notice published in the Federal Register, but a final listing rule is pending.</p> <p><b>C = Candidate.</b> Species 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>

## Methods

Information on monitoring, surveys, new research, and changes in status for listed plant species in Washington were derived from fieldwork conducted in 2020 by WNPS staff and colleagues working in consulting, academia, or for state and federal agencies (see Acknowledgements for a complete list). Monitoring studies entail revisiting known occurrences to census the entire population or re-read permanently established plots to extrapolate population numbers. Surveys may include visits to new areas of potential habitat to determine if the species of interest is present, or revisits to known sites that may not include formal monitoring. Some



additional information was derived from a review of recent published and unpublished literature (see references under each species for complete lists).

## Discussion and Recommendations

As of December 31, 2020, the state of Washington had 12 listed Threatened and Endangered vascular plant species under the ESA (Table 1). Three of these species, golden paintbrush (*Castilleja levisecta*), Bradshaw's lomatium (*Lomatium bradshawii*), and water howellia (*Howellia aquatilis*), were recently proposed for de-listing due to recovery. In April, 2021, the de-listing of Bradshaw's lomatium became official (USFWS 2021a). Water howellia will be formally removed from the ESA in July 2021 (USFWS 2021b). In late June, 2021, the Service is expected to announce a de-listing proposal for golden paintbrush (*Castilleja levisecta*), to be effective later in the year. Nelson's checkermallow (*Sidalcea nelsoniana*) is approaching recovery benchmarks and may be considered for de-listing in the next few years. There has been no change in ESA status for the other eight listed species from Washington.

In December 2020, whitebark pine (*Pinus albicaulis*) was formally proposed for listing as Threatened under the ESA (USFWS 2020). A final listing decision is expected in late 2021 or early 2022. There are currently no formal Candidate species for potential listing in the state (USFWS 2019). As many as 53 globally rare (G1, G2, T1, and T2) plant species may warrant consideration for designation as Candidates in the future due to their present status, threats, or downward trends (Fertig 2020).

Despite efforts to relocate populations in 2020, swamp sandwort (*Arenaria paludicola*) remains the only federally listed species in Washington that is either historical or potentially extirpated. This species is still extant in California, however. Most reports of swamp sandwort in Washington are based on misidentified specimens of other species in the Caryophyllaceae. The single confirmed report from the Tacoma area still needs to be revisited, though it is probable that this population has been lost due to urban development or completion from invasive plants.

Due to the Covid-19 pandemic, fewer occurrences of listed plant species were monitored in 2020 than normal. Despite incomplete data, five of the 11 extant listed species in Washington appeared to have increasing populations in 2020, four were stable (although with reduced numbers over the last decade or more), and two continued to decline (Table 1).

Both native and introduced populations of golden paintbrush in Washington showed an overall increase in numbers from 2019. Native occurrences, however, are still 86% below their peak numbers in 2012. Rangewide, the abundance of *Castilleja levisecta* has dropped from its highest point in 2018. New threats are also emerging, especially related to drought conditions during the past 7 years and a reduction in seed set due to loss of pollinators (Martin 2021, Dunwiddie and Pellant 2021). Other species showing short-term population increases in Washington are Water howellia, Bradshaw's lomatium, Nelson's checkermallow, and Wenatchee Mountains checkermallow (*Sidalcea oregana* var. *calva*). The long-term prognosis for water howellia and Wenatchee Mountains checkermallow is tempered by the continuing loss of habitat due to competition from invasive non-native plants, encroachment of woody vegetation in the

absence of disturbance, and projected environmental impacts from predicted climate change (Kleinknecht et al. 2019).

Of the four listed species considered stable in 2020, Kincaid's lupine (*Lupinus oregonus* var. *kincaidii*) is the only one with a long-term upward trend. Several occurrences of this species have not been revisited in recent years, however, and are still threatened by conversion of habitat to agriculture or development. Although stable over the past 3-4 years, the numbers of Ute ladies' tresses (*Spiranthes diluvialis*) and White Bluffs bladderpod (*Physaria douglasii* ssp. *tuplashensis*) have declined by over 50% during the past decade. Long-term trend data are lacking for most occurrences of Spalding's catchfly (*Silene spaldingii*), but the total number of extant populations and its range in eastern Washington has decreased in the past 100 years as Palouse grassland and Channeled scabland (lithosol) habitats have become increasingly fragmented.

Two of the state's rarest listed species show short-term and long-term declines. The native population of showy stickseed (*Hackelia venusta*) has declined by over 72% since the last thorough census was conducted in 2011. New out-plantings have been established within the core population and in additional areas of the Wenatchee Mountains to increase the number and size of populations. These new populations exhibit high rates of mortality, but some plants have been able to persist and are producing second-generation seedlings (Gibble 2020). Umtanum desert buckwheat (*Eriogonum codium*) has declined by 40-50% since monitoring began in 1997, due largely to mortality from wildfires and drought. Recent efforts to establish new occurrences outside of its core range are still in their early stages, but offer some hope of reducing the risk of another catastrophic wildfire destroying the remaining plants at the native population.

All of the state's federally listed Endangered and Threatened vascular plant taxa will benefit from continued monitoring to detect population trends and assess emerging threats in time to spark corrective management. The two de-listed species will continue to be monitored for several years to ensure that their populations remain stable or increase. Should these trends be reversed, the species could be considered for emergency listing again under the ESA. Monitoring of all listed species should be conducted in cooperation with USFWS, WNHP, the University of Washington's Rare Care program, and state or federal land management agencies, with data shared in the central repository of the WNHP database.

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## *Arenaria paludicola* - swamp sandwort (Caryophyllaceae)

### 2020 Research and Monitoring Updates

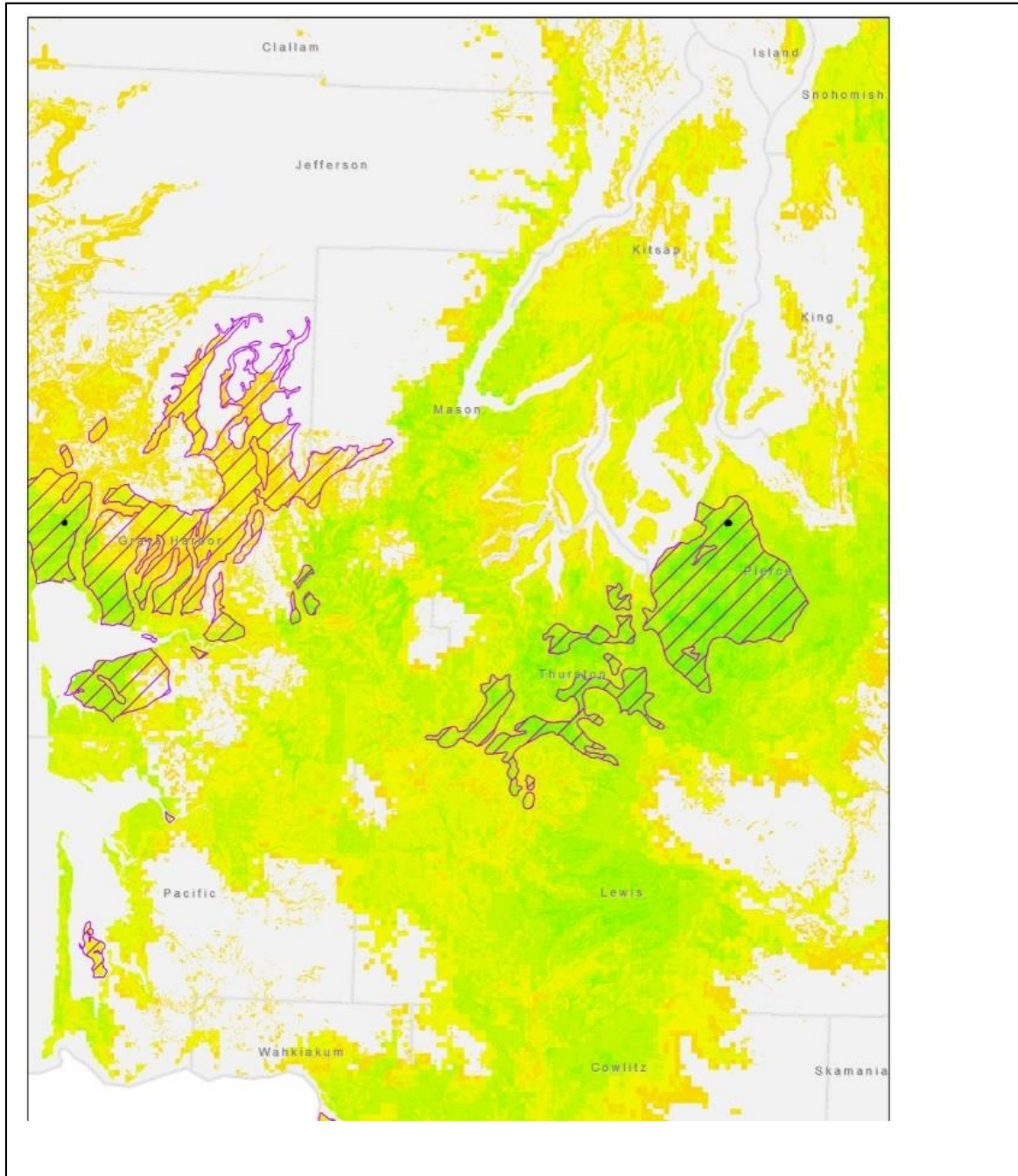
2020 Survey: Prior to 2020, *Arenaria paludicola* had not been formally surveyed in Washington State since the early 1990s (Gamon 1991). In 2020, WNHP received Section 6 funding from USFWS to relocate historical occurrences of this species and identify potential new sites for survey work. Jake Kleinknecht (WNHP database manager) and I developed a potential habitat model for *Arenaria paludicola* to help identify areas for survey. The GIS model was developed by overlaying values for mean monthly precipitation and temperature, soils, geology, landscape position, and vegetation with historical locations from Tacoma and Carlisle Bog Natural Area Preserve in Pierce and Grays Harbor County (Figure 1). Other historical reports based on misidentifications were excluded (Table 3). For improved accuracy, the report from “swamps near Tacoma” was remapped to Flett’s Creek in the Lakewood area based on information from John Gamon, former WNHP botanist.



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

On 6 July and 9 October 2020, I visited Carlisle Bog with Regina Johnson of the WA DNR Natural Areas Program. We were unable to relocate *Arenaria paludicola* at this site, where it had first been reported by Gordon Alcorn from a lakeshore in 1976 or 1979. Subsequent efforts to relocate this population in 1990, 2005, and 2006 were also unsuccessful. The site has a mix of hummocky peatlands bordering small ponds with *Empetrum nigrum*, *Vaccinium oxycoccus*, *Rhododendron groenlandicum*, *Kalmia microphylla*, *Myrica gale*, and *Rhynchospora alba* interspersed with marshes of *Carex obnupta*, *C. utriculata*, *Eriophorum chamissonis*, and *Sanguisorba officinalis* and forested swamps of *Tsuga heterophylla* and *Pinus contorta* var. *contorta*. Neither *Arenaria paludicola* nor other look-alike species in the Caryophyllaceae (such as *Stellaria borealis*) were observed in any of these habitats. Vegetative *Gentiana sceptrum* bears a resemblance to *Arenaria* in having elongated stems with narrow, opposite, glaucous leaves and may be the source of reports for *A. paludicola* at Carlisle Bog. In the absence of physical evidence (specimens or photos), the report of *A. paludicola* at this site may be erroneous, and the model of potential habitat built on environmental characteristics from this site may need to be re-done (Figure 1).

Rod Gilbert and I visited potential habitat for *Arenaria paludicola* in the extensive Spanaway Creek wetland complex on the east side of Joint Base Lewis-McChord (JBLM) on 17 June 2020, but were unsuccessful in documenting this species. The common, look-alike taxon, *Stellaria borealis* ssp. *sitchana* occurred frequently on floating mats of *Carex cusickii*, *Scirpus*



**Figure 1. Model of potential habitat of *Arenaria paludicola* in Washington.** Striped polygons contain the most likely habitat. Black points are known or reported historical occurrences in western Washington.

*microcarpus*, *Juncus effusus*, and *Comarum palustre* bordering dense stands of *Phalaris arundinacea* on the shoreline. *Arenaria paludicola* was also absent from 10 ephemeral wetland sites occupied by *Howellia aquatilis* on JBLM surveyed earlier in June.

Additional recent surveys in the Kennedy Creek wetland (Thurston County), Preacher’s Slough (Grays Harbor County), and Lake Terrell (Whatcom County) failed to locate populations of *Arenaria paludicola*. These areas all have dense and extensive patches of *Phalaris arundinacea*, which may out-compete *A. paludicola* for space and resources. Further work is planned in 2021 to visit wetlands in the Tacoma area identified in the model and the historical report from Mud Mountain dam in King County. For now, the species remains classified as “extirpated” in Washington.

**Table 3. Reported and Confirmed locations for *Arenaria paludicola* in Washington.**

Population	County	Ecoregion	Ownership	Yr last Obs	Comments	Status
Carlisle Bog (EO 6)	Grays Harbor	Pacific NW Coast	Carlisle Bog NAP	1976	Not relocated in 1990, 2005, 2006, or 2020	False Report or Extirpated?
Lake Sylvia State Park, Montesano	Grays Harbor	Pacific NW Coast	Lake Sylvia SP	1960	<i>Tveten s.n.</i> (PLU) misidentified, = <i>Stellaria borealis</i>	False Report
Mud Mountain (EO 2)	King	North Cascades	Unknown	1973	Not relocated in 1981 or 1987	False Report or Extirpated?
Campo Verde	Pierce	Puget Trough	Private	1972	<i>Creso s.n.</i> (PLU) misidentified; = <i>Stellaria borealis</i>	False Report
Flett Creek, Tacoma (EO 8)	Pierce	Puget Trough	Private	1896	Only WA report with a verified herbarium voucher.	Extirpated?
Stuart Island airport	San Juan	Puget Trough	Private	1984	<i>Atkinson 96</i> (WWB) is sterile, but appear to be <i>Stellaria borealis</i>	False Report
Happy Valley Tree Farm	Snohomish	Puget Trough	Private	1989	<i>Habermans.n.</i> (WTU) misidentified; = <i>Stellaria borealis</i>	False Report

### 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, sessile, linear to lance-shaped leaves that are widest at the base, 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 that are up to twice as long as the sepals. Other Washington

species in the Caryophyllaceae (especially *Stellaria borealis*) differ in having more egg-shaped leaves that are often narrowed at the base, hairy stems, flowers with 0 or 4 petals that are equal or shorter than the sepals, 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. This population is based on a collection by pioneer Washington botanist John Flett who ran a dairy along Flett’s Creek in the Lakewood area of South Tacoma (Fertig 2019). Despite extensive urban development in the past century, some marshy sites still occur in the area, including Seeley Lake Park, Wards Lake Park, and the northwest corner of Joint Base Lewis McChord. 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 that have not been corroborated or relocated since 1976.

Number of Occurrences in WA: *Arenaria paludicola* has been reported from seven locations in Washington (Table 3), of which four have been verified as false reports based on misidentifications. The remaining reports are all historical (last observed before 1981) and two may be false reports (the populations have not been relocated in recent years and there are no specimens for verification). The record from the Tacoma area may be the only valid report of this species from Washington, but was last observed in 1896 (Gamon 1991; Consortium of Pacific Northwest Herbarium records, March 2021).

Abundance: Considered extirpated in Washington. Efforts to relocate populations in Washington occurred in 1981, 1987, 1990, 2005, 2006, 2018, and 2020 and have all been unsuccessful.

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

Threats: In Washington, threatened by conversion of habitat to industrial or residential development and changes in plant communities through natural succession or invasion by aggressive or non-native species, such as *Phalaris arundinacea*. In California, one population is impacted by competition from other wetland plants due to enhanced productivity from 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 (reported) and private.

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# ***Castilleja levisecta* - golden paintbrush (Orobanchaceae)**

## **2020 Research and Monitoring Updates**

Washington Surveys: Despite the impacts of Covid-19 on travel and group gatherings, eight of the state's 10 extant naturally occurring populations of *Castilleja levisecta* were monitored in 2020. A total of 2,223 flowering plants were recorded at these occurrences (Table 4) (Dunwiddie and Pelant 2021, Sheehan 2020). The number of plants showed an increase of 19.2% from 2019 when 1,865 flowering plants were observed, but a decrease from 4,686 flowering individuals in 2018 (Fertig 2019). The increase in 2020 reverses a seven-year decline, but current numbers are still 86% lower than the peak count of 15,573 flowering plants in 2012 (Tables 4, 5).

Members of the golden paintbrush survey team\* also revisited nine of the ten established out-plantings for *Castilleja levisecta* in Washington. The number of flowering individuals in out-planted and augmented native sites increased 47.8% from 136,846 in 2019 to 202,208 in 2020 (Tables 4, 6) (Dunwiddie and Pelant 2021, Martin 2021). The current number of introduced plants is the second highest ever recorded in the state and the highest count since 2015.

Including both naturally -occurring and introduced populations, the total number of flowering plants of *Castilleja levisecta* in Washington is estimated to be 204,431 in 2020 (Tables 4, 5, Figure 2). Coupled with a recent decline in abundance in Oregon, Washington now has the largest population of *C. levisecta* in the world (Table 7).

Five new out-plantings have been initiated since 2018, but these are not currently included in the annual census until it can be determined that they are successfully established. These new populations include the Bayshore Preserve (Mason County), Colvin Ranch, Deschutes Preserve, and Riverbend Ranch (Thurston County), and Sabra Prairie (Grays Harbor County) (Martin 2021). Several recently established populations are no longer being included in annual counts due to problems with hybridization with *Castilleja hispida* (Table 8).

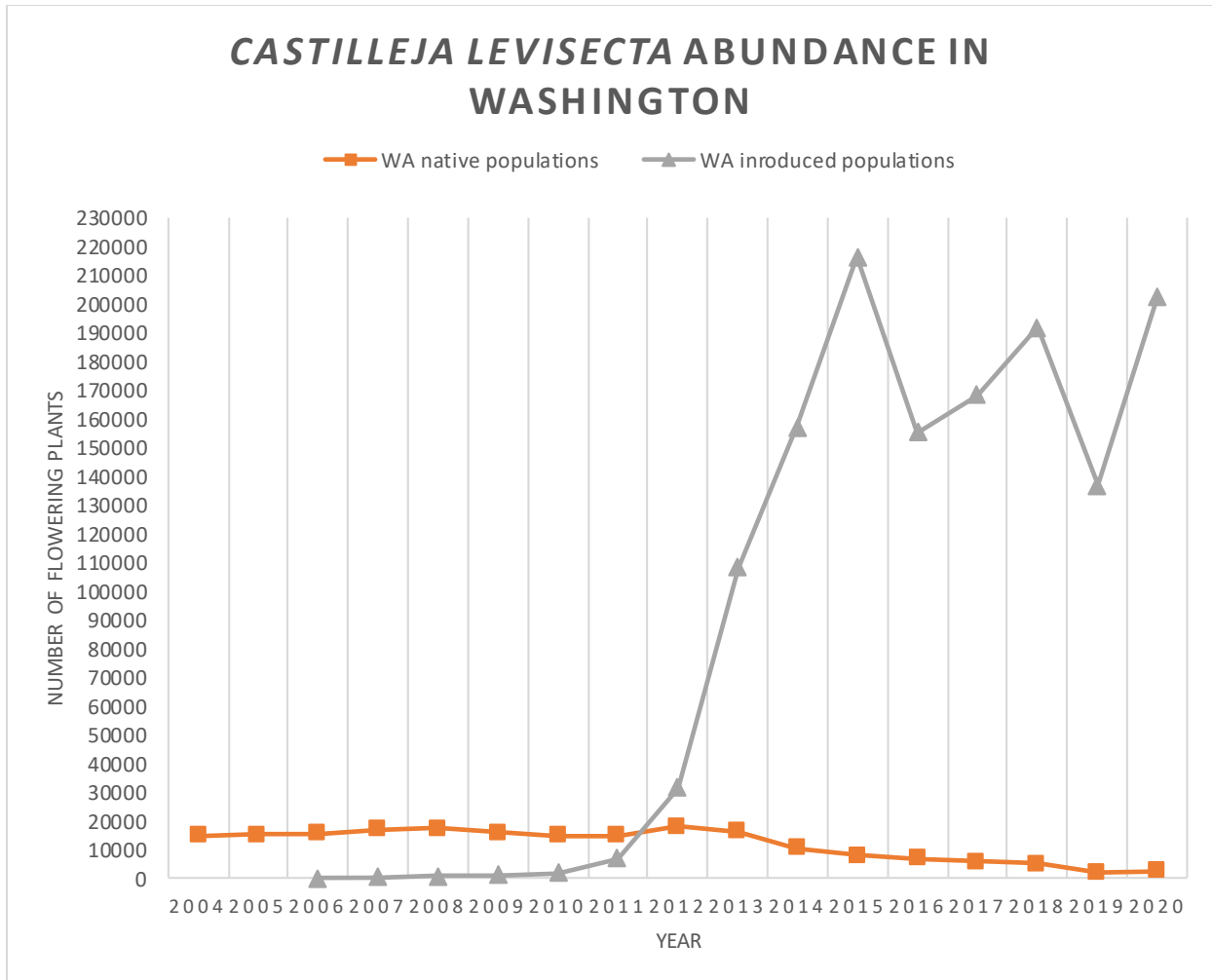


*Castilleja levisecta* at Smith Prairie, Whidbey Island, May 2019, By W. Fertig.

\* Participants in 2020 surveys included Peter Dunwiddie, Walter Fertig, John Hill, Regina Johnson, Adam Martin, Robert Pelant, Mark Sheehan, David Wilderman, and staff of WA DNR and the Center for Natural Lands Management.

**Table 4: 2019-2020 counts of extant native and out-planted populations of *Castilleja levisecta* in Washington.** Recently established out-plantings at Bayshore Preserve (Mason County), Colvin Ranch, Deschutes Preserve, and Riverbend Ranch (Thurston County), and Sabra Prairie (Grays Harbor County) do not meet recovery criteria yet and are excluded from these counts. Extirpated native populations and failed or abandoned out-plantings are listed in Table 8. \* Indicates out-planted and naturally-occurring individuals were not differentiated.

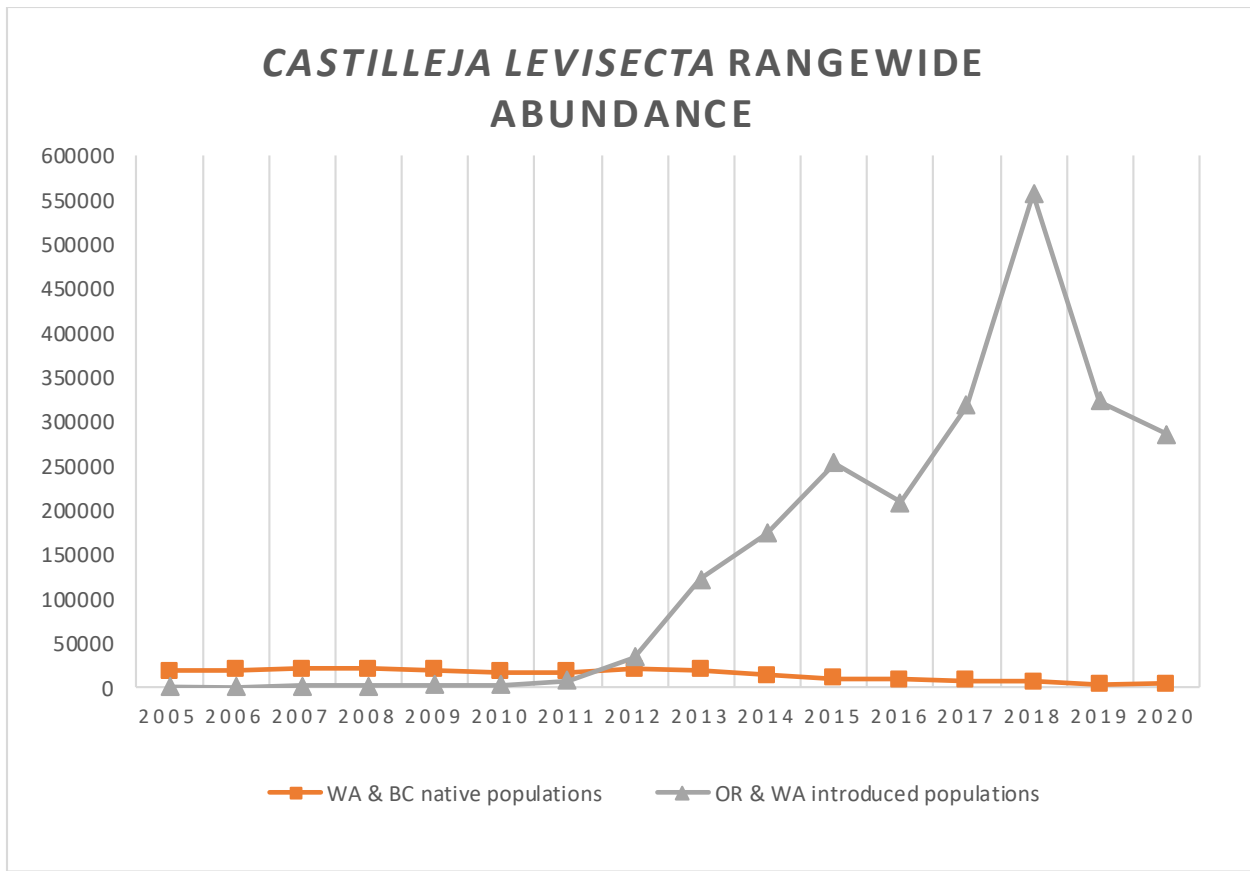
Population	2019			2020		
	Total Out-Planted	Naturally-Occurring	Total	Total Out-Planted	Naturally-Occurring	Total
<b>North Puget Sound</b>						
San Juan Island, American Camp	28	0	28	65	0	65
San Juan Island, Cady Mountain	39	0	39	31	0	31
San Juan Island, False Bay Middle (EO #020)	130	4	134	*	8	8
San Juan Island, False Bay South (EO #024)	0	77	77	0	No Data	No Data
San Juan Island, San Juan Valley (no EO #)	0	217	217	0	289	289
San Juan Island, West Side Preserve	10	0	10	6	0	6
USFWS Headquarters, Dungeness	2,962	0	2,962	2,485	0	2,485
Whidbey Island, Admiralty Inlet NAP, Naas Prairie Unit and North Bluff (EO #009a)	723	332	1,055	619	255	874
Whidbey Island, Admiralty Inlet NAP, South Bluff Prairie Unit (EO #009b)	263	34	297	489	61	550
Whidbey Island, Ebey's Landing	283	0	283	No Data	No Data	No Data
Whidbey Island, Forbes Point (EO #016)	68	28	96	*	128	128
Whidbey Island, Fort Casey (EO #005)	*	251	251	*	582	582
Whidbey Island, Hill Road – Ebey's Landing (EO #021)	0	32	32	0	213	213
Whidbey Island, Smith Prairie, PRI	20,747	0	20,747	22,421	0	22,421
Whidbey Island, West Beach (EO #012)	0	No Data	No Data	0	No Data	No Data
<b>South Puget Sound</b>						
Cavness	67,978	0	67,978	78,736	0	78,736
Glacial Heritage Preserve	29,781	0	29,781	82,692	0	82,692
Mima Mounds Natural Area Preserve	9,936	0	9,936	10,233	0	10,233
Rocky Prairie NAP (EO #011)	0	890	890	0	687	687
Wolf Haven, Tenino	3,898	0	3,898	4,431	0	4,431
<b>TOTAL</b>	<b>136,846</b>	<b>1,865</b>	<b>139,293</b>	<b>202,208</b>	<b>2,223</b>	<b>204,431</b>



**Figure 2. Abundance of native and introduced populations of *Castilleja levisecta* in Washington from 2004 to 2020.** Wild population numbers include census and extrapolated estimates (see Table 5).

British Columbia Surveys: Karen Stefanyk, Mike Stefanyk, Matt Fairbarns, and Jacques Sirois counted 784 mature individuals at Trial Island and 60 at Alpha Islet in 2020 (Table 5). Both populations continue their long-term decline. Trial Island had a peak of 3,192 flowering plants in 2006, but has since dropped by 75%. Alpha Islet has oscillated in numbers since first being documented in 1994, but has decreased by 95% since having 1,333 plants in 2004. The out-planting from Mini D’Arcy Islet dropped to 4 plants in 2018 and its current status is unknown. Eight other populations from the province are considered extirpated (Table 8).

Oregon Surveys: Historically, at least five native populations of *Castilleja levisecta* were known from Oregon, but none have been relocated since 1938 and are considered extirpated (Table 8). Since 2010, more than 30 introduced populations have been established in Oregon to meet recovery objectives for the species (Kaye 2019). Population numbers in Oregon peaked in 2018 with an estimated 364,811 flowering plants at 25 introduced sites in the Willamette Valley



**Figure 3. Change in abundance of all populations (native and out-planted) of *Castilleja levisecta* across its global range from 2005 to 2020.** Native population numbers include census and extrapolated estimates (see Table 5). The two trajectories of introduced plants in 2020 reflect actual population counts in Oregon (lower line) and projected counts (upper line) for out-planted sites that were not surveyed in 2020 due to Covid-19 issues.

(Fertig 2019) (Table 7). Numbers declined in 2019 to 199,345 (Kaye 2019), a decrease of 83%. Due to Covid restrictions, only seven of 32 introduced populations in the state were surveyed in 2020, with a total of 83,338 flowering plants (Table 7) (Tom Kaye, personal communication). If population counts from 2019 are carried over for the 25 populations that could not be surveyed in 2020, the estimated number of *C. levisecta* plants in Oregon would be about double at 166,634 (Table 7). This adjusted number would still represent a decline from 2019. The recent downward trend in Oregon is strongly correlated with decreases in just four extremely large populations (Finley NWR Pigeon Butte, Bellfountain Prairie, Fern Ridge, and Howell Savanna) which made up nearly 95% of the total state population in 2018 (Figure 3). Although reduced in number, these populations still exceed the USFWS recovery criteria for individual occurrences. Kaye (2019) has noted that successful older out-plantings tend to decline over time and stabilize at a lower, but more sustainable, population size.

**Table 5. Counted and Extrapolated Totals for all extant native *Castilleja levisecta* populations between 1980 and 2020.**

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 except where indicated by \* in 2020.

Occurrence	Year												
	1980	1983	1984	1985	1991	1993	1994	1995	1996	1997	1998	1999	2000
<b>British Columbia</b>													
Alpha Islet							2,560	[2,237]	[1,916]	[1,595]	[1,274]	953	[902]
Trial Island							1,000	[1,144]	[1,288]	[1,432]	[1,576]	[1,720]	[1,864]
Beacon Hill (extirpated ca 1993)					3	0	-	-	-	-	-	-	-
<b>Washington</b>	<b>1980</b>	<b>1983</b>	<b>1984</b>	<b>1985</b>	<b>1991</b>	<b>1993</b>	<b>1994</b>	<b>1995</b>	<b>1996</b>	<b>1997</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>
Davis Point (EO #23) extirpated							1	5	4	-	-	0	-
Long Island (EO #27) extirpated?											22	43	87
Rocky Prairie NAP (EO#11)		15,634	[13821]	[12008]	[10195]	[8,382]	[6,569]	[4,756]	2,942	[3,916]	[4,890]	5,864	[5,740]
San Juan Island False Bay Middle (EO#20)								128	50	[50]	[50]	[50]	[50]
San Juan Island False Bay North (EO #25)									100+	[100]	[100]	100 est	[83]
San Juan Island False Bay South (EO#24)									12+	[81]	150 est	[162]	[174]
San Juan Island, San Juan Valley (no EO#)													4,021
Whidbey Island, Admiralty Inlet NAP, Naas Prairie (EO#9a)			1,200+	2,700	[1487]	273	[328]	383	306	[336]	367	277	97
Whidbey Island, Admiralty Inlet NAP, South Bluff (EO# 9b)													
Whidbey Island, Forbes Point (EO#16)				2,700	[2,362]	[2,024]	[1,686]	1,346	[1,402]	[1,458]	[1,514]	1,572	1,882
Whidbey Island, Fort Casey (EO#5)	400	[344]	[288]	[232]	[176]	120	[172]	224	109	[144]	179	164	151
Whidbey Island, Hill Road - Ebey's Landing (EO#21)						4,000 est	[3,208]	[2,416]	1,625	[1,443]	[1,261]	1,079	7,627
Whidbey Island, West Beach (EO#12)						496	107	557	1,255	543	559	762	355
<b>WA &amp; BC Counted Total</b>	<b>400</b>	<b>15,634</b>	<b>1,200</b>	<b>5,400</b>	<b>3</b>	<b>4,889</b>	<b>3,668</b>	<b>2,643</b>	<b>6,403</b>	<b>543</b>	<b>1,277</b>	<b>10,814</b>	<b>14,220</b>
<b>WA &amp; BC [Extrapolated Total]</b>	<b>-</b>	<b>[344]</b>	<b>[14109]</b>	<b>[12240]</b>	<b>[14220]</b>	<b>[10406]</b>	<b>[11963]</b>	<b>[10553]</b>	<b>[4,606]</b>	<b>[10555]</b>	<b>[10665]</b>	<b>[1,932]</b>	<b>[8,813]</b>
<b>WA &amp; BC Counted &amp; [Extrapolated] Grand Total</b>	<b>400</b>	<b>15,978</b>	<b>15,309</b>	<b>17,640</b>	<b>14,223</b>	<b>15,295</b>	<b>15,631</b>	<b>13,196</b>	<b>11,009</b>	<b>11,098</b>	<b>11,942</b>	<b>12,746</b>	<b>23,033</b>

**Table 5, Continued.**

<b>Occurrence</b>	<b>Year</b>												
	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>
<b>British Columbia</b>													
Alpha Islet	[851]	800	[1,067]	1,333	[749]	165	155	[153]	[151]	[149]	[147]	[144]	[142]
Trial Island	[2,008]	2,150	[2,410]	[2,670]	[2,930]	3,192	[3,089]	[2,985]	[2,881]	[2,777]	[2,673]	[2,569]	2,465
Beacon Hill (extirpated)	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>Washington</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>
Davis Point (EO #23) extirpated	-	0	-	-	-	-	0	-	-	-	-	-	-
Long Island (EO #27) extirpated?	[120]	154	-	-	-	-	-	-	-	-	-	-	-
Rocky Prairie NAP (EO#11)	[5,616]	5,493	[6,014]	[6,535]	7,056	[7,834]	[8,613]	9,392	[8,322]	[7,252]	6,183	8,910	[7,240]
San Juan Island False Bay Middle (EO#20)	[50]	50 est	[50]	50 est	[52]	54	40	42	33	32	20	11	22
San Juan Island False Bay North (EO #25) extirpated?	[66]	[49]	[32]	15 est	-	-	-	-	0	-	-	-	-
San Juan Island False Bay South (EO#24)	[187]	200+	[228]	[256]	[284]	312	401	453	407	319	430	193	245
San Juan Island, San Juan Valley (no EO#)	[5,190]	[6,359]	7,528	[6,965]	[6,402]	[5,839]	[5,276]	[4,713]	[4,150]	[3,587]	[3,024]	[2,461]	[1,898]
Whidbey Island, Admiralty Inlet NAP, Naas Prairie (EO#9a)	97	98	122	59	120	94	86	148	241	274	347	1,128	841
Whidbey Island, Admiralty Inlet NAP, South Bluff (EO# 9b)										80	71	67	103
Whidbey Island, Forbes Point (EO#16)	1,834	711	765	532	123	260	105	201	56	50	18	54	84
Whidbey Island, Fort Casey (EO#5)	166	185	307	235	260	760	1,544	1,713	1,497	1,538	2,471	2,534	1,196
Whidbey Island, Hill Road - Ebey's Landing (EO#21)					669	214	747	601	[1,044]	1,487	1,984	2,656	4,612
Whidbey Island, West Beach (EO#12)	167	53	54	82	130	189	69	97	75	47	65	20	14
<b>WA &amp; BC Counted Total</b>	<b>2,264</b>	<b>9,894</b>	<b>8,776</b>	<b>2,306</b>	<b>8,358</b>	<b>5,240</b>	<b>3,147</b>	<b>12,647</b>	<b>2,309</b>	<b>3,827</b>	<b>11,589</b>	<b>15,573</b>	<b>9,582</b>
<b>WA &amp; BC [Extrapolated Total]</b>	<b>[14088]</b>	<b>[6,408]</b>	<b>[9,769]</b>	<b>[16426]</b>	<b>[10417]</b>	<b>[13673]</b>	<b>[16978]</b>	<b>[7,851]</b>	<b>[16548]</b>	<b>[13765]</b>	<b>[5,844]</b>	<b>[5,174]</b>	<b>[9,280]</b>
<b>WA &amp; BC Counted &amp; [Extrapolated] Grand Total</b>	<b>16,352</b>	<b>16,302</b>	<b>18,545</b>	<b>18,732</b>	<b>18,775</b>	<b>18,913</b>	<b>20,125</b>	<b>20498</b>	<b>18,857</b>	<b>17,592</b>	<b>17,433</b>	<b>20,747</b>	<b>18,862</b>

**Table 5. Continued**

<b>Occurrence</b>	<b>Year</b>						
	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>	<b>2020</b>
<b>British Columbia</b>							
Alpha Islet	[140]	[138]	[136]	[134]	131	[95]	60
Trial Island	[2,132]	[1800]	[1,468]	[1,135]	801	798	784
Beacon Hill (extirpated)	-	-	-	-	-	-	-
<b>Washington</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>	<b>2020</b>
Davis Point (EO #23) extirpated	-	-	-	-	-	-	-
Long Island (EO #27) extirpated?	-	-	-	-	-	-	-
Rocky Prairie NAP (EO#11)	5,569	[4583]	3,597	[3,390]	3,183	890	687
San Juan Isl., False Bay Middle (EO#20)	16	6	5	28	4	4	8
San Juan Isl., False Bay North (EO #25)	-	-	-	-	-	-	-
San Juan Isl., False Bay South (EO#24)	321	232	134	171	38	77	[77]
San Juan Isl., San Juan Valley (no EO#)	1,336	477	664	466	96	217	289
Whidbey Isl., Admiralty Inlet NAP, Naas Prairie (EO#9a)	658	536	404	550	364	332	255
Whidbey Isl., Admiralty Inlet NAP, South Bluff (EO# 9b)	109	94	57	46	29	34	61
Whidbey Isl., Forbes Point (EO#16)	108	60	40	27	19	28	128*
Whidbey Isl., Fort Casey (EO#5)	227	952	1004	375	953	251	582*
Whidbey Isl., Hill Road - Ebey's Landing (EO#21)	2191	883	766	687	[360]	32	213
Whidbey Isl., West Beach (EO#12)	18	24	11	9	[9]	[9]	[9]
<b>WA &amp; BC Counted Total</b>	<b>10,553</b>	<b>3,264</b>	<b>6,682</b>	<b>2,359</b>	<b>5,618</b>	<b>2,663</b>	<b>3,067</b>
<b>WA &amp; BC [Extrapolated Total]</b>	<b>[2,272]</b>	<b>[6,521]</b>	<b>[1,604]</b>	<b>[4,659]</b>	<b>[369]</b>	<b>[104]</b>	<b>[86]</b>
<b>WA &amp; BC Counted &amp; [Extrapolated] Grand Total</b>	<b>12,825</b>	<b>9,785</b>	<b>8,286</b>	<b>7,018</b>	<b>5,987</b>	<b>2,767</b>	<b>3,153</b>

**Table 6: Out-planted populations of *Castilleja levisecta* in Washington.** Counts based only on flowering plants that meet recovery criteria. \* Indicates out-planted and naturally occurring individuals were not differentiated. X = indicates an established out-planting that eventually failed. Xh = indicates an out-planting that was abandoned due to hybridization with *Castilleja hispida*. New out-plantings that have been started since 2019, or older attempts that failed to become established, are excluded.

Out-Planting or Augmentation	2006	2007	2008	2009	2010	2011	2012	2013
<b>North Puget Sound</b>								
Kah Tai Prairie, Port Townsend (X)	-	18	No data	14	2	3	No data	No data
Protection Island (X)	-	-	-	-	-	-	-	-
San Juan Island, American Camp	-	-	-	-	-	-	-	-
San Juan Island, Cady Mountain	-	-	-	-	-	-	-	-
San Juan Island, False Bay Middle (EO #020)	-	-	-	-	-	-	19	26
San Juan Island, False Bay South (EO #024)	-	-	-	-	-	76	35	34
San Juan Island, West Side Preserve	-	-	-	-	-	-	-	-
USFWS Headquarters, Dungeness	-	-	-	-	-	-	-	-
Waldron Island, Bitte Baer Preserve (X)	-	-	-	-	22	23	22	67
Whidbey Island, Admiralty Inlet NAP, Naas Prairie Unit and North Bluff (EO #009a)	-	-	449	770	733	1,367	1,655	1,079
Whidbey Island, Admiralty Inlet NAP, South Bluff Prairie Unit (EO #009b)	-	-	-	-	-	-	-	-
Whidbey Island, Ebey's Landing	-	-	-	-	-	-	1,739	4,308
Whidbey Island, Forbes Point (EO #016)	12	55	161	41	220	60	116	108
Whidbey Island, Fort Casey (EO #005)	-	135	138	78	170	410	402	232
Whidbey Island, Perego's Bluff (X)	-	-	-	-	-	-	-	-
Whidbey Island, Smith Prairie, PRI	-	-	-	14	186	1,355	12,250	9,106
<b>South Puget Sound</b>								
Cavness	-	-	-	-	-	-	-	-
Glacial Heritage Preserve	-	-	-	-	97	3,016	11,141	87,457
Mima Mounds Natural Area Preserve	-	-	-	106	78	216	313	347
Morgan-Tenalquot (Xh)	-	-	-	-	89	108	1,029	619
Scatter Creek South (X)	-	-	-	-	156	129	117	25
West Rocky Prairie (Xh)	-	-	-	-	91	84	2,353	3,201
Wolf Haven, Tenino	-	-	-	-	32	No data	246	1,349
<b>Southwest WA</b>								
Steigerwald NWR (Xh)	-	-	-	-	-	-	-	-
<b>TOTAL</b>	<b>12</b>	<b>208</b>	<b>748</b>	<b>1,023</b>	<b>1,876</b>	<b>6,847</b>	<b>31,437</b>	<b>107,958</b>



**Table 6: Continued**

<b>Out-Planting or Augmentation</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>	<b>2020</b>
<b>North Puget Sound</b>							
Kah Tai Prairie, Port Townsend (X)	1	3	3	X	X	X	X
Protection Island (X)	-	66	113	69	X	X	X
San Juan Island, American Camp	-	185	91	29	15	28	65
San Juan Island, Cady Mountain	-	-	-	-	30	39	31
San Juan Island, False Bay Middle (EO #020)	21	19	10	22	95	130	*
San Juan Island, False Bay South (EO #024)	15	4	1	X	X	X	X
San Juan Island, West Side Preserve	-	12	10	7	7	10	6
USFWS Headquarters, Dungeness	-	-	-	-	1,304	2,962	2,485
Waldron Island, Bitte Baer Preserve (X)	78	53	X	X	X	X	X
Whidbey Island, Admiralty Inlet NAP, Naas Prairie Unit and North Bluff (EO #009a)	2,329	1,813	915	1,363	1,081	723	619
Whidbey Island, Admiralty Inlet NAP, South Bluff Prairie Unit (EO #009b)	-	-	-	-	386	263	489
Whidbey Island, Ebey's Landing	3,143	1,112	No data	416	373	283	No Data
Whidbey Island, Forbes Point (EO #016)	186	108	55	84	75	68	*
Whidbey Island, Fort Casey (EO #005)	137	184	161	*	953	*	*
Whidbey Island, Perego's Bluff (X)	-	7	7	X	X	X	X
Whidbey Island, Smith Prairie, PRI	5,291	14,854	13,865	22,544	9,458	20,747	22,421
<b>South Puget Sound</b>							
Cavness	-	75,985	47,334	79,910	121,550	67,978	78,736
Glacial Heritage Preserve	134,098	108,647	83,355	53,614	40,724	29,781	82,692
Mima Mounds Natural Area Preserve	749	992	817	801	6,314	9,936	10,233
Morgan-Tenalquot (Xh)	1,677	1,974	297	720	Xh	Xh	Xh
Scatter Creek South (X)	83	32	19	19	X	X	X
West Rocky Prairie (Xh)	6,380	6,747	4,468	700	Xh	Xh	Xh
Wolf Haven, Tenino	2,970	3,616	3,546	8,075	9,112	3,898	4,431
<b>Southwest WA</b>							
Steigerwald NWR (Xh)	-	-	-	-	451	Xh	Xh
<b>TOTAL</b>	<b>157158</b>	<b>216413</b>	<b>155067</b>	<b>168373</b>	<b>191928</b>	<b>136846</b>	<b>202,208</b>

**Table 7. 2018-2020 counts of flowering plants in introduced populations of *Castilleja levisecta* in Oregon.** Table does not include out-planted populations that have failed to become established or are extirpated (see Table 7). \* indicates a new population added in 2019. ! indicates data sampling issues and numbers not reported. If the 25 populations cited as “no data” or “present” in 2020 had the same number of plants as in 2019, the adjusted total for 2020 would be 166,634.

<b>Oregon Population</b>	<b>County</b>	<b>2018 Out-Planted</b>	<b>2019 Out-Planted</b>	<b>2020 Out-Planted</b>
<b>Corvallis West Recovery Zone</b>				
Bald Hill Park	Benton	4	3	1
Beazell Memorial Forest (Beazell)	Benton	1,369	997	No data
Cardwell Hill (Percy-Schoener)	Benton	353	307	No data
Finley NWR, Bald Top (Bluebird Strip)	Benton	3,411	9,422	Present!
Finley NWR, Bellfountain Prairie	Benton	24,263	16,337	21,177
Finley NWR, Field 1	Benton	390	655	843
Finley NWR, Field 29 (includes large east and west plots from previous years)	Benton	3,333	6,413	9,254
Finley NWR, Pigeon Butte (includes Fender's Prairie from previous years)	Benton	224,814	91,913	51,425
Fitton Green	Benton	856	706	No data
*Fort Hoskins	Benton	-	120	No data
Herbert Farm	Benton	3	296	567
Lupine Meadows Preserve	Benton	579	303	No data
<b>Eugene East Recovery Zone</b>				
*Courtney Creek	Linn	-	60	No data
Dorena Prairie (Dorena Lake)	Lane	4	20	No data
<b>Eugene West Recovery Zone</b>				
Carnine	Lane	144	170	71
Coyote Prairie	Lane	220	83	No data
Fern Ridge (USACOE)	Lane	50,820	46,569	No data
Hollyer	Lane	19	0	No data
*TNC Willow Creek	Lane	-	131	No data
Wild Iris Ridge	Lane	32	15	No data
<b>Portland Recovery Zone</b>				
Cooper Mountain Nature Park	Washington	250	143	No data
Graham Oaks	Clackamas	32	55	No data
Howell Regional Park, Howell Savanna	Multnomah	49,208	16,978	No data
Peach Cove	Clackamas	No data	37	No data
*St. Johns landfill	Multnomah	-	30	No data
Tualatin River NWR, Tualatin-Olsen	Washington	605	1,357	No data
<b>Salem East Recovery Zone</b>				
Jefferson Farm (Heritage Jefferson)	Marion	3	426	No data
<b>Salem West Recovery Zone</b>				
Ankeny National Wildlife Refuge (NWR)	Marion	256	2,600	No data
Baskett Slough NWR, Baskett Butte East	Polk	1,468	1,025	No data
Baskett Slough NWR, Baskett Butte West	Polk	2,375	2,147	No data
*Noble Oaks (TNC)	Polk	-	19	No data
*Yamhill Oaks South (TNC)	Yamhill	-	8	No data
<b>Total # Flowering Plants in OR</b>		<b>364,811</b>	<b>199,345</b>	<b>83,338</b>

**Table 8: Native and out-planted populations of *Castilleja levisecta* in Washington, British Columbia, and Oregon that are abandoned, historical, or extirpated.**

Population	Land District/ County	Year Last Observed	Status
<b>British Columbia</b>			
Beacon Hill	Victoria	1991	Presumed Extirpated, not relocated since 1991 (not found 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
<b>Oregon</b>			
Bon neville	Multnomah	1905	Extirpated
Brownsville	Linn	1922	Extirpated
Field 31, Finley NWR	Benton	2014	Failed out-planting
Kingston Prairie Preserve	Marion	2010	Failed out-planting
Lebanon	Linn	1929	Extirpated
Oak Creek	Benton	2011	Failed out-planting
Peterson Butte	Linn	1938	Extirpated
Salem	Marion	1916	Extirpated
<b>Washington</b>			
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
Scatter Creek South	Thurston	2017	Abandoned; site will be managed for <i>Castilleja hispida</i> (Taylor's checkerspot habitat) in future

Population	Land District/ County	Year Last Observed	Status
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	Site probably unsuitable; encroachment of <i>C. hispida</i> increases likelihood of hybridization; 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

\*relocated in 2021 and still extant with 25-30 plants, but no data from 2015-2020

**Rangewide Population Totals and Trends:** The total, range-wide population of *Castilleja levisecta* reached a record high of approximately 562,726 flowering plants in 2018 (Tables 5, 6, 7). Since then, the overall population has declined to 325,320 plants in 2019 and 288,699 in 2020 (Figure 3), a decrease of 49%. The 2020 totals exclude 25 populations from Oregon that were not surveyed due to Covid restrictions. If 2019 data were included for these missing populations, the total rangewide abundance would be 372,257 plants and represent an increase over 2019. Even if unadjusted, the 2020 counts still represent the fourth highest number of *C. levisecta* plants recorded since monitoring began in 1980 (Figure 3). Rangewide population numbers have increased by 425% since 2012.

Presently, out-planted individuals from introduced and augmented native populations outnumber wild plants from native populations by a factor of 90:1. Out-planted individuals comprised 98.9% of the total population of *Castilleja levisecta* observed in Washington, Oregon, and British Columbia in 2020 (Tables 4-7).

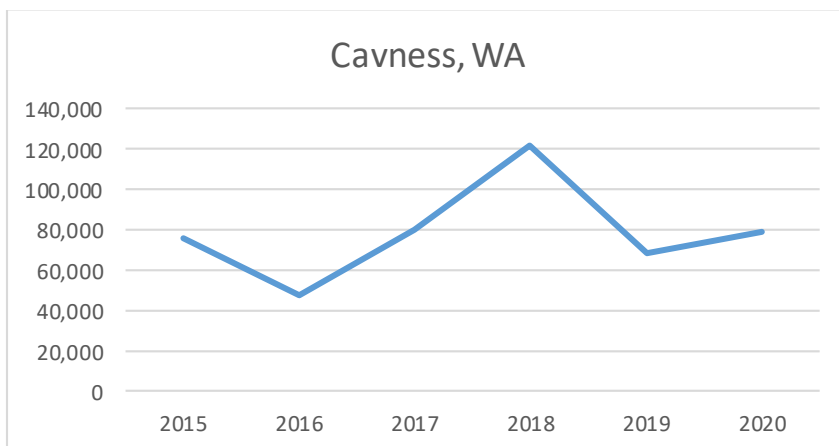
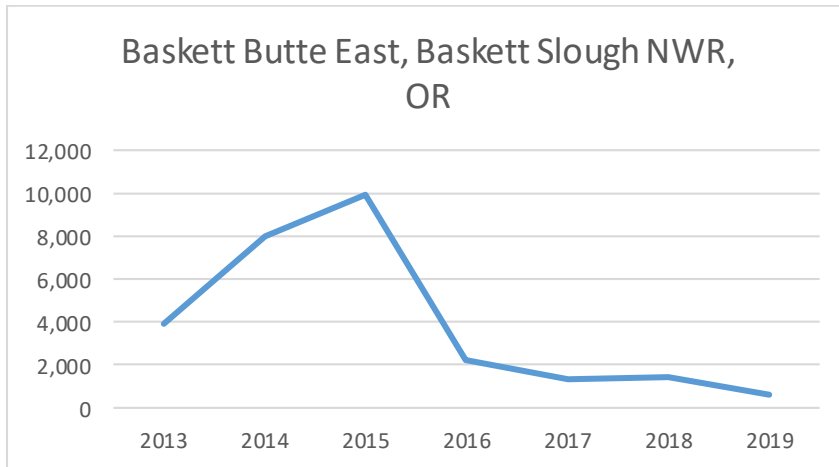
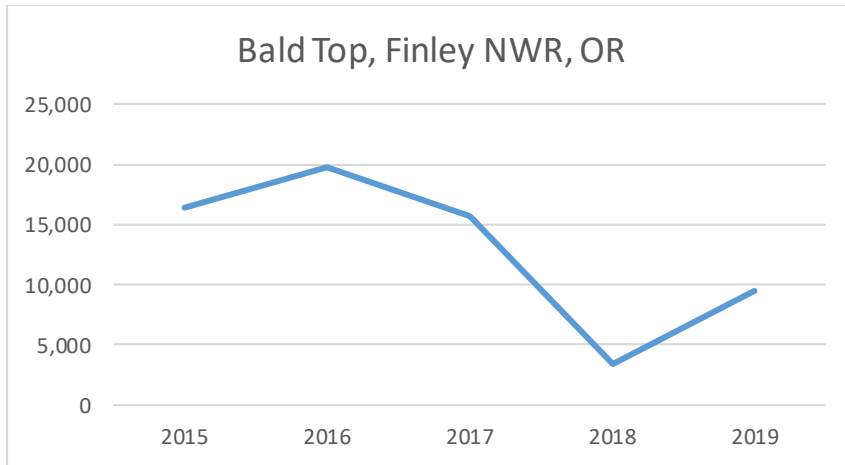
Native populations in Washington increased in 2020 for the first time since 2012. Long-term, the native populations in the state have declined 78% since their peak year in 2000 (Table 5). Part of the increase observed at Fort Casey State Park and Forbes Point in 2020 was due to previously introduced plants not being distinguished from wild plants (Dunwiddie and Pelant 2021). Differentiating between introduced and wild individuals in augmented populations is becoming increasingly problematic at all sites, especially as second generation individuals become established. Future counts may need to treat native and introduced individuals the same in augmented populations. The increase in wild plants at San Juan Valley and Ebey's Landing-Hill Road helped overcome the continued decline of populations at Rocky Prairie and Trial Island (British Columbia). 2020 marked the first time since monitoring began in 1980 that

Trial Island displaced Rocky Prairie as the largest surviving native population of *Castilleja levisecta*. Presently, no native populations of *C. levisecta* exceed 1000 individuals and none are meeting recovery criteria for de-listing.

In spite of Covid restrictions, all but two of the native populations in Washington and British Columbia were revisited in 2020 (Tables 4-5). As in previous years, population estimates for occurrences that were not revisited were extrapolated from incremental changes from previous years, based on the system developed by Arnett and Goldner (2017). These missing populations only accounted for 86 plants in 2020, or less than 3% of the total population (Table 5).

Abundance can vary markedly from year to year in monitored populations, depending on climate conditions, survivorship of mature individuals, or recruitment of new seedlings (Martin 2021). Demographic plots at Cavness, Glacial Heritage, and Wolf Haven exhibited high rates of seed production in 2018, followed by steep decreases in 2019 and a rebound in 2020. These same sites had matching increases and decreases in total numbers of flowering and vegetative (non-reproductive) plants and new seedling recruits from 2018-2020 (Martin 2021). Fluctuations in the numbers of flowering plants at all occurrences over time are summarized in Table 9, and includes the minimum and maximum counts for each population, long-term population average (1980-2020) and average abundance over the past 5 years (2016-2020).

There can be great variability in abundance both across populations and between years within the same population. The five-year and long-term average population size is typically 1/4 to 1/2 smaller than the maximum count (Table 9). For 8 of the 12 native occurrences in Washington and British Columbia, the average number of flowering plants over the last five years is smaller than the long-term average, indicating these populations are declining. The formerly large native occurrence at Rocky Prairie NAP has been in an overall decline since 1983, punctuated by intermittent periods of short term increases (Figure 4). Three of the four native occurrences that have increased (Admiralty Inlet Naas Prairie and Bluff units and False Bay Middle) have been augmented by out-plantings that are now significantly more abundant than the native patches (Table 4). By contrast, 32 of 43 introduced populations have 5-year averages equaling or exceeding the long-term average. This appears to be driven primarily by a period of exponential growth in the first few years of a successful introduction (Figures 3, 4) (Kaye 2019). When population change is plotted over time, nine of the 11 largest out-plantings exhibit a sharp decline over the past 1-5 years after attaining a maximum abundance (Figure 4). Some populations in Oregon have continued to grow or rebounded following a decline due to additional seed being released (Tom Kaye, personal communication). These populations may continue to grow in the short-term, but are more likely to experience a decline like other large out-plantings toward a smaller, equilibrium population (Kaye 2019).



**Figure 4. 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. Some Oregon out-plantings were not censused in 2020.

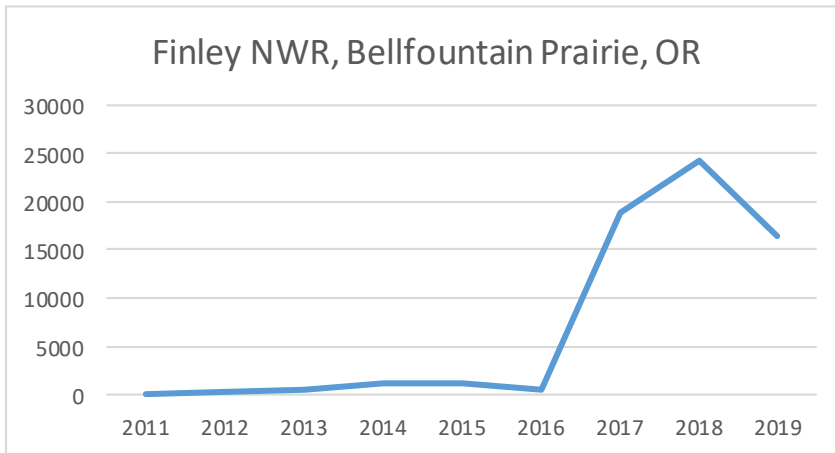
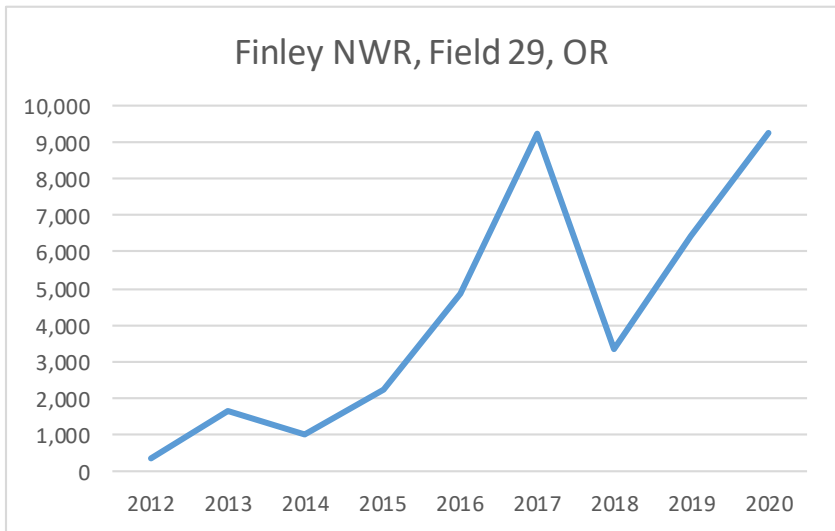
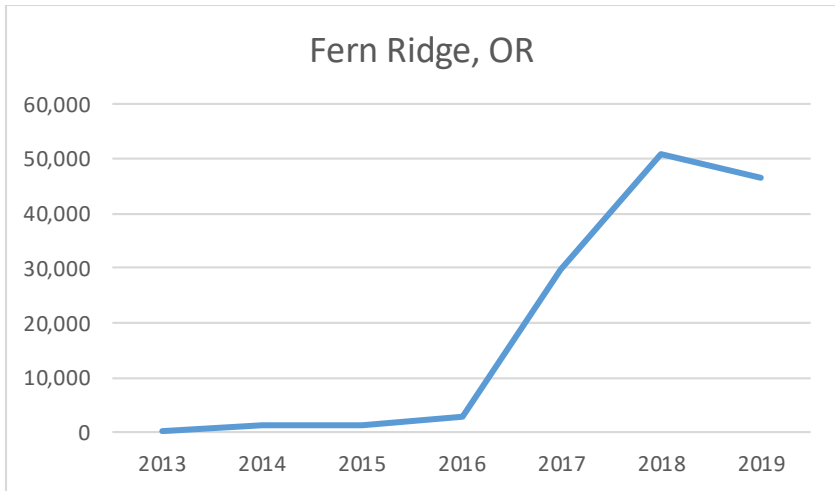


Figure 4. Continued.

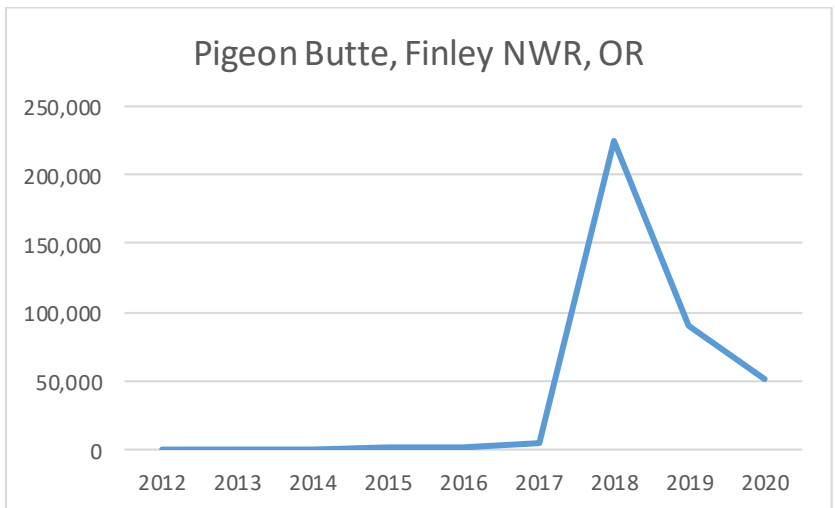
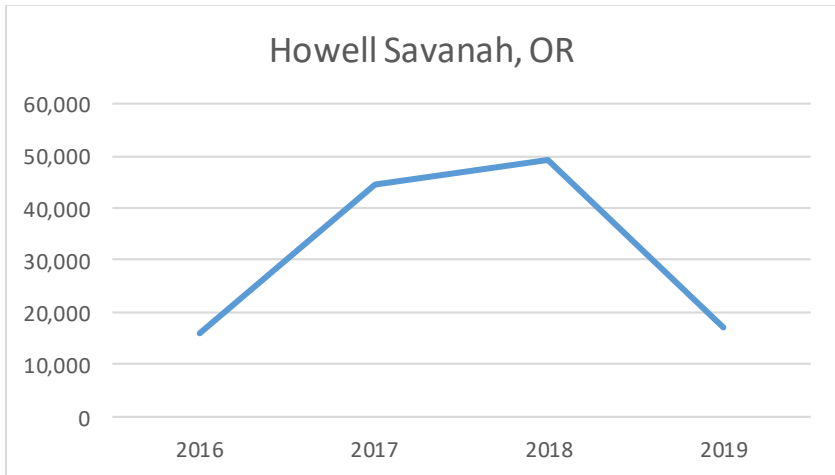
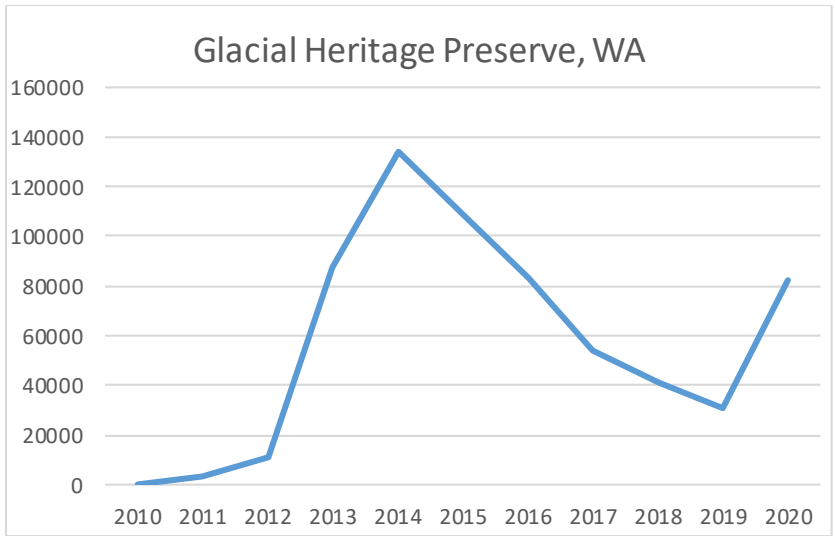


Figure 4. Continued.



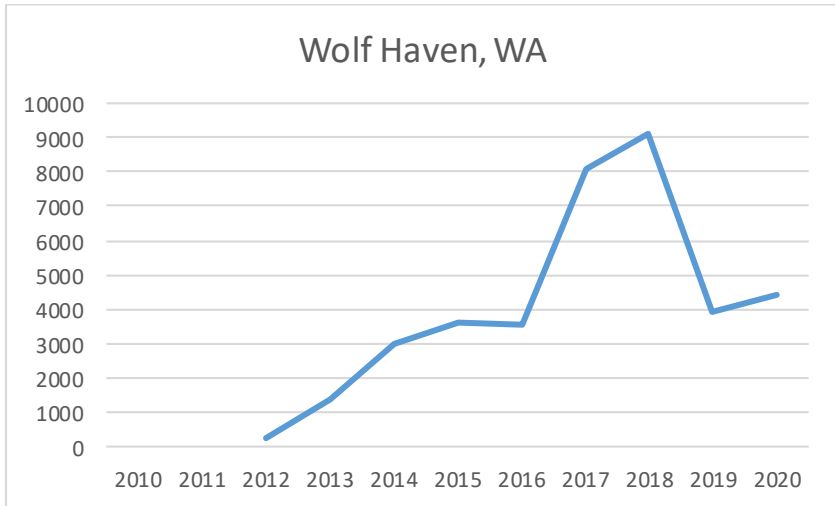
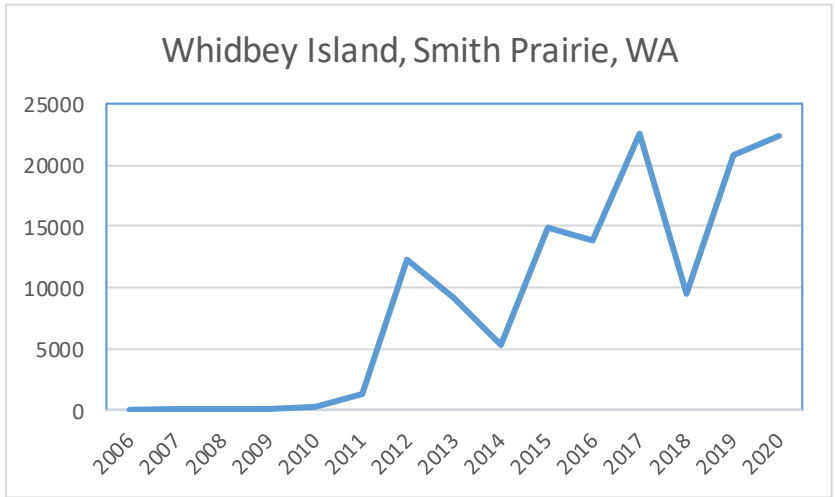
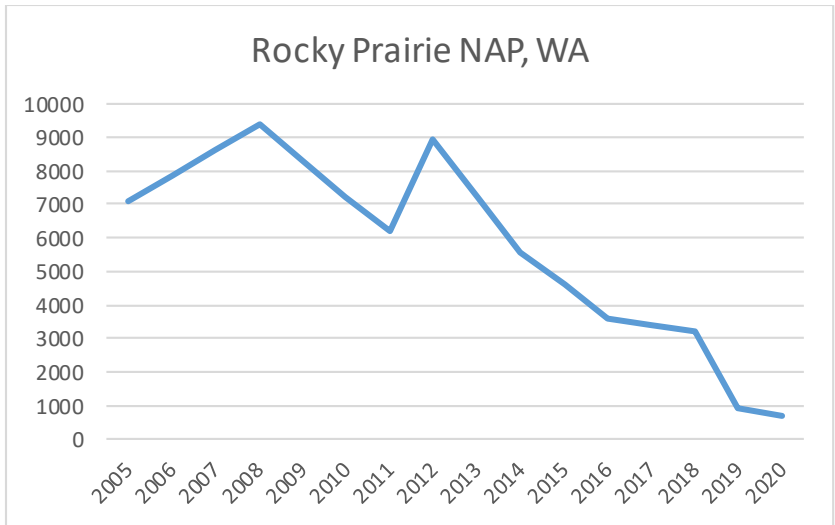


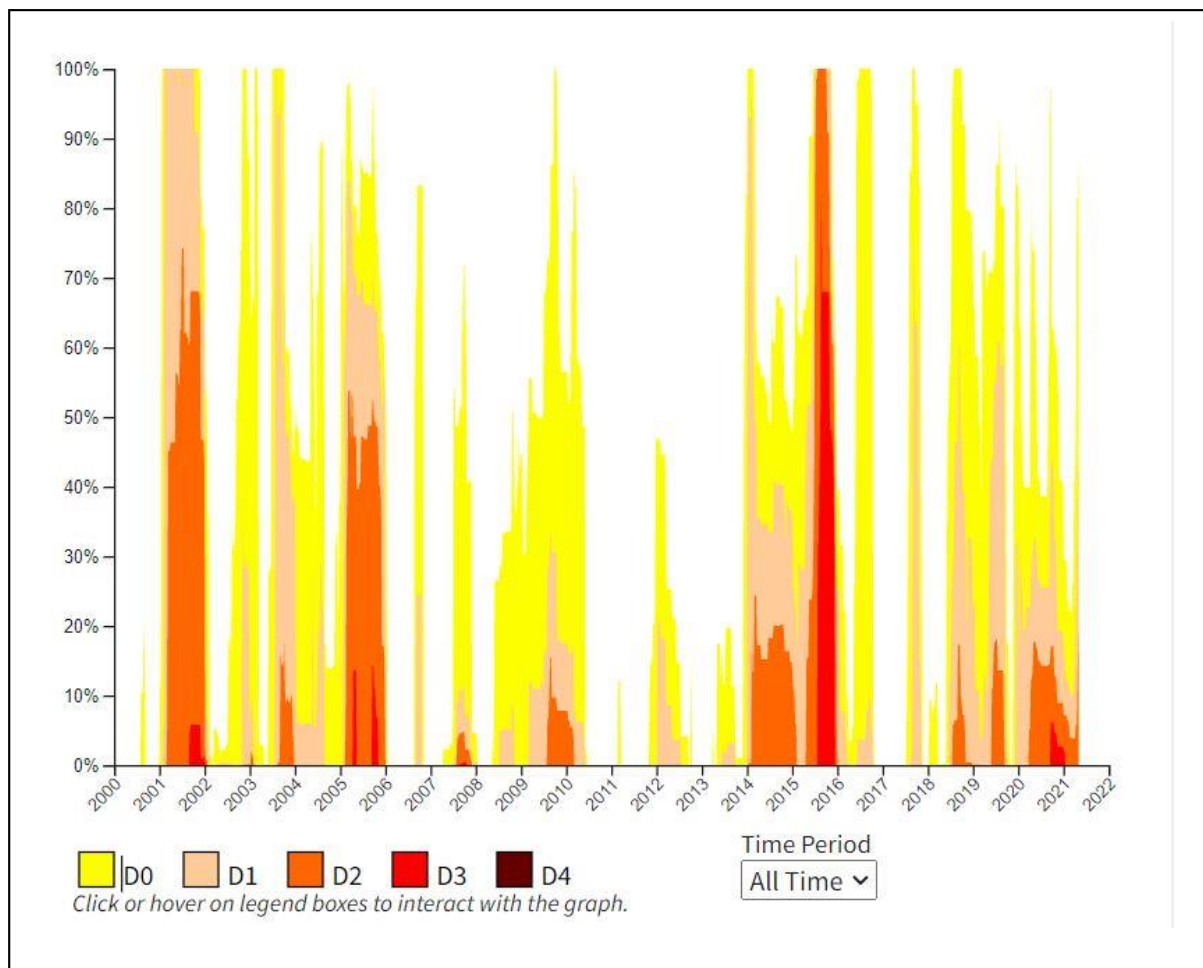
Figure 4. Continued.

**Table 9. Minimum, maximum, long-term average and 5-year average population counts for all extant native and out-planted *Castilleja levisecta* populations.** Native (N) or Out-planted (O) status is indicated in column 1. See text for discussion of *r*, CV, and Viability Index. “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 Cond refers to expert assessment of habitat and management conditions (USFWS 2018). \* Indicates new populations that have not previously been counted towards recovery. Table excludes populations that are no longer eligible for recovery due to hybridization issues, or which have failed or been abandoned. **Bolded** populations presently meet USFWS recovery criteria for 5-year average population size, stable to upward trend, and formal protection.

Population	Min Pop	Max Pop	Long-term Avg	5 year Avg (2016-20)	<i>r</i>	CV	Viability Index	Formal Protect	USFWS Cond
<b>British Columbia</b>									
Alpha Islet (N)	60	2,560	575	96	-1.00	0.526	1		Mod
Mini D'Arcy Islet, Gulf Islands Nat. Preserve (O)	2	243	42	4	-0.759	1.23	0	x	Low
Trial Island (N)	784	3,192	1,821	794	-0.937	0.011	1		Mod
<b>Oregon</b>									
<b>Corvallis West Recovery Zone</b>									
Bald Hill Park (O)	1	4	3	3	-0.683	0.365	1		Low
Bezell Memorial Forest (O)	74	3,299	1,362	946	0.717	0.339	2	x	High
Cardwell Hill (Percy-Schoener) (O)	307	678	465	348	-0.753	0.362	1	x	Mod
<b>Finley NWR, Bald Top (Bluebird Strip) (O)</b>	3	19,744	9,247	12,065	-0.736	0.502	2	x	High
<b>Finley NWR, Bellfountain Prairie (O)</b>	45	24,263	8,439	16,237	0.793	0.754	3	x	High
Finley NWR, Field 1 (O)	32	1,120	633	536	-0.189	0.598	1	x	Mod
<b>Finley NWR, Field 29 (includes large East &amp; West plots) (O)</b>	352	9,254	4,256	6,611	0.615	0.503	3	x	High
<b>Finley NWR, Pigeon Butte (includes Fender's Prairie) (O)</b>	24	224,814	41,839	74,917	0.454	1.394	2	x	High
Fitton Green (O)	38	856	428	629	0.802	0.476	2	x	Mod
*Fort Hoskins (O)	120	120	120	120	na	na	0		
Herbert Farm (O)	4	296	289	289	na	na	0		Low
Lupine Meadows Preserve (O)	186	689	442	526	0.038	0.356	2	x	High
<b>Eugene East Recovery Zone</b>									
*Courtney Creek (O)	60	60	60	60	na	na	0		
Dorena Prairie (Dorena Lake) (O)	4	20	12	12	na	na	0		Low
<b>Eugene East Recovery Zone</b>									
Carnine (O)	56	170	102	102	0.353	0.499	2		Mod
Coyote Prairie (O)	79	220	120	127	0.082	0.437	2	x	Mod
<b>Fern Ridge (USACOE) (O)</b>	172	50,820	18,939	32,457	0.933	0.895	3	x	High
Hollyer (O)	19	76	33	33	-0.977	0.988	1		Low
*TNC Willow Creek hayfield (O)	131	131	131	131	na	na	0		
Wild Iris Ridge (O)	15	32	21	21	-0.108	0.436	1		Low
<b>Portland Recovery Zone</b>									
Cooper Mountain Nature Park (O)	5	250	83	101	0.680	1.213	1		Mod
Graham Oaks (O)	32	132	80	67	-0.601	0.578	1		Low
Howell Regional Park, Howell Savanna (O)	16,007	49,208	31,723	31,723	0.054	0.558	3		High
Peach Cove (O)	37	116	76	56	-0.999	0.522	1		Low

Population	Min Pop	Max Pop	Long-term Avg	5 year Avg (2015-19)	r	CV	Viability Index	Formal Protect	USFWS Cond
*St. Johns (Portland) (O)	9	30	20	20	na	na	0		
Tualatin River NWR Field 5S (O)	2	1,357	655	655	0.968	1.037	1	x	Mod
<b>Salem East Recovery Zone</b>									
Jefferson Farm (Heritage Jefferson) (O)	3	426	215	215	na	na	0		Low
<b>Salem West Recovery Zone</b>									
<b>Ankeny NWR (O)</b>	194	2,600	1,017	1,017	0.877	1.349	2	x	Mod
Baskett Slough NWR, Baskett Butte East (O)	1,025	9,925	3,972	1,510	-0.774	1.187	1	x	High
<b>Baskett Slough NWR, Baskett Butte West (O)</b>	136	2,796	1,019	1,878	0.711	0.689	3	x	High
*Noble Oaks (TNC) (O)	19	19	19	19	na	na	0	x	
Yamhill Oaks South (O)	8	8	8	8	na	na	0		
<b>Washington</b>									
<b>North Puget Sound</b>									
San Juan Island, American Camp (O)	15	185	69	46	-0.676	0.922	1	x	Low
San Juan Island, Cady Mountain (O)	20	39	30	33	0.812	0.260	2		Low
San Juan Island, False Bay Middle (EO 020) (N, O)	4	128	51	61	0.338	0.921	2		Low
San Juan Island, False Bay South (EO 024) (N, O)	12	506	251	106	-0.843	0.597	1		Low
San Juan Island, San Juan Valley (no EO #) (N)	96	7,528	346	384	-0.688	0.559	1	x	Low
San Juan Island, West Side Preserve (O)	6	12	9	8	-0.686	0.270	1	x	Low
<b>USFWS Headquarters, Dungeness (O)</b>	1,304	2,962	2,250	2,250	0.692	0.379	3	x	High
Whidbey Island, Admiralty Inlet NAP, Naas Prairie Unit (EO 009a) (N, O)	59	2,987	977	1,332	-0.839	0.366	2	x	High
<b>Whidbey Island, Admiralty Inlet NAP, South Bluff Unit (EO 009b) (N, O)</b>	29	550	227	396	0.786	0.443	2	x	Mod
Whidbey Island, Ebey's Landing (O)	283	4,308	1,625	357	-0.937	0.698	1		Mod
Whidbey Island, Forbes Point (EO 016) (N, O)	18	2,700	586	105	-0.395	0.251	1	x	Low
Whidbey Island, Ft. Casey (EO 005) (N, O)	109	2,936	823	680	-0.644	0.534	1	x	High
Whidbey Island, Hill Road – Ebey's Landing (EO 21) (N)	32	7,627	1,782	425	-0.928	0.720	1	x	Mod?
Whidbey Island, Smith Prairie, PRI (O)	4	22,544	8,816	17,807	0.451	0.311	3		High
Whidbey Island, West Beach (EO 012) (N)	9	1,255	230	10	-0.921	0.555	1		No data
<b>South Puget Sound</b>									
<b>Cavness (O)</b>	47,343	121,550	78,582	78,551	0.34	0.35	3	x	High
Glacial Heritage Preserve (O)	97	134,098	57,749	63,397	-0.12	0.48	2		Mod
<b>Mima Mounds Natural Area Preserve (O)</b>	78	10,223	2,575	5,620	0.924	0.943	3	x	High
Rocky Prairie NAP (EO 011) (N)	687	15,634	5,802	2,089	-0.905	0.725	2	x	High
Wolf Haven (O)	32	9,112	3,728	5,568	-0.65	0.67	2		High

Growing evidence suggests that population fluctuations observed since 2015 may be correlated with high spring temperatures and drought in western Washington over the same time period. Martin (2021) has shown that the percentage change in number of flowering *C. levisecta* plants since 2015 is strongly correlated ( $R^2 = 0.791$ ) with the percentage difference in potential evapotranspiration from the historic average. Drought records in western Washington (Figure 5) since 2000 ([www.drought.gov/states/washington](http://www.drought.gov/states/washington)) show three major droughts in 2001, 2005, and 2015 and several smaller ones (2004, 2009, 2014, 2019, 2020). Out-planted populations across Washington increased during the wet period from 2011 to 2015, declined following the 2015 drought, rebounded in the wet period of 2017-2018, and then decreased in the 2019 drought (Figures 2, 5). Native populations are harder to assess due to frequent data gaps (extrapolations to fill these gaps may dampen inter-annual variability), but show a 29% decline in the drought year of 2001 and a long-term (86% decline) from 2013-2019, a period in which four of seven years were in drought (Figures 2, 5, Table 5).



**Figure 5. Drought in Washington from 2000-2021.** D0 = abnormally dry; D1 = moderate drought, D2 = severe drought, D3 = extreme drought, D4 = exceptional drought. From Drought.gov ([www.drought.gov/states/washington](http://www.drought.gov/states/washington)).

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 whether a species warrants de-listing.

Table 9 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 (2016-2020) 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 9). 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 9 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 9) 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).

Based on 2020 monitoring data, 17 of the 52 extant native and introduced populations of *Castilleja levisecta* eligible for recovery (32.7%) have a five-year average of at least 1000 flowering individuals (Table 9). Twenty-eight of 52 native and introduced occurrences in Oregon and Washington are formally protected (53.8%). Currently 11 populations in Oregon and Washington (Table 9) meet the *C. levisecta* recovery plan objectives of having a 5-year average of over 1,000 flowering plants, a positive or stable population trend, and are formally protected (Bald Top, Bellfountain Prairie, Finley Field 29, Pigeon Butte, Fern Ridge, Ankeny NWR, and Baskett Butte West in Oregon and Dungeness, Admiralty Inlet NAP Naas Prairie, Cavness, and Mima Mounds NAP in Washington). Another six occurrences meet recovery criteria for 5-year average population size but are either experiencing a downward trend (Baskett Slough East in Oregon and Rocky Prairie NAP in Washington) or are not sufficiently protected at present (Howell Savanna in Oregon and Smith Prairie, Glacial Heritage, and Wolf Haven in Washington) based on USFWS criteria.

Twenty-three populations have a positive Pearson's  $r$ , (44.2%) indicating there is a positive correlation between population growth and time over the past 5 years (Table 9). At least 38 of 52 sites (73.0%) have a Coefficient of Variance <1, indicating that annual population counts have been relatively stable from 2016-2020. Only nine populations have a Viability Index score of 3 (Bellfountain Prairie, Finley Field 29, Fern Ridge, Howell Savanna, and Baskett Butte West in Oregon and Dungeness, Smith Prairie, Cavness, and Mima Mounds NAP in Washington), while another 15 sites have a score of 2 (Table 9). Lastly, 18 populations have a "high" score for their USFWS Condition Assessment (34.6%) and another 12 are rated moderate (23.1%).

Hybridization Strategy: In 2020, USFWS convened a working group with WA Department of Natural Resources and the WA Department of Fish and Wildlife to develop a strategy to reduce hybridization between *Castilleja levisecta* and *C. hispida* in western Washington prairies. Historically, these two species were not known to occur in sympatry in prairie habitats and were not suspected to hybridize. *Castilleja hispida* is a preferred forage and oviposition species for the Endangered Taylor's checkerspot butterfly (*Euphydryas editha taylori*) and so has been planted at several sites in the Puget Trough ecoregion to promote the recovery of that species (Haan et al. 2021). Hybridization between diploid races of *C. hispida* and *C. levisecta* (always a diploid) can result in fertile progeny capable of reproducing with other hybrid individuals or back-crossing with either parent species (Kaye and Blakely-Smith 2008, Sandlin 2018). Several *C. levisecta* out-planted populations (including Steigerwald National Wildlife Refuge, West Rocky Prairie State Wildlife Area, Tenalquot Preserve, Glacial Heritage Preserve) have become too over-run with hybrid plants to still qualify as recovery populations, and low levels of hybridization could threaten other sites (Mima Mounds NAP and Wolf Haven Preserve) (Dunwiddie and Pellant 2019, Fertig 2019). The hybridization strategy was developed to reduce the likelihood of unintentional mixing of the two *Castilleja* species by identifying specific sites in the North and South Puget Sound areas that will prioritize the management of either *C. levisecta* or *C. hispida*/Taylors checkerspot. The strategy also provides a decision framework for conservation practitioners to avoid introducing new populations of one *Castilleja* species within 1-2 km of the other (US Fish and Wildlife Service et al. 2021, in ed.).

Observation Database: In 2019, WNHP received Section 6 funding from USFWS to develop an observation database to better record location and abundance data for both native and

introduced populations of *Castilleja levisecta* in Washington. Previously, data for native extant and historical occurrences were maintained in the WNHP Biotics database, but information from out-planted populations was kept separately in an Excel spreadsheet and paper files. The new *C. levisecta* observation database was designed to track the precise location of each out-planting in GIS, as well as the source material of the population (plugs or seeds), yearly monitoring data, and whether the out-planting was augmenting an existing native occurrence. The final database records 511 separate observation records distributed among 23 native occurrences and 31 introduced populations (Kleinknecht and Fertig 2020). The observation database will be used to store new information from on-going monitoring and out-planting efforts in the future.

Climate Change Vulnerability Index: As part of a USFWS Section 6 grant, *Castilleja levisecta* and three other federally listed plant species were evaluated using the NatureServe Climate Change Vulnerability Index (Kleinknecht et al. 2019, Young et al. 2016). The index was developed to rate and prioritize plant and animal species based on their response to projected climate change using environmental predictors (changes in temperature and precipitation) and various life history characteristics (such as dispersal ability, reproductive biology, genetic diversity, and habitat specialization). *C. levisecta* was ranked as Highly Vulnerable (full report is available at [https://www.dnr.wa.gov/publications/amp\\_nh\\_ccvi\\_cale.pdf](https://www.dnr.wa.gov/publications/amp_nh_ccvi_cale.pdf)) due to its sensitivity to competition from non-native plant species, reliance on few pollinators, and documented impacts from existing drought and anomalous high spring temperatures (Kleinknecht et al. 2019).

## **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 lobe, and pubescence of the stems, leaves, and bracts that is soft and slightly sticky. Yellow-flowered forms of *Castilleja hispida* (which is usually orange) have more deeply divided bracts and upper leaves and longer corollas with the tubular upper lobe 4-5 x longer than the lower lobe. Hybrid individuals between these species can be recognized by flowers with orange to yellow bracts and corolla tubes 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 Clallam, Island, Jefferson, San Juan, and Thurston

counties within the Puget Trough ecoregion. Additional populations have been out-planted in Grays Harbor and Mason counties, but these have not been present long enough to be considered established. Golden paintbrush is extirpated in Clark, 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 2020, there were an estimated 2,223 flowering plants in 10 extant native occurrences and 202,208 flowering individuals in established out-plantings or augmentation sites. The total state population is currently estimated at 204,431 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. Historically, island prairies may have 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. Prior to European settlement, fire was probably significant in maintaining open prairie conditions (Gamon 1995).

Threats: Historically, the most significant threats to *Castilleja levisecta* have been conversion of prairie habitat to agriculture or residential development, competition with non-native plants, encroachment of forest vegetation, fire suppression, recreation, and loss of pollinators (Gamon 1995, US Fish and Wildlife Service 2000). Additional significant threats that have emerged in the past 20 years include spring and summer drought, herbivory by deer, elk, and rabbits, and hybridization with *Castilleja hispida* (Dunwiddie and Pellant 2020, 2021, Fertig 2019, Kaye 2019, Kaye and Blakely-Smith 2008, Martin 2021). Evidence is emerging that when individual populations fall below a certain threshold (perhaps 500 plants), they may be less likely to be effectively pollinated, resulting in reduced seed production, as evidenced by empty fruits (Peter Dunwiddie, personal communication). Reduction in the number of pollinators has been observed at several sites since 2019, and may become a significant threat across the range of *C. levisecta*.

Trends: Historically, the number of native occurrences has been decreasing. At least 9 populations in Washington have not been relocated since 1936 and may be extirpated. 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 except where augmented by introduced plugs or seeding. 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.

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

### **2020 Research and Monitoring Updates**

Annual Demographic Monitoring: Annual monitoring of mature *Eriogonum codium* plants took place on 9 July 2020 at three permanent belt transects (consisting of 24 one x two m plots) on Umtanum Ridge. Monitoring was done by Heidi Newsome and myself. Due to Covid-19 restrictions, our usual cohort of volunteers from the Tri-Cities area were not allowed to participate. We counted 52 living plants, of which 50 were survivors from 2019 and two were apparent new recruits (Table 10). Three additional plants from 2019 were dead, resulting in a net decrease of one plant. The 52 surviving plants represent the lowest number of individuals in the demographic plots since they were established in 1997 and a net decrease of 50.4% from the 105 plants initially tagged that year (Table 10, Figure 6). Transect #2, which was not burned in the 2017 Silver Dollar Fire, contained 29 living plants (55.7% of the total). Lightly burned transect #1 contained 21 living plants (40.4%), while severely burned transect #3 had just 2 surviving plants in 2020 (3.9%) (Table 11).



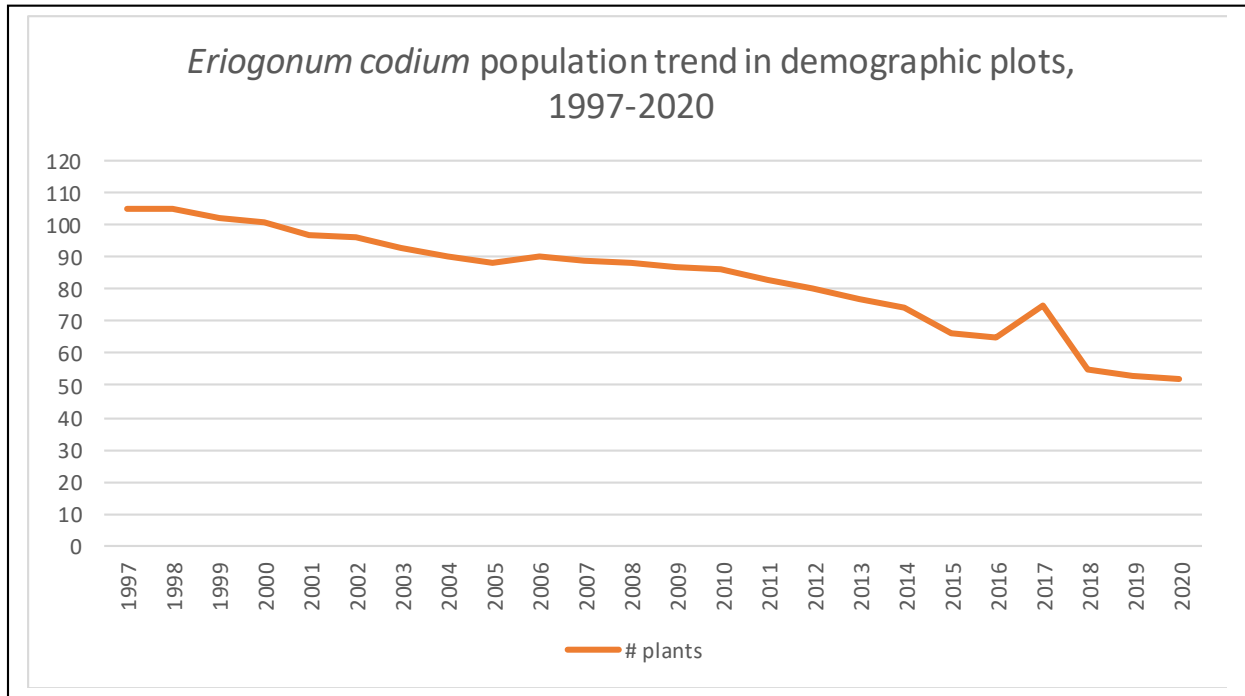
*Eriogonum codium* from Umtanum Ridge, Benton County, Washington, July 2018. Photo by W. Fertig.

Covid-19 travel issues prevented us from conducting the annual April seedling count within the 24 monitoring plots (Table 10).

Table 11 documents the fate of all mature *Eriogonum codium* plants in the 24 permanent demographic monitoring plots from 1997 to 2020. The population experienced a slow, steady decline from 1997 to 2014, followed by a more precipitous decrease since 2017. This latest decline coincides with the Silver Dollar Fire which burned over 60% of *E. codium* habitat and eliminated most of the native sagebrush steppe vegetation (Figure 6). 2017 also stands out as having the largest cohort of seedlings (333) ever recorded at the plots, probably due to the wet winter/spring (the same conditions that contributed to dense growth of annual weeds that made the site more susceptible to wildfire) (Newsome 2017). Based on monitoring data from 2018, there was also a positive recruitment of new plants in 2017 (Figure 6), which unfortunately was negated by mortality induced by the subsequent fire. Other periods of positive recruitment (in which 3 or more new recruits were added to the population) occurred in 2006, 2010, 2016, and 2019 but have been masked by the death of mature individuals. Long-term trend data indicate that most new recruits ultimately die after 1-3 years. Some new “recruits” also appear to be an artifact of either mature plants originally found outside of a plot slowly growing and expanding into the plot, or large mature individuals splitting into two due to death of stems and tissue at the center of the plant.

**Table 10. *Eriogonum codium* demographic plot and census data from 1995-2020.** Demographic 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 Mature Plant Count				Total Population Census
		Alive	Survivors from previous year	New Recruits	Dead since previous year	
1995						4900
1996	4					
1997	26	105	na	na	na	5207
1998	3	105	105	0	0	
1999	20	102	101	1	4	
2000	73	101	101	0	1	
2001	37	97	97	0	4	
2002	0	96	96	0	1	
2003	3	93	93	0	3	
2004	6	90	90	0	3	
2005	0	88	88	0	2	4408
2006	5	90	87	3	1	
2007	154	89	89	0	1	
2008	12	88	87	1	2	
2009	5	87	87	0	1	
2010	67	86	80	6	7	
2011	79	83	81	2	5	5169
2012	6	80	79	1	4	
2013	7	77	77	0	3	
2014	7	74	74	0	3	
2015	6	66	65	1	9	
2016	76	65	63	3	4	
2017	333	75	65	10	na	
2018	9	55	52	3	23	Estimated 2515
2019	124	53	47	6	8	3016
2020	No data	52	50	2	3	



**Figure 6. *Eriogonum codium* population trend from demographic plots at Umtanum Ridge, 1997-2020.** See Table 11 for more detailed yearly results.

Population Census: In 2018, the entire Umtanum buckwheat population was censused over two days by a team of volunteers using hand clickers and walking together in a single row. That census resulted in the documentation of 2,515 mature plants which represented a decrease from 5,159 plants counted in the last census in 2011 (Arnett and Goldner 2017, Fertig 2019). In consultation with the USFWS, we decided to undertake a second census in 2019 using pin flags instead of clickers. The pin-flag method has been used successfully for other rare plants (such as *Sidalcea oregana* var. *calva*) where it can be difficult to determine whether all individuals have been counted, especially in areas where vegetation is dense or the population is diffuse. The method entails teams of surveyors carefully walking through a population and placing a colored pin flag next to each plant observed. After this is completed, the team goes back and picks up and counts the flags, with the total number of flags representing the number of individuals in the population.

Using the flagging method, we counted 3,016 *Eriogonum codium* plants on 11-12 July 2019. This method increased the number of observed plants by 20%. We observed 657 flowering and vegetative plants at the far western subpopulation, 120 in the middle area of the rim (near an old powerline pole), and 2,239 at the eastern end of the occurrence (which includes the three demographic plots) (Table 12). Based on the low rates of annual recruitment found in our long term demographic monitoring, the increase observed in 2019 is not likely to be from the

**Table 11. Yearly population numbers and survival of *Eriogonum codium* plants in monitoring transects from 1997 to 2020.**

Data for each year includes total number of living mature plants per plot (Alive), number of plants surviving from the previous year (Surv), number of new mature plants recruited into the population since the previous year (Recr) and number of newly dead plants since the previous year (Dead). Transect 1 was lightly burned, transect 2 was unburned, and transect 3 was severely burned in the July 2017 Silver Dollar Fire.

Trans/ Plot #	10206	10212	10401	10416	11403	11407	11605	11611	13006	13024	20205	20601	20607	23004	23008	23408	23804	23810	30408	31813	33007	33408	33411	34206	Total
1997 Alive	10	7	2	1	7	5	10	2	9	2	7	10	1	1	2	5	9	1	2	1	3	5	1	2	105
1997 Surv	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1997 Recr	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1997 Dead	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1998 Alive	10	7	2	1	7	5	10	2	9	2	7	10	1	1	2	5	9	1	2	1	3	5	1	2	105
1998 Surv	10	7	2	1	7	5	10	2	9	2	7	10	1	1	2	5	9	1	2	1	3	5	1	2	105
1998 Recr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1998 Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1999 Alive	10	7	2	1	7	6	10	2	9	2	7	9	1	1	2	4	7	1	2	1	3	5	1	2	102
1999 Surv	10	7	2	1	7	5	10	2	9	2	7	9	1	1	2	4	7	1	2	1	3	5	1	2	101
1999 Recr	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1999 Dead	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	2	0	0	0	0	0	0	0	4
2000 Alive	10	7	2	1	7	6	10	2	9	1	7	9	1	1	2	4	7	1	2	1	3	5	1	2	101
2000 Surv	10	7	2	1	7	6	10	2	9	1	7	9	1	1	2	4	7	1	2	1	3	5	1	2	101
2000 Recr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000 Dead	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2001 Alive	9	7	2	1	7	4	10	2	9	1	6	9	1	1	2	4	7	1	2	1	3	5	1	2	97
2001 Surv	9	7	2	1	7	4	10	2	9	1	6	9	1	1	2	4	7	1	2	1	3	5	1	2	97
2001 Recr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2001 Dead	1	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	4
2002 Alive	9	7	2	1	7	4	10	2	9	1	6	9	1	1	2	3	7	1	2	1	3	5	1	2	96
2002 Surv	9	7	2	1	7	4	10	2	9	1	6	9	1	1	2	3	7	1	2	1	3	5	1	2	96
2002 Recr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2002 Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
2003 Alive	9	6	2	1	7	4	9	2	9	1	6	9	1	1	2	3	7	1	2	1	3	5	1	1	93
2003 Surv	9	6	2	1	7	4	9	2	9	1	6	9	1	1	2	3	7	1	2	1	3	5	1	1	93
2003 Recr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2003 Dead	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3
2004 Alive	8	6	2	1	7	4	8	2	9	1	6	9	1	1	2	3	7	1	2	1	3	4	1	1	90
2004 Surv	8	6	2	1	7	4	8	2	9	1	6	9	1	1	2	3	7	1	2	1	3	4	1	1	90
2004 Recr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004 Dead	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3



Trans/ Plot #	10206	10212	10401	10416	11403	11407	11605	11611	13006	13024	20205	20601	20607	23004	23008	23408	23804	23810	30408	31813	33007	33408	33411	34206	Total
2005 Alive	8	6	2	1	6	4	8	2	9	1	6	9	1	1	2	3	7	1	2	1	3	3	1	1	88
2005 Surv	8	6	2	1	6	4	8	2	9	1	6	9	1	1	2	3	7	1	2	1	3	3	1	1	88
2005 Recr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
2005 Dead	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2
2006 Alive	9	7	2	1	6	4	8	2	8	2	6	9	1	1	2	3	7	1	2	1	3	3	1	1	90
2006 Surv	8	6	2	1	6	4	8	2	8	1	6	9	1	1	2	3	7	1	2	1	3	3	1	1	87
2006 Recr	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
2006 Dead	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2007 Alive	9	6	2	1	6	4	8	2	8	2	6	9	1	1	2	3	7	1	2	1	3	3	1	1	89
2007 Surv	9	6	2	1	6	4	8	2	8	2	6	9	1	1	2	3	7	1	2	1	3	3	1	1	89
2007 Recr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2007 Dead	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2008 Alive	8	6	2	1	6	4	7	2	8	2	6	9	1	1	2	3	7	1	2	1	3	4	1	1	88
2008 Surv	8	6	2	1	6	4	7	2	8	2	6	9	1	1	2	3	7	1	2	1	3	3	1	1	87
2008 Recr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1*	0	0	1
2008 Dead	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
2009 Alive	8	6	2	1	5	4	7	2	8	2	6	9	1	1	2	3	7	1	2	1	3	4	1	1	87
2009 Surv	8	6	2	1	5	4	7	2	8	2	6	9	1	1	2	3	7	1	2	1	3	4	1	1	87
2009 Recr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2009 Dead	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2010 Alive	7	6	2	1	4	4	7	2	7	2	4	8	1	1	2	3	7	1	2	1	6	6	1	1	86
2010 Surv	7	6	2	1	4	4	7	2	7	2	4	8	1	1	2	3	7	1	2	1	2	4	1	1	80
2010 Recr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	2*	0	0	6
2010 Dead	1	0	0	0	1	0	0	0	1	0	2	1	0	0	0	0	0	0	0	0	1	0	0	0	7
2011 Alive	6	6	2	1	5	4	8	2	7	2	4	7	1	1	2	3	7	1	2	0	5	5	1	1	83
2011 Surv	6	6	2	1	4	4	7	2	7	2	4	7	1	1	2	3	7	1	2	0	5	5	1	1	81
2011 Recr	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
2011 Dead	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	1	0	0	5
2012 Alive	5	6	2	0	5	4	8	2	7	2	4	7	0	1	2	3	7	1	2	0	5	5	1	1	80
2012 Surv	4	6	2	0	5	4	8	2	7	2	4	7	0	1	2	3	7	1	2	0	5	5	1	1	79
2012 Recr	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2012 Dead	2	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	4
2013 Alive	3	6	2	0	5	4	7	2	7	2	4	7	0	1	2	3	7	1	2	0	5	5	1	1	77
2013 Surv	3	6	2	0	5	4	7	2	7	2	4	7	0	1	2	3	7	1	2	0	5	5	1	1	77
2013 Recr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2013 Dead	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3

Trans/ Plot #	10206	10212	10401	10416	11403	11407	11605	11611	13006	13024	20205	20601	20607	23004	23008	23408	23804	23810	30408	31813	33007	33408	33411	34206	Total
2014 Alive	3	6	2	0	4	3	7	2	7	2	4	6	0	1	2	3	7	1	2	0	5	5	1	1	74
2014 Surv	3	6	2	0	4	3	7	2	7	2	4	6	0	1	2	3	7	1	2	0	5	5	1	1	74
2014 Recr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2014 Dead	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	3
2015 Alive	3	5	2	0	4	3	6	2	7	1	4	6	0	1	2	3	5	1	2	0	1	5	1	2	66
2015 Surv	3	5	2	0	4	3	6	2	7	1	4	6	0	1	2	3	5	1	2	0	1	5	1	1	65
2015 Recr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1*	1
2015 Dead	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	2	0	0	0	4	0	0	0	9
2016 Alive	3	5	2	0	4	3	5	3	7	1	4	6	0	1	2	3	5	1	2	0	1	5	0	2	65
2016 Surv	3	4	2	0	4	3	5	2	7	1	4	6	0	1	2	3	5	1	2	0	1	5	0	2	63
2016 Recr	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	3
2016 Dead	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	4
2017 Alive	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	75?
2017 Surv	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	73?
2017 Recr	3*	na	1*	na	na	na	4*	na	na	na	na	1*	na	na	na	na	na	na	1*	na	na	na	na	na	10
2017 Dead	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
2018 Alive	3	2	0	0	2	0	9	3	7	0	7	7	0	1	2	3	5	1	0	0	0	1	0	2	55
2018 Surv	3	2	0	0	2	0	9	3	7	0	4	7	0	1	2	3	5	1	0	0	0	1	0	2	52
2018 Recr	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	3
2018 Dead	3*	3	3*	0	2	3	0	0	0	1	0	0	0	0	0	0	0	0	3	0	1	4	0	0	23
2019 Alive	4	2	0	0	2	0	6	2	5	0	6	8	0	2	2	3	7	2	0	0	0	0	0	2	53
2019 Surv	3	2	0	0	2	0	6	2	5	0	6	7	0	1	2	3	5	1	0	0	0	0	0	2	47
2019 Recr	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	2*	1*	0	0	0	0	0	0	6
2019 Dead	0	0	0	0	0	0	3	1	2	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	8
2020 Alive	5	2	0	0	2	0	6	2	4	0	7	8	0	2	2	3	5	2	0	0	0	0	0	2	52
2020 Surv	4	2	0	0	2	0	6	2	4	0	6	8	0	2	2	3	5	2	0	0	0	0	0	2	50
2020 Recr	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2
2020 Dead	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	3
Net Change 1997-2020	-5	-5	-2	-1	-5	-5	-4	0	-5	-2	0	-2	-1	+1	0	-2	-4	+1	-2	-1	-3	-5	-1	0	-53

**Table 12. *Eriogonum codium* Census Data.** Count in 2018 was conducted using hand-held clickers by teams walking in parallel rows and counting individual mature plants (flowering or vegetative). The 2019 census was done by placing pin flags next to each mature plant and then counting the number of flags. This method was more accurate and avoided problems of over-looking plants (or possibly counting them twice). \*Differences from 2018 to 2019 are the result of a more accurate census and not a large increase in the number of plants between the two years.

Year	Umtanum Ridge Occurrence # 01			Total
	East End (includes demographic monitoring plots)	Middle (next to and E of old wooden power pole)	West End	
1995				4917
1997				5228
2005	3367	168	873	4408
2011	4061	168	940	5169
2018	1860	100	555	2515*
2019	2239	120	657	3016

addition of new plants to the population since 2018. One downside to the flagging method is that it introduces additional trampling to the site, thus census counts should only be undertaken periodically (every 3-5 years). Other technology, such as photo interpretation from drone-captured imagery, might be considered to avoid additional trampling risk.

Out-planting Monitoring: Two experimental out-plantings of *Eriogonum codium* were established in 2011 at Yakima Ridge and Saddle Mountain within the Hanford Reach National Wildlife Refuge. These plantings were undertaken to increase the number of occurrences of the species in the wild and to demonstrate the feasibility of out-plantings as a conservation strategy. Sites were selected that appeared to have comparable Kiona silt loam soils and similar aspects and elevations (Newsome and Goldie 2017).

A total of 102 seedling plants were planted at three sites on Yakima Ridge in 2011 and 2012. After 20 months, only 10 of the original cohorts were still alive (9.8% survival) and by July 2016 only 3 stressed plants were still alive (2.9%). This area subsequently burned in the Range 12 fire in July 2016 and all plants are now presumed dead (Newsome and Goldie 2017). Although suitable habitat may still be here and elsewhere on Yakima Ridge, the area has not been replanted, and is currently inaccessible due to road damage following recent fires (Heidi Newsome, personal communication, 2020).

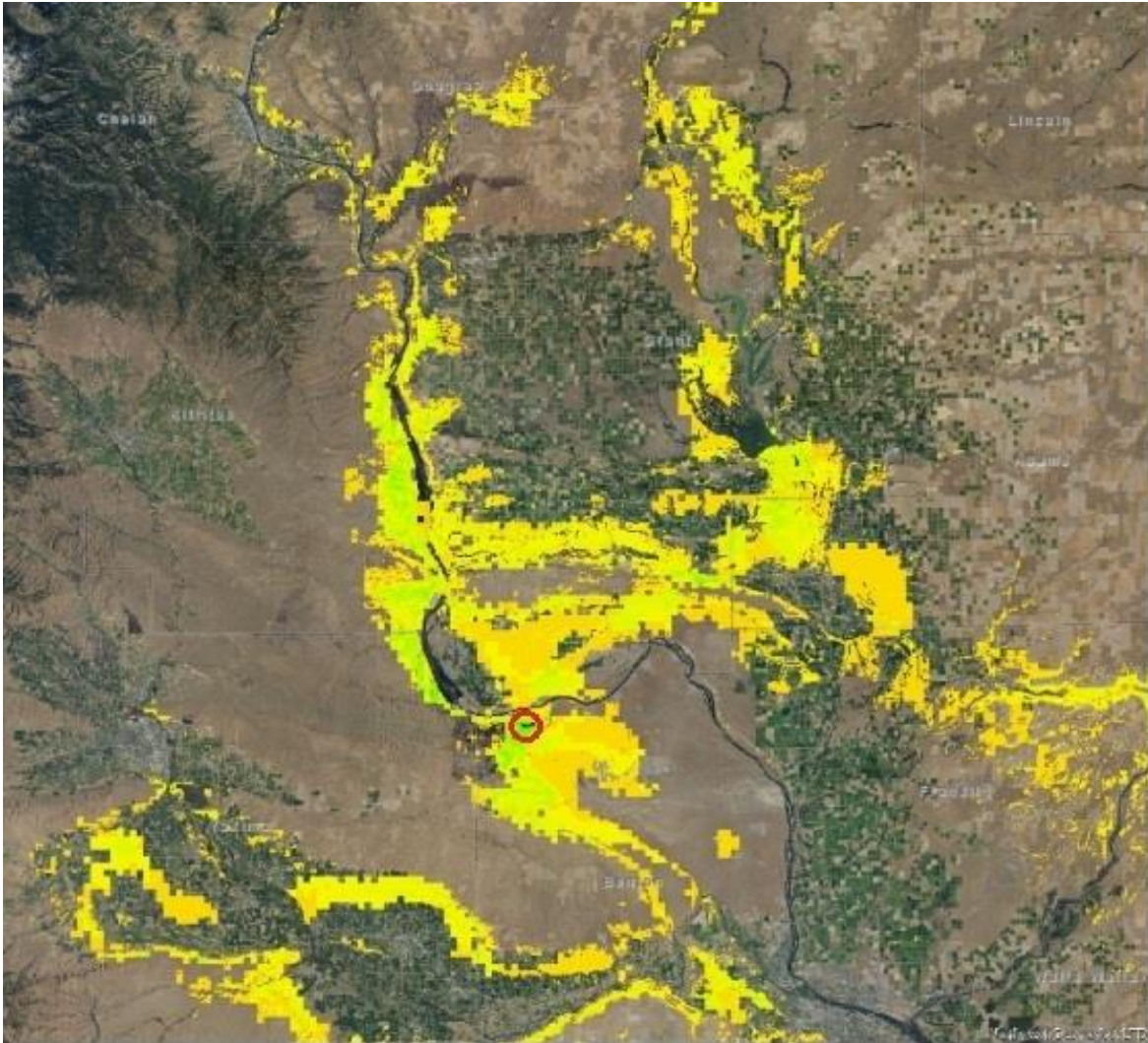
In November 2012, 100 seedling Umtanum buckwheat plants were planted at one site on Saddle Mountain. From 2013-2017, an additional 386 seedling plugs were introduced at three more

sites on the mountain (Newsome and Goldie 2017). Only 9% of these outplanted seedlings were still alive in 2017, of which just 4 had been present for more than 21 months and considered “established” (Newsome and Goldie 2017). In November, 2019, 88 new seedling plugs were planted to augment two plants that had survived fires in 2017 and 2018. One year later, 21 plants were still alive (23.8%). Since out-planting efforts began in 2011, no introduced plants at Yakima Ridge or Saddle Mountain have become large enough to flower (Newsome 2020).

An additional population was introduced at the Badger Mountain Centennial Preserve south of Richland in 2020 (Newsome and Abel 2020). Twelve one-year old plugs were planted at sites on the north and south side of the mountain in March 2020, and in the fall seed was directly sown. As of September 2020, 11 plants were still alive. Another out-planting of 59 seedlings was established at three sites in Snow Mountain Ranch (now managed by the Cowiche Canyon Conservancy) in fall 2020 (Newsome and Abel 2021). Snow Mountain is at a higher elevation than the native populations at Umtanum Ridge, but otherwise has similar rocky rim habitat.

Potential Habitat Modeling: In 2020 WNHP received funding to develop a potential habitat model for *Eriogonum codium*, based on the environmental characteristics of the one naturally-occurring population on Umtanum Ridge. Jake Kleinknecht and I developed four different models based on the intersection of a variety of climate, geology, vegetation, and landform/relief variables. These included mean January, April, July, and October precipitation and temperature, surficial geology, soils, elevation, relief, and ecological system (Kleinknecht and Fertig 2020). The final model (Figure 7) depicts areas of low (orange) to moderate (yellow) to high (green) potential habitat in central Washington. Unfortunately, the model could not be ground-truthed in 2020 due to Covid-19 related closures. The area of most likely habitat (in green) covers only 115 acres and includes other areas of Umtanum Ridge, the Saddle Mountains, Frenchman Hills, Rattlesnake Hills, Yakima Ridge, Naches Heights, and Badger Mountain (Figure 7). Four of these areas (Saddle Mountains, Yakima Ridge, Snow Mountain Ranch, and Badger Mountain) have been used for experimental outplantings (Newsome and Abel 2020, 2021; Newsome and Goldie 2017).

Climate Change Vulnerability Index (CCVI): At the request of USFWS botanist Tara Callaway, I evaluated *Eriogonum codium* using the NatureServe Climate Change Vulnerability Index (Young et al. 2016). The index was developed to rate and prioritize plant and animal species based on their response to projected climate change using environmental predictors (changes in temperature and precipitation) and life history variables (such as dispersal ability, reproductive biology, genetic diversity, and habitat specialization). *Eriogonum codium* scored as Moderately Vulnerable despite greatly increased changes in its historical hydrological niche, increased projected temperatures, reduced dispersal ability due to anthropogenic barriers, increased threat from competing weed species, and documented decline due to wildfire (Fertig 2020; also available at [https://www.dnr.wa.gov/publications/amp\\_nh\\_ccvi\\_erc.pdf](https://www.dnr.wa.gov/publications/amp_nh_ccvi_erc.pdf)).



**Figure 7. Potential habitat model for *Eriogonum codium* in central Washington.** This model is derived from the intersection of January, April, July, and October mean temperature and precipitation, geology and soils, elevation, landform relief, and ecological systems (Kleinknecht and Fertig 2020). Areas in green contain the most likely habitat, while areas in yellow are of medium suitability, and red to orange of low suitability. All other (uncolored) areas are unsuitable. The current, native range of the species is contained within the red circle.

## **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 native occurrence first discovered in 1993 (Fertig 2018) and last visited in 2020. Additional out-plantings have been attempted at two additional sites on the Hanford Reach National Monument and at Badger Mountain, south of Richland and Snow Mountain Ranch west of Yakima (Newsome and Abel 2020, 2021; Newsome and Goldie 2017).

**Abundance:** 3,016 plants were counted in the entire Umtanum Ridge population in 2019, down from 5,169 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 a 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). Today, the rim vegetation consists primarily of 20-25% cover of *Eriogonum codium*, *Bromus tectorum*, *Salsola tragus*, *Poa secunda*, *Achnatherum hymenoides*, *Achillea millefolium*, *Astragalus purshii*, *Elymus elymoides*, *Sphaeralcea grossulariifolia*, *Dieteria canescens*, and *Balsamorhiza careyana* (Fertig 2019).

**Threats:** Umtanum desert buckwheat is highly threatened by wildfire (Newsome 2020), competition from invasive annuals (especially flammable species such as *Bromus tectorum* and *Salsola tragus*), trampling, low rate of seedling establishment, and loss of pollinators (Fertig 2019).

**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 population decrease of 41% from 2011 to 2019 (Fertig 2019).

Managed Areas/Ownership: Hanford Reach National Monument (Department of Energy & US Fish and Wildlife Service).

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## ***Hackelia venusta* - showy stickseed (Boraginaceae)**

### **2020 Research and Monitoring Updates**

Population census: Wendy Gibble counted 171 *Hackelia venusta* plants (149 flowering and 22 vegetative) in the core population area in May 2020. In 2011, Joe Arnett (2011) counted 43 plants in the outlying subpopulations to the south and southeast of the core area. If included, these plants bring the estimated total population size of the Tumwater Canyon occurrence to 214 (Table 13). This number represents a 72.3% decrease from the estimated high of 772 plants in 2004 (Arnett 2011).



*Hackelia venusta*, Tumwater Canyon. Photo by W. Fertig.

Monitoring of Out-Plantings: In May 2020, Wendy Gibble completed a fifth season of monitoring the original set of out-plantings established near the core population in Tumwater Canyon in 2015. Of the 228 individuals originally planted in four plots, 46 were still alive in 2020 (21%) (Gibble 2020). This continues a long-term trend of decline, starting with 83% survival in 2016, 51% in 2017, and 26% in 2018 and 2019 (Gibble 2019). Some surviving plants have reached reproductive maturity, however, and at least 58 new seedlings were detected in 2019 and 5 in 2020 (Gibble 2020). The Icicle Canyon out-planting contained just 3 surviving individuals when last monitored in 2019 (Gibble 2020).

In 2019, Wendy Gibble established three new out-plantings outside of the core population with 178 plants. Between 87-90% of the plants were still alive when monitored in May 2020. One other new out-planting of 104 plants was established on Okanaogan-Wenatchee National Forest lands north of the Tumwater Canyon population in 2019. This site had 74% survival when revisited in 2020 (Gibble 2020).

One other out-planting at Icicle Canyon was re-established in 2015 with 39 individuals. Only a single plant was still present when last visited by Wendy Gibble and me in May 2019.

Drew Foster, a Master's student at the University of Washington, conducted drone surveys in Tumwater Canyon in 2020 to identify potential habitat of *Hackelia venusta* for new surveys or introduction sites. While flying drones within the steep, wooded canyon presented numerous technical challenges, the study demonstrated that drone imagery can be useful in surveying potential habitat while reducing human impacts to the fragile soils (Wendy Gibble, personal communication 2020).

**Table 13. Population estimates for *Hackelia venusta* in Tumwater Canyon** (updated from Arnett 2011b). An ‘\*’ indicates only a subset of the population was surveyed.

Year	Population Size	Comments
1968	“Common”	Reported by Gentry and Carr (1976) in an area of a few hundred acres. Second population to north (EO 2) also cited by Gentry and Carr, but has not been relocated since 1968 and may represent the same locality.
1978	“Occasional”	Monitored by D. Varney.
1981	ca 1000	Estimated by Reid Schuller on 1 May
1984	396	Census by Jim Barrett on 5 June
1987	384	Census by John Gamon (WNHP) over 12 acres (Gamon 1997)
1995	ca 140	Census by Ted Thomas (USFWS), Richie Harrod (USFS) (and Paul Wagner (WDOT) over 2.5 acres on May 11 (Gamon 1997)
2000	ca 300	Census over 10 acres by Lauri Malmquist and Jennifer Brickey (USFS) in June
2001	ca 500	Census over 10 acres by Lauri Malmquist and Ellen Kuhlmann (USFS) on 29 May
2004	572-772	Outlying populations counted and core population estimated by Florence Caplow (WNHP), Barry Wendling, Carolyn Alfano, and Dan Shepherd (Rare Care), & Tim McCracken and Christiana Manville (USFWS) on 11-12 May
2009	282	Census of core population and estimate of outlying populations (based on previous years count) by Joe Arnett (WNHP)
2010	316	Census of core population and estimate of outlying populations (based on previous years count) by Joe Arnett (WNHP) on 24 May
2011	283	Census of outlying populations (43 plants) and estimate of core population by Joe Arnett and Jason Sandberg (USFS) on 25 May.
2012	477	Census and estimate conducted by Joe Arnett (WNHP)
2014	275	Census and estimate conducted by Joe Arnett (WNHP)
2015	25*	Count of only those plants along highway within slope stabilization project area
2020	171* (214 estimated for total occurrence)	Count of plants only in core population by Wendy Gible (149 in flower). Out-lying populations contained 43 plants in 2011, suggesting that the total population may be about 214.

### 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 margins 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 2020) and one vague historical locality, last visited in 1968 (these two occurrences may actually represent the same population). Several populations with dark blue flowers from higher elevation sites in the Alpine Lakes Wilderness Area were once included in *Hackelia venusta*. These populations are now recognized as a different species, Taylor's stickseed (*Hackelia taylorii*) which was formally described in 2013 (Harrod et al. 2013). New out-planted populations have been established adjacent to the "core" native population and at two sites in Tumwater and Icicle canyons (Gibble 2020).

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 46 surviving plants in 2020 (down from an initial population of 218) but includes some second generation seedlings (Gibble 2020).

Habitat: Found in crevices in granite cliffs (often on north and west aspects, but also shady areas on south aspects) and on loose granitic sand or talus in eroding gullies on sparsely vegetated slopes at 450-2250 meters (1500-7400 ft) (Arnett 2007). *Hackelia venusta* appears to be a poor competitor with shrubs and is more strongly correlated with barren sites or forb cover (Gibble 2015).

Threats: Fire suppression has increased competing vegetation cover and encroachment by trees and shrubs. Highway construction and maintenance and use of de-icing chemicals and herbicides is a potential threat. Trampling by hikers and rock climbers can dislodge soil or kill individual plants. This species appears to have low fecundity.

Trends: The population declined from 1984 to 2011, but showed an increase in 2012 (Table 13). More recently, the natural populations appear to be decreasing.

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

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## ***Howellia aquatilis* - water howellia (Campanulaceae)**

### **2020 Research and Monitoring Updates**

2020 Monitoring: In June 2020, Rod Gilbert and I revisited 11 of the 21 known occurrences of *Howellia aquatilis* on Joint Base Lewis-McChord (JBLM) in Pierce County (Table 14). One of these occurrences (Roy, EO 72) had no plants in 2020 or 2018 and may be extirpated. The ten other occurrences we revisited ranged in size from 1 to approximately 2,000 individuals. In all, we counted 6,876-7,941 water howellia plants. These counts represent an increase from the 3,929-4,609 plants observed in these same sites in 2018 (Fertig 2019). Data from eight other occurrences at JBLM last surveyed in 2015 indicate another 318-393 plants are known from the base, bringing the total number of plants observed from 2015-2020 to 7,194-8,334 (Table 14). Two other occurrences from JBLM have not been relocated since 1998 and their current status is unknown.



*Howellia aquatilis* at Joint Base Lewis McChord, Pierce County, Washington, June 2020. Photo by W. Fertig

Elsewhere across its range in Washington, 34 occurrences of *Howellia aquatilis* were relocated from 2007-2019 and contain approximately 4,400 plants. Presently, the estimated abundance of *H. aquatilis* in Washington is about 11,600-12,700.

De-listing: In 2013, USFWS 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 formal proposal for de-listing was published by USFWS in October 2019 and a final ruling issued in June 2021, which will take effect on 16 July, 2021 (US Fish and Wildlife Service 2019, 2021).

Post De-Listing Monitoring: 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 (0, <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 five years after

**Table 14. Location data for *Howellia aquatilis* in Washington.**

**Puget Trough Ecoregion**

Population	County	Ownership	Year last Obs	Status
<b>Blackwater Island RNA (EO #2)</b>	Clark	Blackwater Island RNA, Ridgefield NWR	2018	2018: observed in all 4 ponds; 2014: 100s of plants observed (highest count yet recorded). 1980: abundant
<b>Foot Lake (EO #39) JBLM wetland #1</b>	Pierce	Joint Base Lewis McChord	2020	2020: 300-500; 2018: 516 plants. 2015: 120-170 plants. 1998: 338 plants
<b>S of Bentsen (EO #40) JBLM wetland #3</b>	Pierce	Joint Base Lewis McChord	1998	2015: not found; 1998: 4 plants; 2015: 0 plants observed
<b>Bentsen wetland (EO #41) JBLM wetland #2</b>	Pierce	Joint Base Lewis McChord	2015	2015: 5 plants. 1998: Could not be relocated; 1994: large pop, scattered
<b>Binocular Pond (EO #42) JBLM wetland #15</b>	Pierce	Joint Base Lewis McChord	2015	2015: 7 plants; 1998: 90 plants
<b>Shaver Kettle (EO #43) JBLM wetland #7</b>	Pierce	Joint Base Lewis McChord	2020	2020: 1050-1100 plants; 2018: 805-1235 plants. 2015: 200 plants. 2001: 80-140 plants; 1998: estimated 800 plants
<b>Trench Wetland (EO #44) JBLM wetland #6</b>	Pierce	Joint Base Lewis McChord	2020	2020: 870-1010 plants obs; 2018: 255-355 plants; 2015: 230-330 plants. 1998: 20 plants
<b>NE Chambers Satellite (EO #45) JBLM wetland #11</b>	Pierce	Joint Base Lewis McChord	2015	2015: 52 plants. 1998: not relocated; 1996: "a few plant fragments"
<b>North Chambers Pond (EO #46) JBLM wetland #9</b>	Pierce	Joint Base Lewis McChord	2015	2015: 107-182 plants. 1998: 706 plants
<b>West Shaver Pond (EO #47) JBLM wetland #8</b>	Pierce	Joint Base Lewis McChord	2020	2020: 610 plants; 2018: 558 plants; 2015: 148-198 plants. 1998: 804 plants
<b>Crone Marsh (EO #48) JBLM wetland #4</b>	Pierce	Joint Base Lewis McChord	2020	2020: 250 plants (Crone West) and 700 plants (Crone East); 2018: 416 plants (Crone West) and 685-785 plants (Crone East); 2015: 105 plants (Crone West) and 1200 plants (Crone East). 1998: 1000+ obs
<b>Joseph Marsh (EO #49) JBLM wetland #5</b>	Pierce	Joint Base Lewis McChord	2020	2020: 450-550 plants; 2018: 455-505 plants; 2015: 202 plants; 1999: ca 500 plants
<b>Middle East Chambers (EO #50) JBLM wetland #10</b>	Pierce	Joint Base Lewis McChord	1998	1998: 53 plant; 2015: 0 plants observed
<b>Dailman Lake (EO #51) JBLM wetland #14</b>	Pierce	Joint Base Lewis McChord	2015	2015: 8 plants. 1998: 39 plants; 1997: 100s of plants
<b>Hamilton Lake (EO #52) JBLM wetland #16</b>	Pierce	Joint Base Lewis McChord	2015	2015: 16 plants. 1998: 13 plants; 1997: 4 plants
<b>Chambers East (EO #53) JBLM wetland #13</b>	Pierce	Joint Base Lewis McChord	2020	2020: 330-560 plants; 2018: 45 plants; 2015: 144-194 plants. 1998: 91 plants
<b>Powder Factory (EO #64)</b>	Thurston	Scatter Creek Wildlife Area	2008	2008: observed but not censused; 1995: "small population"
<b>Willow Kettle, 13th Div Prairie (EO #66) JBLM wetland #17</b>	Pierce	Joint Base Lewis McChord	2020	2020: 315-560 plants; 2018: <50 plants; 2015: 80 plants. 1998: scattered and in clusters
<b>Combs (EO #70) JBLM wetland #22</b>	Pierce	Joint Base Lewis McChord	2015	2015: 120 plants
<b>Lynch (EO #71) JBLM wetland #21</b>	Pierce	Joint Base Lewis McChord	2020	2020: ca 2000 plants; 2018: >400 plants; 2015: 485 plants
<b>Roy (EO #72) JBLM wetland #20</b>	Pierce	Joint Base Lewis McChord	2015 (X)	2020: 0 plants; 2018: 0 plants; 2015: 11 plants
<b>Ressa (EO #73) JBLM wetland #19</b>	Pierce	Joint Base Lewis McChord	2015	2015: 3 plants
<b>Shaver Puddle (EO #74) JBLM wetland #18</b>	Pierce	Joint Base Lewis McChord	2020	2020: 1 plant observed. 2018: 14 plants; 2015: 30 plants

“ ca 20 miles N of Shelton”	Mason	Private	1937	1937: collected; not relocated since
<b>Columbia Plateau Ecoregion</b>				
<b>Population</b>	<b>County</b>	<b>Ownership</b>	<b>Year last Obs</b>	<b>Status</b>
<b>Dishman Hills (EO #1)</b>	Spokane	Dishman Hills NRCA	2019	2019: 187 plants observed (185 in west pond); 2011: 50 plants observed; 2002: 217
<b>Cheney-Spangle &amp; Curtis roads (EO #3)</b>	Spokane	unknown	1986	1986: Hundreds to thousands estimated
<b>Curtis Road (EO #4)</b>	Spokane	unknown	1986	1986: Hundreds reported
<b>Bretz Pothole (EO #5)</b>	Spokane	unknown	1990	1990: observed; 1986: several 100 to 1000; not relocated in 1991 or 1992
<b>Cameron Road (EO #6)</b>	Spokane	unknown	1987	No data
<b>Jennings Road (EO #7)</b>	Spokane	Private	1987	No data
<b>Cross Tracks I (EO #8)</b>	Spokane	Private	1987	1987: noted as “small population”
<b>Cross Tracks II (EO #9)</b>	Spokane	unknown	1987	No data
<b>Cross Tracks III (EO #10)</b>	Spokane	Private	1987	1987: “very few plants” observed
<b>Turnbull NWR, E of Findley Lake (EO #11)</b>	Spokane	Turnbull NWR	2007	2007: 100s observed; 1996: 402 plants
<b>E of Kepple Lake (EO #12)</b>	Spokane	unknown	1987	No data
<b>Pond E of Campbell Lake (EO #13)</b>	Spokane	Turnbull NWR	2008	2008: 6 plants
<b>Squirrel View (EO #14)</b>	Spokane	Turnbull NWR	2008	2008: 105+ plants; 1996: 16 plants
<b>Lily Pond (EO #15)</b>	Spokane	unknown	1987	1987: “small population”
<b>Anderson Road (EO #16)</b>	Spokane	unknown	1987	1987: “scattered”
<b>N of West Tritt Lake (EO #17)</b>	Spokane	Turnbull NWR	1990	1990: “very few”; Not relocated in 2008, 2009, 2012
<b>Pond 10, Pine Creek RNA S pond (EO #18)</b>	Spokane	Turnbull NWR	2007	2007: 60-120 plants; 1996: 156 plants; 1993: 2 plants
<b>S of West Blackhorse Lake (EO #19)</b>	Spokane	Turnbull NWR	2010	2010: 2 small clusters; 1997-2009: not found; 1990: “fair” population
<b>Pond 85 Turnbull NWR (EO #20)</b>	Spokane	Turnbull NWR	2009	2009: observed but not censused, 1996: 57 plants
<b>Pond 21A Turnbull NWR (EO #21)</b>	Spokane	Turnbull NWR	2009	2009: 2 plants; 1997: 0; 1993: 1 plant
<b>Pond 77 Turnbull NWR, Findley Lake NE (EO #22)</b>	Spokane	Turnbull NWR	2007	2007: 1 plant
<b>Pond 72 Turnbull NWR (EO #23)</b>	Spokane	Turnbull NWR	2010	2010: 240 plants; 1993: 2 plants
<b>Pond 55 Turnbull NWR (EO #24)</b>	Spokane	Turnbull NWR	2008	2008: 10 plants; 1996: 150 plants; 1993: 2 plants
<b>Pond 39 Turnbull NWR (EO #25)</b>	Spokane	Turnbull NWR	2008	2008: 23 plants
<b>Pond 21C Turnbull NWR (EO #26)</b>	Spokane	Turnbull NWR	2009	2009: observed, but not censused; 2007: 200+ plants; 1993: 1 plant
<b>Pond 61 Turnbull NWR (EO #28)</b>	Spokane	Turnbull NWR	2007	2007: 250+ plants; 1997: 50-75 plants; 1996: 46 plants



Population	County	Ownership	Year last Obs	Status
<b>Pond 18 Turnbull NWR (EO #29)</b>	Spokane	Turnbull NWR	2008	2008: 1 plant, 1993: 1 plant
<b>Pond 21 B Turnbull NWR (EO #30)</b>	Spokane	Turnbull NWR	2009	2009: observed; 1993: 2-3 plants
<b>Pond 31 Turnbull NWR (EO #31)</b>	Spokane	Turnbull NWR	2008	2008: 297 plants; 1993: 3 plants
<b>Pond 29 Turnbull NWR (EO #32)</b>	Spokane	Turnbull NWR	2007	2007: 15 plants; 1997: 2 plants; 1996: 18 plants; 1993: 50+ plants
<b>Pond 12 Turnbull NWR (EO #33)</b>	Spokane	Turnbull NWR	2007	2007: 40-70 plants
<b>Pond 1A Stubblefield Lake Turnbull NWR (EO #34)</b>	Spokane	Turnbull NWR	1993	1993: 1 plant; Could not be relocated in 2010, 2011, or 2012
<b>Pond 112 Turnbull NWR (EO #35)</b>	Spokane	Turnbull NWR	1993	Could not be relocated in 2011 Rare Care search; 1993: 3 plants
<b>Pond 96 Turnbull NWR (EO #36)</b>	Spokane	Turnbull NWR	2007	2007: 110+ plants; 1996: 15 plants
<b>NW of Hog Lake (EO #37)</b>	Spokane	BLM	2012	2012: ca 50 plants; monitored almost yearly; no plants found in 2017; 1993: 50
<b>Pond 107 Turnbull NWR (EO #38)</b>	Spokane	Turnbull NWR	2009	2009: scattered throughout pond; 1996: 30 plants; 1993: 2 plants
<b>Turnbull NWR Pond 13 South RNA (EO #54)</b>	Spokane	Turnbull NWR	2008	2008: 32-35 plants; 1993: 9 plants
<b>Turnbull NWR Pond 82 (EO #55)</b>	Spokane	Turnbull NWR	2008	2008: 25 plants; 1993: 1 plant
<b>Turnbull NWR Pond 63 (EO #56)</b>	Spokane	Turnbull NWR	1993	Not relocated in 1997, 2008, 2009, 2012 visits; 1993: 3 plants
<b>Turnbull NWR pond 32 (EO #57)</b>	Spokane	Turnbull NWR	2008	2008: ca 1000; 1996: 39
<b>Turnbull NWR pond 138 (EO #58)</b>	Spokane	Turnbull NWR	2009	2009: observed but not censused; 1997: 10-20 plants; 1993: 100+ plants
<b>Turnbull NWR pond 139 (EO #59)</b>	Spokane	Turnbull NWR	2009	2009: 1 patch; 1996: 9 plants; 1993: 1 plant
<b>Turnbull NWR pond 117 (EO #60)</b>	Spokane	Turnbull NWR	2009	2009: observed but not censused; 1996: 1 plant; 1993: 3 plants
<b>Turnbull NWR pond 18 (EO #61)</b>	Spokane	Turnbull NWR	2008	2008: 48 plants; 1997: 1 plant; 1993: 3 plants
<b>Turnbull NWR pond 149 (EO # 062)</b>	Spokane	Turnbull NWR	2009	2009: <200; 1996: 111 plants
<b>Turnbull NWR pond 150 (EO # 063)</b>	Spokane	Turnbull NWR	2008	2008: observed throughout pond; 1996: 76 plants
<b>Turnbull NWR, NW of Campbell Lake (EO #65)</b>	Spokane	Turnbull NWR	1997	1997: 7 plants
<b>Smythe Rd North (EO #67)</b>	Spokane	WA DNR	2011	2011: 85-120 plants; 1999: 1260-1860 plants
<b>Burnett Rd (EO #68)</b>	Spokane	WA DNR	2013	2013: observed but not censused; 2010: 1000+; 1999: ca 1100
<b>N of S Luke Rd (EO #69)</b>	Spokane	unknown	2012	2012: <100 plants

the species is de-listed and the range-wide results analyzed to determine whether *Howellia aquatilis* should remain de-listed or be placed back on the Endangered Species list (US Fish and Wildlife Service 2017).

Thirty sites have been selected for post-delisting monitoring of *Howellia aquatilis* in Washington, beginning in 2022. These include 11 occurrences at JBLM, one at Ridgefield National Wildlife Refuge, 11 from Turnbull National Wildlife Refuge, three from DNR and private lands near Spokane, and three others from Dishman Hills National Resource Conservation Area, Hog Lake (BLM), and Scatter Creek State Wildlife Area. Monitoring is planned for years 1 and 2, 7 and 8, and 14 and 15 following official de-listing.

**Climate Change Vulnerability Index:** As part of a USFWS Section 6 grant, *Howellia aquatilis* and three other federally listed plant species were evaluated using the NatureServe Climate Change Vulnerability Index (Young et al. 2016). The index was developed to rate and prioritize plant and animal species based on their response to projected climate change using environmental predictors (changes in temperature and precipitation) and life history variables (such as dispersal ability, reproductive biology, genetic diversity, and habitat specialization). *H. aquatilis* scored as Extremely Vulnerable (see report at [https://www.dnr.wa.gov/publications/amp\\_nh\\_ccvi\\_hoaq.pdf](https://www.dnr.wa.gov/publications/amp_nh_ccvi_hoaq.pdf)) due to its unusual life history in which it is reliant on both exposed mudflats for germination in the fall and deep water for growth and reproduction in spring and summer, making it especially susceptible to changes in hydrology associated with decreased or more variable precipitation and higher temperatures (Kleinknecht et al. 2019). The species is also vulnerable due to its poor dispersal ability across natural and human barriers, reduced gene flow as populations become fragmented, short-lived seedbank, and increased competition from invasive weed species or encroaching woodland vegetation.

### **Current Status Summary**

**Legal Status:** Listed as Threatened under the ESA in 1994 (US Fish and Wildlife Service 1994), but to be delisted effective 16 July 2021.

**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 74 occurrences (Table 14). 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. One record from Mason County has not been relocated since 1937 and is presumed extirpated (Mincemoyer 2005). Fifty-five occurrences have been discovered or relocated since 2000, with 21 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 abundance fluctuates 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 14).

**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:** Main threats are competition from invasive plant species (especially *Phalaris arundinacea*), succession, changes in hydrology (flooding or dewatering), and impacts from timber harvest. Long-term impacts from climate change on water availability in the growing season may be significant (Kleinknecht et al. 2019).

**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 JBLM, where at least 9 of 21 known populations are declining (Table 14).

**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.

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## ***Lomatium bradshawii* - Bradshaw's lomatium (Apiaceae)**

### **2020 Research and Monitoring Updates**

Monitoring at Lacamas Prairie NAP: Annual monitoring of *Lomatium bradshawii* at Lacamas Prairie Natural Area Preserve was not conducted in 2020 due to Covid-19 precautions. In May 2019, a total of 1,024 plants was counted at the preserve, including 526 within macroplot #2 (monitored every 1-6 years since 1998; Table 15) (Wilderman 2019). This represented an increase of 55% from 2018 and was the highest number of plants recorded since 2007 (Wilderman 2019). Overall, the Lacamas Prairie population remains in a long-term decline since having an estimated 13,829 plants in 1998 (Fertig 2019, Wilderman 2019).



*Lomatium bradshawii* (above) in flower and fruit (below) by W. Fertig.

Camas Meadows (Lacamas golf course) Subpopulation:

No formal population sampling or surveys have been done at the Camas Meadows golf course adjacent to Lacamas Prairie NAP since 2010. The golf course site has the largest known population of *Lomatium bradshawii* in the world, and has been estimated at 800,000 to 22 million individuals (St. Hilaire 1998, Dillon 2007). In 2010, Joe Arnett randomly sampled 119 plots of 0.25 square meter size distributed across 8 relatively homogeneous subunits of the golf course to calculate average density and extrapolate estimated abundance. Arnett (2010) estimated the population to be 9,149,912 plants, with an error of approximately 4% (8.78 to 12.8 million). Plant densities ranged from 22 to 220 plants per square meter. Repeat sampling using more plots and stratification of the golf course into finer units based on differences in habitat quality and density are needed to assess the trend of the population and derive more current abundance estimates.



Climate Change Vulnerability Index: As part of a USFWS Section 6 grant, *Lomatium bradshawii* and three other federally listed plant species were evaluated using the NatureServe Climate Change Vulnerability Index (Young et al. 2016). The index was developed to rate and prioritize plant and animal species based on their response to projected climate change using environmental predictors (changes in temperature and precipitation) and life history variables (such as dispersal ability, reproductive biology, genetic diversity, and habitat specialization). *Lomatium bradshawii* scored as Moderately Vulnerable (report available here [https://www.dnr.wa.gov/publications/amp\\_nh\\_ccvi\\_lobr.pdf](https://www.dnr.wa.gov/publications/amp_nh_ccvi_lobr.pdf)), due largely to its low dispersal ability, dependence on periodic disturbance to maintain habitat, and competition from other plant species, such as invasive non-natives (Kleinknecht et al. 2019). The habitat of *L.*

**Table 15. Monitoring and census data for *Lomatium bradshawii* at Lacamas Prairie NAP, Washington from 1998-2020.** Numbers include both reproductive (flowering and fruiting) and vegetative plants. From 1998-2013 population size was extrapolated from 10 50 x 1 m quadrats within Macroplot 2. In 2015 the method was changed to a complete census of Macroplot 2 and then a full census of Lacamas Prairie NAP since 2016. Data from Wilderman (2019). Due to COVID restrictions, monitoring did not occur in 2020.

Year	Total number of plants in quadrats (Macroplot 2)	Mean # plants/ quadrat (Macroplot 2)	Estimated population in Macroplot 2 extrapolated from quadrats	Census data Macroplot 2	Census Data for rest of Lacamas Prairie NAP	Total Population Census Lacamas Prairie NAP
1998	1608	160.8	13,829	n/a	n/a	n/a
1999	1360	136.0	11,696	n/a	n/a	n/a
2000	842	84.2	7,241	n/a	n/a	n/a
2001	300	30.0	2,580	n/a	n/a	n/a
2002	645	64.5	5,547	n/a	n/a	n/a
2003	810	81.0	6,966	n/a	n/a	n/a
2004	1109	110.9	9,537	n/a	n/a	n/a
2007	593	59.3	5,100	n/a	n/a	n/a
2013	20	2.0	172	n/a	n/a	n/a
2015	n/a	n/a	n/a	420	n/a	n/a
2016	n/a	n/a	n/a	520	447	967
2017	n/a	n/a	n/a	496	308	804
2018	n/a	n/a	n/a	387	271	658
2019	n/a	n/a	n/a	526	498	1,024
2020	n/a	n/a	n/a	n/a	n/a	n/a

*bradshawii* at Lacamas Meadows was also evaluated and found to be at long-term risk of becoming too dry or warm to support this species. Suitable climatic conditions are likely to shift to the north outside of the plant's current range and known envelope of soil and vegetation conditions (Kleinknecht et al. 2019).

De-Listing: The US Fish and Wildlife Service (2019a) proposed to de-list *Lomatium bradshawii* in a notice published in the *Federal Register* on 26 November 2019. Following public comments, the de-listing became official on 7 April 2021 (US Fish and Wildlife Service 2021). The rationale for de-listing included the reduction or elimination of threats identified in the original listing proposal, the discovery of large new occurrences since it was listed in 1988, and the protection of an adequate number of populations with sufficient habitat quality across most of its historic range (Silvernail et al. 2016, US Fish and Wildlife Service 2018). The Camas Meadows (golf course) subpopulation adjacent to Lacamas Prairie NAP is the largest known

occurrence and accounts for over 90% of the total estimated population. Excluding this population, approximately 485,000 plants have been documented at nine sites in Oregon, which exceeds the goals for delisting identified in the species' recovery plan (US Fish and Wildlife Service 2010). The most recent five-year review (US Fish and Wildlife Service 2017) acknowledges that *Lomatium bradshawii* will remain a "conservation reliant" species that will need human management intervention to maintain its wet prairie habitat through periodic controlled burning and weed management. As part of de-listing, the Service and partners will be conducting biennial post-delisting monitoring of selected populations (including the Washington occurrence) over the next 6 years (US Fish and Wildlife Service 2019b). If this monitoring identifies new threats or significant downward trends, the species could be re-listed under emergency procedures of the ESA.

### **Current Status Summary**

**Legal Status:** Originally listed as Endangered under the ESA in 1988 (US Fish and Wildlife Service 1988). De-listed as recovered on 7 April 2021 (US Fish and Wildlife Service 2021).

**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 rather than 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 1999). 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). Arnett felt there could be at least a 4% error in this estimate, suggesting the population might vary from 8.78 to 12.8 million (Arnett 2010). The US Fish and Wildlife Service (2018) took the average of Arnett's estimate for the Lacamas golf course subpopulation and included census data from Wilderman (2018) to derive an estimate of 10,790,640 plants. The Washington occurrence is larger than any in Oregon (US Fish and Wildlife Service 2018). Abundance within the NAP has been in a long-term decline since 1998 (Fertig 2019, Wilderman 2019).

Habitat: Seasonally flooded, prairies and grasslands in a narrow hydrologic ecotone between drier uplands and wet creek or riverbanks. 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 residential settlement and agriculture; competition from introduced plants, invasion of meadow sites by shrubs and trees; fire suppression; rodent herbivory; and changes in hydrology (US Fish and Wildlife Service 2018). Ramm-Granberg and Rocchio (2018) found that prescribed fire and herbicide treatments may be needed every 1-3 years to promote *Lomatium bradshawii* reproduction and reduce competition from invasive plants. Studies in Oregon suggest that the species responds favorably to annual mowing and burning (US Fish and Wildlife Service 2018).

Climate change appears to be a significant long-term threat in Washington. Although scored as Moderately Vulnerable to climate change based on the NatureServe Climate Change Vulnerability Index, the current mean annual temperature and annual precipitation patterns at the single known population at Lacamas Prairie are likely to shift northward under projected climate change. The Lacamas Prairie site may become unsuitable for this species, and areas to the north with a more conducive climate may lack the proper soil types (Kleinknecht et al. 2019).

Trends: Historically, trends are probably downward due to the extreme loss of prairie habitat in the south Puget Trough. Recent trends in the Camas Meadows (golf course) area are not known, since the site has not been formally monitored since 2010. Estimating population size in this extremely dense population is a logistic challenge, and past estimates have differed significantly based on how sampling and extrapolations were done (Arnett 2010, Fertig 2019). 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 the overall trend has been downward since 1998 (Wilderman 2019).

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

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

### **2020 Research and Monitoring Updates**

2020 Monitoring: Due to Covid-19 precautions, no populations of Kincaid's lupine in Washington were revisited in 2020.

In June 2019, I visited two of the four known occurrences in the state (Table 16). The dairy subpopulation of the Boistfort Prairie occurrence (EO 1) contained an estimated 1,500 flowering plants and contributed about 20% of total cover. Individual plants were as large as 1 m across. Four other WNHP plant species of concern co-occur with *Lupinus oreganus* at this site: *Carex densa*, *Delphinium leucophaeum*, *Lathyrus holochlorus*, and *Wyethia angustifolia*. The Cemetery Hill subpopulation could not be observed from the road, but is becoming dense with competing vegetation and may no longer provide suitable habitat.



*Lupinus oreganus* var. *kincaidii* from Boistfort Prairie, Lewis County, Washington, June 2018. Photo by W. Fertig.

Nathan Reynolds, biologist with the Cowlitz Tribe, and I visited the Lozier Prairie Preserve near Toledo (EO 3) and estimated the population of Kincaid's lupine at 100-250 plants. This population was monitored from 2011-2018 and the foliar area nearly doubled from 21.8 to 41.5 m<sup>2</sup> during that time (Table 14). Unfortunately, more recent monitoring data are not available. On 7 June I also revisited the subpopulation bordering the baseball field at the Toledo school and observed 119 plants along the fence line. Kincaid's lupine contributed about 30% of total vegetative cover in open areas. Additional potential habitat was mowed or has dense thickets of shrubs.

### **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 oreganus* 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

**Table 16. Summary of Washington populations of *Lupinus oreganus* var. *kincaidii***

<b>Element Occurrence Number</b>	<b>Location</b> (year last observed in parentheses)	<b>Lupine cover in square meters (year) or estimated # of stems</b>	<b>Comments</b>
1	Boistfort – Dairy (2019)	1040 m <sup>2</sup> (2016 – data from Ottombrino-Haworth et al. 2016); 4,000 m <sup>2</sup> (2006)	2019: ca 1500 plants observed, comprising ca 20% cover: 2018: Several 1000 plants, lupines make up to 20% of total cover. Locally common in 2 main patches.
	Boistfort – Cemetery Hill (2016)	150 (2008); appears to be declining (2016)	2018: plants not observed in ocular search from roadside; habitat becoming increasingly overgrown
3	Cowlitz Prairie-adjacent to School District property (2008)	286 m <sup>2</sup> , ca 250-300 stems (2008)	
	Cowlitz Prairie-Lozier Preserve (2019)	41.52 m <sup>2</sup> (2018), 41.63 m <sup>2</sup> (2017), 34.48 m <sup>2</sup> (2016), 28.89 m <sup>2</sup> (2015), 15.4 m <sup>2</sup> (2014), 20.7 m <sup>2</sup> (2013), 33.22 m <sup>2</sup> (2012), 21.82 m <sup>2</sup> (2011)	Inflorance counts: 1022 (2018), 2146 (2017), 475 (2016), 643 (2015), 570 (2014), 753 (2013), 1096 (2012), 980 (2011)
	Cowlitz Prairie-School District property (2019)	100-200 stems, cover ca 10% (2018), 100 – 150 m <sup>2</sup> ; ca 333 stems (2016)	2019: 119 plants observed along fence line, cover ca 30%. Largest plants 2 m across.
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	

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 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 four sites in Washington, all of which have been relocated since 2010 (most recently observed in 2019).

**Abundance:** Populations in Washington range in size from one individual to nearly 1,100 (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 2018 (Nathan 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*).

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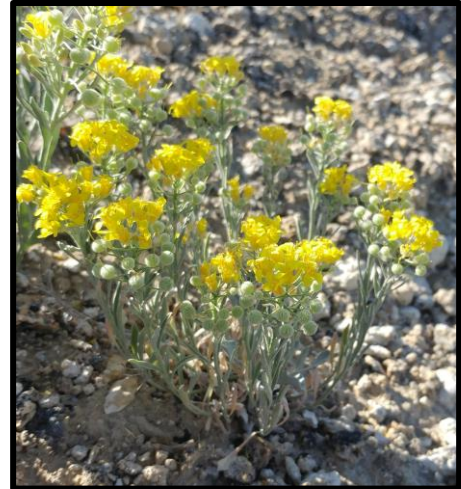
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## ***Physaria douglasii* ssp. *tuplashensis* - White Bluffs bladderpod (Brassicaceae)**

### **2020 Research and Monitoring Updates**

2020 Population Monitoring: On 28 May, 2020, Heidi Newsome, James Rebholz, and Sheri Whitfield of the US Fish and Wildlife Service and Central Washington National Wildlife Refuge Complex conducted annual monitoring of White Bluffs bladderpod at 20 permanent 100-meter transects in the northern portion of its range in Hanford Reach National Monument. The group counted 13,532 individuals in these transects (Newsome 2020a). Individual transects ranged in size from 72 to 1,365 plants, with an average of 676.6 plants per transect. This average represented a small increase from 618 plants per transect in 2019 (Newsome 2019a). The 2020 totals represent a 54.9% decrease from the 30,026 plants counted in 2017 (Figure 8).

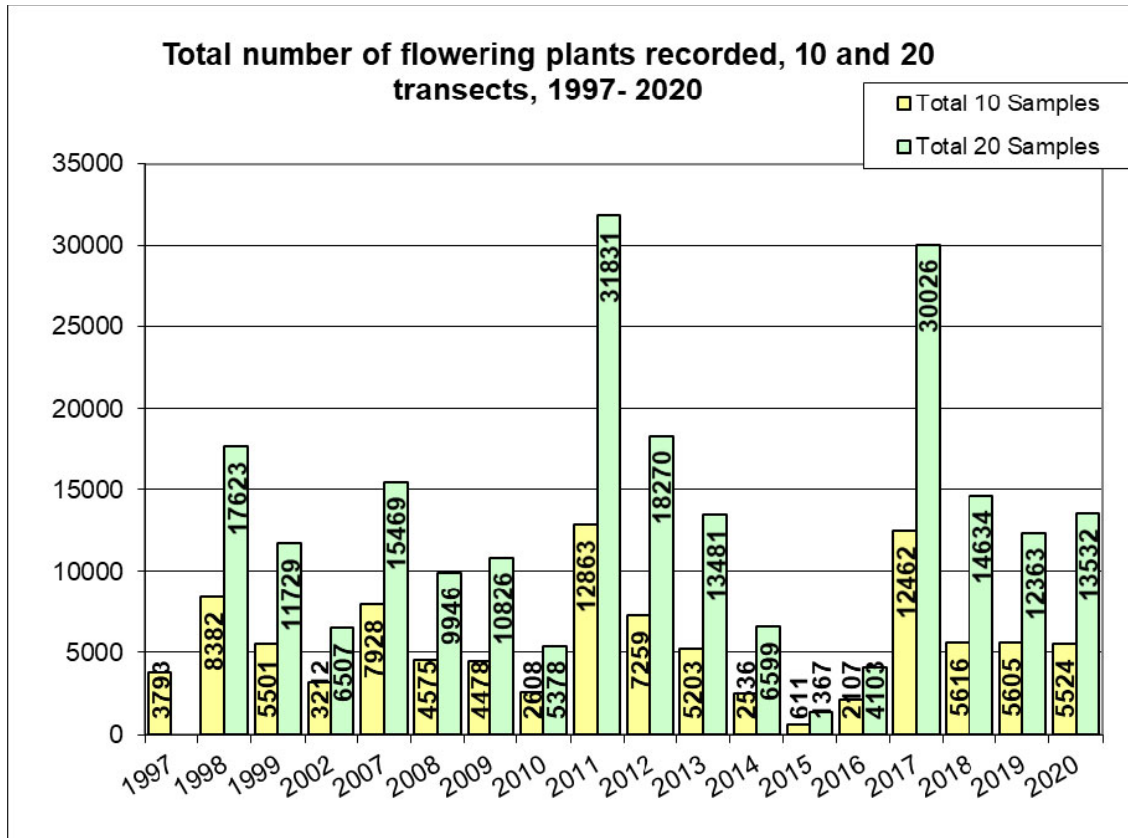


*Physaria douglasii* var. *tuplashensis* from White Bluffs, Franklin County, Washington, May 2018. Photo by W. Fertig

Beck (1999) and Caplow (2003) derived a population estimate for the north half of the White Bluffs occurrence by multiplying the average number of plants per transect by the total number of possible transects ( $N = 37$ ) in the area. Based on this formula, the estimated total population of *Physaria douglasii* ssp. *tuplashensis* in the northern subpopulation in 2020 is 25,034 plants (Figure 9) (Newsome 2020). This figure is slightly higher (0.5%) than the average population size of 24,884 plants between 1997 and 2020. Population numbers are not available for the more sparsely distributed plants along the southern half of the White Bluffs.

Caplow (2003) recommended that management actions be taken if populations in the monitoring transects fell below a threshold of 10,500 individuals for two consecutive years. This threshold was crossed in both 2014-2015 and 2015-2016 (Arnett and Goldner 2017). Since 2017, however, the population has increased significantly and each pair of years since 2016-2017 has averaged well over 10,500 plants. The most recent two-year period (2019-2020) has an average number of individuals of 23,953—more than double the threshold identified by Caplow.

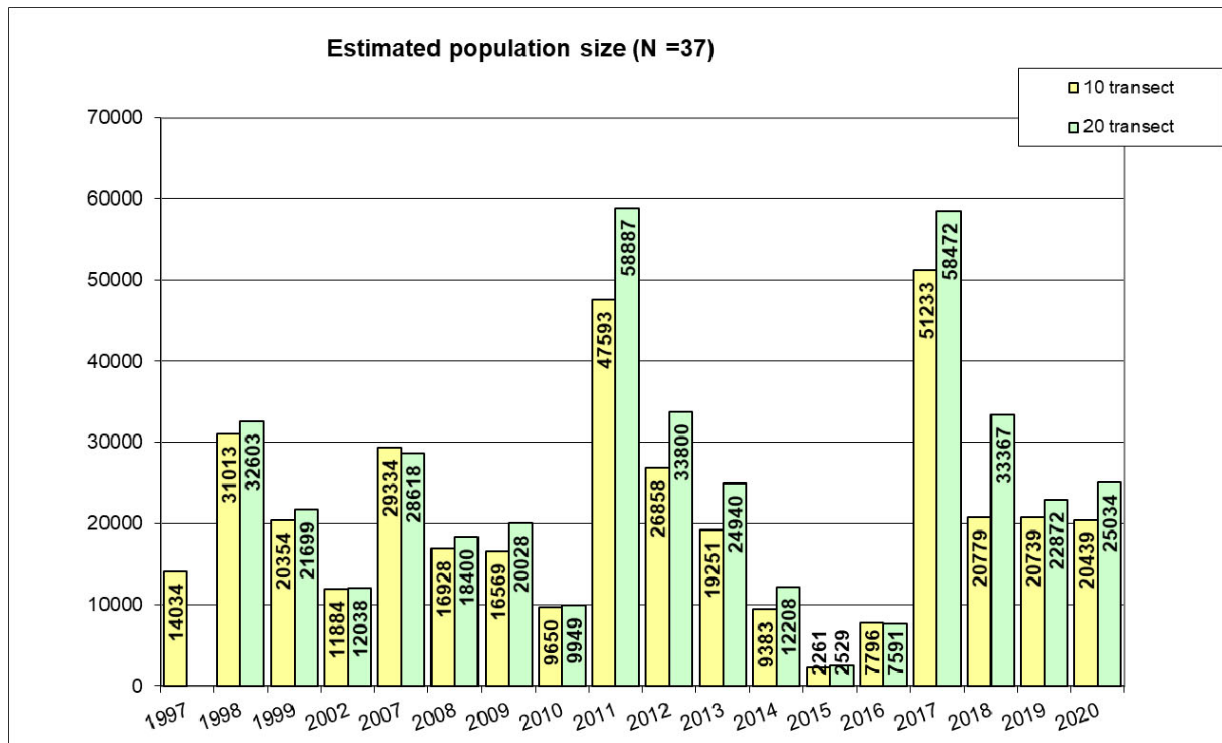
2020 Out-planting Monitoring: Heidi Newsome, DNR, and University of Washington Rare Care staff initiated an experimental out-planting in 2013. The reintroduction site includes a pair of mesas at the northwest end of the White Bluffs north of the Columbia River in Grant County. These sites have soils that are similar to the native population and are also protected within the Hanford Reach National Monument. Plants for the introduction effort were grown from seed beginning in fall 2012. The first cohort was planted in fall 2013, followed by three additional sets of plants in fall 2014, spring 2015, and fall 2015. In all, 893 plants were installed from 2013-15 (Newsome 2018b).



**Figure 8. Total number of reproductive plants of *Physaria douglasii* ssp. *tuplashensis* from north half of White Bluffs, 1997-2020.** From Newsome (2020a).

By November 2015, 572 of the original cohort of 893 plants were still alive (64%). This number decreased to 93 survivors in 2016, 65 in 2017, and just 5 in 2018. All of the original set of out-planted individuals were dead by 2019 (Newsome 2019b). Starting in 2016, however, 133 new seedlings were produced by established plants. The number of first generation seedlings increased to 311 in 2017, but has since dropped to 201 in 2018 and 134 in 2019 (Newsome 2019b). In 2020, the number of new seedlings increased slightly to 137 (Newsome 2020b). Better survival has been noted for plants introduced in fall rather than spring (Newsome 2020b).

In 2017 and 2018, additional seed was released into the reintroduction transects to test the efficacy of direct seeding versus plugs. In 2020, 14 plants were found in these seeded areas (Newsome 2020b). Wendy Gibble of Rare Care also established new seeding plots in 2019 at the north end of the natural population at White Bluffs and in the vicinity of Newsome’s 2013-15 out-plantings. These experimental plantings were done in 4 transects in which individual plots were either covered with jute netting, raked, or left unprepared (control) (Wendy Gibble,



**Figure 9. Estimated number of reproductive plants of *Physaria douglasii* ssp. *tuplashensis* at north end of White Bluffs, 1997-2020.** From Newsome (2020a).

personal communication). No recruitment was observed in these transects in 2020 but a second cohort of seeds was introduced in fall 2020.

### 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 at the north end of the White Bluffs reached a peak of abundance in 2011 with an estimated 58,887 plants. In 2016, the population had declined to an estimated 7,591 (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. Abundance data are not available for plants at the south end of the White Bluffs, but numbers are presumed to be lower. Another 200-376 plants have been established in an experimental out-planting northwest 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 at the north end of the White Bluffs have oscillated around a relatively stable mean of approximately 24,300 individuals. The lowest numbers occurred in 2015 when only 2,529 plants were estimated to occur. By 2017, the number had increased to 58,472 (Newsome 2020a). From 2017-2020 trends have been stable and numbers have averaged 27,090 plants. Trends may be influenced by short-term fluctuations in winter snowfall and spring temperature or precipitation (Newsome 2020a).

Managed Areas: Hanford Reach National Monument, South Columbia Basin State Wildlife Area.

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

### **2020 Research and Monitoring Updates**

2020 Site Visits: Neither of the two known native occurrences were revisited in 2019 or 2020. The Lewis County population was last observed in June 2018 when Joe Arnett and I observed 42 plants that were infested with weevils (Table 17). In 2014 this occurrence had 245 plants. The second native population in Clark County was last visited in 2014 and contained 13-23 plants (Fertig 2019).

Monitoring of Out-Planted Populations: As part of the recovery effort for Nelson's checker-mallow (US Fish and Wildlife Service 2010), 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 2019 by Alex Chmielewski and refuge staff (Chmielewski 2019), but were not revisited in 2020 due to COVID-19 restrictions.

Ridgefield NWR contains four out-planted subpopulations (Table 17). The Smith Lake subpopulation initially contained 1,846 plugs and had grown to 3,871 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% in subplots.

Data were not available for cover in 2018. In 2019, the outplanting was revisited but cover was not recorded. Observers noted "in all sites, plant numbers were good, but plants were small and drought-stressed. Flowering rates were lower than in the past" (Chmielewski 2019).

Two of the other populations at Ridgefield NWR bounced back in 2019 after showing a marked decrease in 2018. The One Hundred Acre North site increased from 15 to 70 plants in 2019 and reversed a long term decline from 160 plugs originally planted in 2007. Likewise the One Hundred Acre South subpopulation increased from 72 plants in 2018 to 165 in 2019. This is the highest number since 2010 (the population started with 400 plugs in 2007). The Texas Island subpopulation, however, continued its long decline from 100 plugs in 2007 to 2 plants in 2018 and 0 in 2019 (Chmielewski 2019). Based on 2016 counts from Smith Lake and 2019 data from the One Hundred Acre North and South sites, the Ridgefield population contains between 235-4,000 plants.



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

**Table 17. Status of *Sidalcea nelsoniana* populations in Washington.**

Population	County	Ecoregion	Ownership	Year last Obs	Status
Coal Creek (EO # 01)	Cowlitz	Puget Trough	Private	2014	2014: 13 plants observed in 2014, although 5-10 more may be in vicinity. 2005: 25 plants. 1991: ca 75 plants.
Halfway Creek (EO # 02)	Lewis	Puget Trough	Private	2018	2018: 45 plants observed, many buds infested by weevils and aborted. Also high foliar herbivory noted. 2014: ca 245 plants. 2006: 88 plants with 1289 stems observed. 2004: ca 70 plants observed. 1997: 13 plants observed in roadside ditch. 1994: ca 60 flowering plants observed
Ridgefield National Wildlife Refuge (outplanting)	Clark	Puget Trough	Ridgefield NWR	2019	2019: 235-4,000 plants estimated (based on most recent counts at each of the 4 subpopulations.
Smith Lake				2019	2019: Areal counts not done, but plant numbers were good (Chmeilweski 2019); 2016: 3871 plants observed
One Hundred Acre North				2019	2019: 70 plants (13% in flower)
One Hundred Acre South, hacking tower site				2019	2019: 165 plants
Texas Island				2018	2019: 0 plants found; 2018: 2 plants, browsed by deer
Steigerwald NWR (outplanting)	Clark	Puget Trough	Steigerwald Lake NWR	2019	2019: 398 plants
Straub Field				2019	2019: 281 plants, with many small plants between the larger, established ones.
Trail head				2017	2019 & 2018: 0 plants; 2017: 2 plants
Office Road Field				2019	2019: 117 plants observed with many new plants in between larger plants.

At Steigerwald Lake National Wildlife Refuge, two of the three subpopulations increased significantly from 2018 to 2019, while the third, at Trailhead, had no plants for a second straight year and may be extirpated. The Straub Field outplanting increased from 27 plants to 281 in 2019 and the Office Road subpopulation increased from 16 to 117 (Chmeilweski 2019).

### 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. *Sidalcea 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. Two 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 over 635 plants in 2019.

**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 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 Washington are on private lands.

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

### **2020 Research and Monitoring Updates**

2020 Monitoring: The Camas Meadows Natural Area Preserve (EO 9) has the largest known population of Wenatchee Mountains 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 re-mapped and counted each year with the goal of developing a more complete distribution map and estimate of abundance. In the process, numerous additional subpopulations have been discovered, particularly in forested areas within the preserve.

In June 2020, Keyna Bugner, David Wilderman, Molly Jennings, Ethan Coggins, Stacy Kinsell, Randi Riggs, and I observed another 3,284 flowering plants in 54 discrete patches. The cumulative number of flowering plants observed at Camas Meadows from 2012-2020 is now 29,715 plants in more than 250 polygons (Table 18). Approximately 50 polygons remain to be monitored and re-mapped. There are plans to complete this work in 2021.

Wendy Gible, Jon Bakker, and Rare Care staff from the University of Washington established 6 treatment blocks at the Mountain Home population (EO 20) to study the effects of clipping snowberry, prescribed fire, and herbicide treatments on maintaining suitable habitat for *Sidalcea oregana* var. *calva*. No formal population counts were made. In 2019, the entire population at Mountain Home was censused by USFWS, Rare Care, and DNR staff and 2,299 plants were observed (Table 18).

2019 Population Surveys: As part of a USFWS Section 6 project, I revisited five native and one out-planted occurrences of *Sidalcea oregana* var. *calva* in 2019 (Table 18). In addition to helping survey the Camas Meadows NAP population, I re-surveyed the Poison Creek subpopulation (EO 9) on Okanogan-Wenatchee NF and counted 1,315 flowering and vegetative plants. This area has been proposed for a controlled burn to open up the forest canopy and stimulate natural regeneration of this species. Another 8,301 flowering plants were counted as part of the annual census of select subpopulations in the NAP. I also helped survey the Mountain Home population (EO 20) mentioned previously, and the nearby Mountain Home Ridge out-planting, managed by the Chelan-Douglas Land Trust. Only six flowering and four



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

**Table 18. 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. (x) indicates a population that is presumed extirpated.

Population	County	Ecoregion	Ownership	Year last Obs	Status
<b>Peshastin (EO # 003)</b>	Chelan	East Cascades	unknown	1893 (x)	Considered historical and probably extirpated.
<b>Leavenworth (EO # 004)</b>	Chelan	East Cascades	Okanogan-Wenatchee NF	1904 (x)	Considered historical and probably extirpated
<b>Tip Top (EO # 005)</b> [Actual site may have been Deer Park Spring, S of Tip Top]	Chelan	East Cascades	Okanogan-Wenatchee NF	1934 (x)	Considered historical and probably extirpated. Not relocated in 1987 or 2019, but potential habitat present in Deer Park Spring.
<b>Camas Meadows (EO # 009) includes Poison Meadows</b>	Chelan	East Cascades	Camas Meadows NAP, Okanogan-Wenatchee NF	2020	Largest known population, with an estimated 29,715 flowering plants in over 250 subpopulations counted from 2012-2020. Another 1,315 flowering plants in Poison Creek subpopulation (Okanogan-Wenatchee NF) in 2019.
<b>*Colockum, S of Grouse Spring (EO # 011)</b>	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.
<b>Circle Creek (EO # 012)</b>	Chelan	East Cascades	Okanogan-Wenatchee NF	1893 (x)	Considered historical and probably extirpated
<b>*Lost Lake Trail (EO # 015)</b>	Kittitas	East Cascades	Okanogan-Wenatchee NF	1982	not relocated in 1987 - might be a misidentification
<b>Pendleton Canyon (EO # 016)</b>	Chelan	East Cascades	Private	2001	2001: 150-200 plants in USFS transect
<b>Upper Camas Land Meadow (EO # 019)</b>	Chelan	East Cascades	Okanogan-Wenatchee NF	1987 (x)	Not relocated in 1999, 2001, or 2019; considered extirpated
<b>Mountain Home Meadow (EO # 020)</b>	Chelan	East Cascades	Private (DNR registry)	2020	2020: 6 research plots to study different vegetation treatments established by Rare Care. 2019: 2,299 plants observed in full census. 2018: 1375 flowering plants observed. 2017: estimated at >100 plants. 2011: 2581 plants found in census. 2005: 2248 plants observed in census
<b>Camas Creek tributary south (EO # 021)</b>	Chelan	East Cascades	Private, Camas Meadows NAP	2014	2014: 21 plants observed, all vegetative. 2001: 8 plants observed. 1990: scattered along old spur road.
<b>FS Rd 120 (EO # 022)</b>	Chelan	East Cascades	Okanogan-Wenatchee NF	2008 (x)	2019: No plants found, population may be extirpated. 2008: 13 plants observed (1 flowering). 2001: 2 mature plants, 24 juveniles, and 17 seedlings observed. 1999: 1 mature plant and several juveniles & seedlings found. 1991: 1 plant.
<b>Mountain Home Ridge (out-planting)</b>	Chelan	East Cascades	Chelan-Douglas Land Trust	2019	2018: 100 of 161 out-planted individuals surviving

juvenile plants were observed on the preserve, and no plants were seen on the adjacent out-planting on Okanogan-Wenatchee National Forest lands. The original outplantings were done at four sites and included 51 plugs (Dunwiddie 2014). The land trust population is found within a forested area that may need to be thinned to allow more light exposure in the future.

I visited three other known occurrences but was unsuccessful in re-locating any *Sidalcea oregana* var. *calva* plants. The historical Tip Top occurrence (EO 5) was probably actually found at nearby Deer Park Spring, which contains suitable wet meadow habitat and is inhabited by two rare associated species found at other var. *calva* occurrences (*Delphinium viridescens* and *Rudbeckia alpicola*). Although Wenatchee Mountains checkermallow is currently absent, this wetland has excellent potential as a reintroduction site. Populations at Upper Camas Lands Meadow (EO 19) and off FS Rod 120 (EO 22) are probably extirpated due to long-term changes in habitat condition. Both sites have become overgrown by upland vegetation and are either too shady or dry to support this species. Management actions to thin or burn the encroaching shrubs and trees could make the sites more conducive for future reintroductions.

The remaining extant occurrences still need to be revisited. Reports from Kittitas County south of Grouse Spring (EO 11) and Lost Lake Trail (EO 15) are based on specimens that appear to be *S. oregana* var. *oregana*. Neither of these occurrences have been relocated since 1982 and could be extirpated. Other recent surveys on the ridge south of Cle Elum and in the Teanaway Community Forest have only found var. *oregana*.

Climate Change Vulnerability Index: As part of a USFWS Section 6 grant, *Sidalcea oregana* var. *calva* and three other federally listed plant species were evaluated using the NatureServe Climate Change Vulnerability Index (Young et al. 2016). The index was developed to rate and prioritize plant and animal species based on their response to projected climate change using environmental predictors (changes in temperature and precipitation) and life history variables (such as dispersal ability, reproductive biology, genetic diversity, and habitat specialization). *Sidalcea oregana* var. *calva* scored as Highly Vulnerable (report available at [https://www.dnr.wa.gov/publications/amp\\_nh\\_ccvi\\_siorc.pdf](https://www.dnr.wa.gov/publications/amp_nh_ccvi_siorc.pdf)) due to its poor dispersal ability across human-altered landscapes, changes in its historical thermal and hydrological niche, potential loss of pollinators, increased pressure from herbivory, competition with non-native plants, and encroachment by trees and shrubs in the absence of periodic disturbance (Kleinknecht et al. 2019).

## **Current Status Summary**

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

Natural Heritage Rank: G5T1/S1?; WA Endangered

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 up 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 three confirmed extant occurrences and seven historical or extirpated populations. Extant populations have all been discovered or relocated since 2001, most recently in 2020. Two additional populations from Kittitas County may be misidentified or extirpated.

**Abundance:** The largest population contains approximately 30,000 plants, while smaller occurrences have 8-2,300 individuals (US Fish and Wildlife Service 2004).

**Habitat:** Occurs in open meadows with poorly drained soils and a high water table or that are seasonally flooded in winter and early spring before drying in summer. Also in openings in Douglas-fir, Ponderosa pine, or Aspen forests and edges of shrub thickets. Found at elevations between 335-1375m (1100-4500 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 (Caplow 2003, Goldsmith-Zimmerman and Reichard 2005).

**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. One private occurrence is on the DNR state registry list.

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

### **2020 Research and Monitoring Updates**

2020 Monitoring of Native Populations: Ten of the 46 extant occurrences of *Silene spaldingii* in Washington were relocated in 2020 (Table 19). Staff from the Bureau of Land Management Spokane Field Office (including Kim Frymire, Hailee Leimbach-Maus, and Jenny Roman) revisited four occurrences on BLM lands. The largest population, with 100-300 plants from 4 subpopulations, was found at the Coal Creek ACEC (EO 48). Additional populations were observed at Miller Ranch/ Fishtrap Lake (EO 32 with 23 plants), Watson Benchmark (EO 45 with 36 plants in 3 subpopulations), and the Telford Parcel (EO 85 with 40 plants in 8 subpopulations). A fifth site was also visited (Rock Creek acquisition, EO 59) but no catchfly plants were observed at two subpopulations. In 2019, BLM staff were able to revisit 9 occurrences with 1,361 plants in 105 separate subpopulations (Table 19).

Peter Lesica, a botanical consultant from Missoula, Montana, visited three populations (Kramer Palouse Biological Station [EO 6], Rock Creek [EO 83, and Hawk Creek [EO 85] to collect fresh seed for a USFWS seed-banking project, but did not make a population count (Table 19). Previously, seed has been collected from Crab Creek (EO 30), Fishtrap Lake (EO 32), Fairchild Air Force Base (EO 44), Coal Creek (EO 48), Twin Lakes (EO 52), Turnbull (EO 61), and Telford (EO 85) by Rare Care staff and from Coal Creek, Smoothing Iron Ridge (EO 92), and Warner Gulch (EO 88) by USFWS staff (US Fish and Wildlife Service 2020).

James Rebholz, Heidi Newsome, and Melissa Scholten of USFWS conducted annual monitoring of the *Silene spaldingii* population in the South Base Special Interest Area (SBSIA) on Fairchild Air Force Base (EO 44) on August 3-4, 2020 (Rebholz 2020). They observed 77 plants in 6 main native subpopulations and another 98 in an out-planting (Table 19). The native population has declined by 43% from the 135 plants observed in 2019, although the observed number may not take into account living individuals that are dormant below-ground (Rebholz 2020). From 2016-2019, the population at Faichild was relatively stable with 134-141 individuals (Rebholz 2019). The majority of native individuals are found in the two subpopulations with high richness of other native plant species. A wildfire burned the entire native population at Fairchild in August, 2020 (after the annual census was completed), but spared the out-planting sites (Rebholz 2020). One additional vegetative plant was discovered outside of the SBSIA in spring 2020 during weed monitoring (Rebholz 2020).



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

**Table 19. Location data for *Silene spaldingii* in Washington.** Occurrences with an (X) or (H) in the Last Obs column are considered extirpated or historical.

Canyon Grasslands

Columbia Plateau Ecoregion & Blue Mountains Ecoregion (Tam Tam Ridge population only)

Population	County	Ownership	Last Obs	Status
Gooseneck Steppe (EO 16)	Asotin	Private (DNR registry)	1990	1995: not found; 1990: 59 plants; 1980: 60+ plants
Sourdough Ridge (EO 49)	Asotin	Umatilla NF, Asotin Creek SWA	2018	2018: 13 plants in one patch; additional subpops monitored by USFS; 2017: observed & monitored. 2015: ca 1200 plants
Blankinship Allotment (EO 86)	Asotin	Spokane BLM	2016	2016: 3 plants. 2004: 2 plants
Warner Gulch (EO 88)	Asotin	Asotin Creek SWA	2020	2020: 12 fr plants found at 4 subpops in brief visit; 2018: Monitoring plots established; 2009: 10000 estimated (6010 counted)
Buffalo Eddy Nez Perce NHP, Snake River (EO 90)	Asotin	Nez Perce NHP	2007	2007: observed; 2006: 11 plants
Smoothing Iron Ridge (EO 92)	Asotin	Asotin Creek SWA	2015	2015: 39 plants
Tam Tam Ridge (EO 94)	Garfield	Asotin Creek SWA	2019	2019: 12 plants obs; 2018: 10-12 plants

Channeled Scablands

Columbia Plateau Ecoregion & Canadian Rockies Ecoregion (Liberty Lake population only)

Population	County	Ownership	Last Obs	Status
Hill S of Winona (EO 3)	Whitman	Unknown	1925 (X)	Possibly extirpated; not relocated in 1990
Liberty Lake (EO 5)	Spokane	Private	1982	Not found in 1990 survey (but habitat good); 1982: 10 plants; 1979: 53 plants
Berry Lake, SW of Lamont (EO 7)	Whitman	Unknown	1995	1995: 38 plants; 1980: ca 50; includes former EO 15
Cheney-Spangle Eyebrow (EO 21)	Spokane	Private (DNR registry)	2018	2018: 59 plants; 2005: 3 plants; 1995: 5 plants
Strangland Road (EO 22)	Spokane	Private	1990	1990: 29 plants; 1995: not found
Tucker Prairie (EO 23)	Spokane	WA DNR	2002	2002: 9 plants; 1999: 12 plants; 1990: 46 plants
Mohler (EO 26)	Lincoln	Spokane BLM	2019	2019: 5 subpops monitored by BLM, 16 plants observed; 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	Spokane BLM, Private	2019	2019: 2 subpops visited, 2 pl obs; 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	Private	1993	1993: 17 plants
Downs Lake (EO 29)	Lincoln	WA DNR	2018	2018: 50 plants; 2007: 1 plant; 1993: 25 plants
Crab Creek (EO 30)	Lincoln	Spokane BLM	2019	2019: 149 plants counted in 10 subpopulations. 2018: 24 plants observed in 5 subpops; 2016: 4 subpops visited with 61 plants 2014: observed; 2010: 1014 plants
Thorpe Steppe (EO 31)	Spokane	Private	1995	1995: 3 plants; 1994: 7 plants
Miller Ranch acquisition, Fishtrap Lake, Hog Lake (EO 32)	Lincoln, Spokane	Spokane BLM	2020	2020: 23 plants observed at Fishtrap Lake; 2019: 18 subpops visited with 167 plants; 2017: 11 subpops visited with 73 plants. 2014: observed; 2010: 708 plants.
Fairchild Air Force Base (EO 44)	Spokane	Fairchild AFB, South Base Special Interest Area	2020	2020: 175 plants observed (77 native and 98 out-planted); 2019: 183 plants observed (135 native & 48 out-planted); 2018: 122 plants observed 2017: 134 plants observed. 2016: 141 plants; 2015: 91 plants 2013: 63 plants; 2004: 67 plants; 1994: 11 plants.

<b>Watson Benchmark (EO 45)</b>	Lincoln	Spokane BLM	2020	2020: 36 plants observed in 3 subpops; 2019: 12 subpops monitored with 292 plants; 2017: Western portion monitored (after 2015 fire), pop estimated at 153 plants. 2014: observed; 2010: 150 plants
<b>Rocky Ford (EO 46)</b>	Lincoln	Spokane BLM	2016	2016: 2 subpops surveyed with 11 plants. 2014: observed; 2010: 580 plants
<b>Coal Creek ACEC (EO 48)</b>	Lincoln	Spokane BLM, Coal Creek ACEC	2020	2020: 100-300 plants estimated at 4 sites. 2019: 2 subpops monitored with 9 plants 2018: 2017: two new subpops discovered. Total of 12 subpops visited, and 160 plants observed. 2015: observed; 2010: 770 plants.
<b>Twin Lakes (EO 52)</b>	Lincoln	Spokane BLM, Private, WA DFW	2019	2019: 4 plants observed at 1 subpop; 2017: 11 plants observed at 1 subpop. 2015: observed; 2010: ca 1055 plants
<b>Rock Creek acquisition (EO 59)</b>	Whitman	Spokane BLM, Private	2016 (2020)	2020: not relocated at 2 sites; 2016: 3 subpops visited with 84 plants. 2014: observed; 2010: 275 plants
<b>Clear Lake area (EO 60)</b>	Spokane	WA DNR	2013	2013: 1 plant; 1999: 2 plants
<b>Turnbull NWR/Pine Lakes (EO 61)</b>	Spokane	Turnbull NWR	2019	2019: 74 plants observed at 2 sites by Rare Care. 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
<b>Turnbull NWR/Cossalman Lake (EO 62)</b>	Spokane	Turnbull NWR	2000 (X?)	2000: 21 plants; not relocated in Rare Care surveys in 2002, 2009, 2011, or 2015
<b>Rock Lake South (EO 70)</b>	Whitman	Private	2001	2001: 1 plant
<b>Rock Creek South (EO 71)</b>	Whitman	Private	2001	2001: 15 plants
<b>Negro Creek West (EO 74)</b>	Spokane	Private	2001	2001: 9 plants
<b>Negro Creek (EO 75)</b>	Spokane	Private	2001	2001: 70 plants
<b>Swanson Lake WA (EO 78)</b>	Lincoln	WA DFW	2010	2010: 81 plants; 2002: 52 plants
<b>Cheney (EO 80)</b>	Spokane	Private	1903 (X)	Possibly extirpated
<b>Rock Creek; Escure Ranch (EO 83)</b>	Adams	Spokane BLM	2020	2020: Seed collected, but n population count made. 2018: 235 plants; 2016: 57 plants. 2014: observed; 2010: 66 plants
<b>Telford Parcel (EO 85)</b>	Lincoln	Swanson Lakes SWA	2020	2020: 40 plants observed at 8 subpops; Seed collected from Hawk Creek subpopulation. 2019: 47 subpops monitored with 681 plants; 2018: 2 new subpops found; 2015: observed; 2010: ca 3060 plants
<b>NW of Hatten Lake (EO 91)</b>	Lincoln	Spokane BLM	2019	2019: 8 subpops monitored with 41 plants; 2008: 20 plants
<b>2 miles N of Maccall (EO 93)</b>	Adams	WA DNR	1946 (H)	Historical

Palouse Grasslands  
Columbia Plateau Ecoregion

Population	County	Ownership	Last Obs	Status
<b>Pullman West (EO 2)</b>	Whitman	state	1951 (X)	Probably extirpated
<b>Kramer Palouse Biological Study Area (EO 6)</b>	Whitman	Kramer Palouse BSA	2020	2020: seed collected; 2017: ca 400 plants; 2000: 216 plants 1981: 147 plants
<b>WSU Prairie preserve, Pullman (EO 8)</b>	Whitman	Campus Prairie BSA (WA State University)	2013	2014: no plants found, late in season, 2013: 3 plants; 1995: 18 plants; 1983: 33 plants
<b>Upper Wawawai (EO 9)</b>	Whitman	DNR, private (DNR registry)	2002	2002: 3 plants; 1990: 17 plants; 1981: 21 plants
<b>Spaulding Road (EO 10)</b>	Whitman	Private	1990	1995: no plants found; 1990: 2 plants
<b>Wawawai Eyebrows (EO 11)</b>	Whitman	Private (DNR registry)	1995	1995: 11 plants; 1983: 51 plants

<b>Upper Steptoe Canyon (EO 12)</b>	Whitman	DNR, private (DNR registry)	1995	2013: no plants found; 1995: 18 plants; 1981: 34 plants
<b>East Upper Steptoe Canyon (EO 13)</b>	Whitman	unknown	1990	1995: not found; 1990: 4 plants; 1981: 12 plants; 1980, ca 40
<b>Pitts Cemetery (EO 14)</b>	Whitman	Private (DNR registry)	2020	2020: 45 plants; 2019: 44 plants; 2018: 54 plants; 2017: 56 plants; 2016: 36 plants; 2004: 41 plants; 1995: 62 plants; 1990: 60 plants; 1981: 12 plants
<b>Smoot Hill BSA (EO 18)</b>	Whitman	Smoot Hill BSA (Washington State University)	1981 (X?)	1981: 4 plants; not relocated in 1990, 1995, or 2014
<b>Johnson-Pullman Rd (EO 19)</b>	Whitman	Private	1981 (H)	1981: 9 plants; 1990: not found
<b>Steptoe Butte (EO 20)</b>	Whitman	Steptoe Butte State Park, private (potential Steptoe Butte NAP)	2020	2020: 491 plants found in outplanted sites in May, but only 239 observed in September. 2017-2019: 1700 seedling plugs planted at 6 sites S of Steptoe Butte SP; 2008: 10-20 plants observed in Steptoe Butte SP; 1990: 15 plants observed in state park
<b>Armstrong (EO 25)</b>	Whitman	Private	1995	1995: 48 plants; 1990: 21 plants
<b>Prune Orchard Road (EO 51)</b>	Whitman	private	1995	1995: 8 plants
<b>Whelan Cemetery (EO 89)</b>	Whitman	Private	2019	2020: not found, monitoring done to late in year; 2019: 17 plants; 2017: ca 30 plants observed; 2005: 11 plants

Anthony Hatcher of the Palouse Conservation District monitored populations at Pitt Cemetery and Whelan Cemetery in 2020. Hatcher observed 45 *Silene spaldingii* plants at Pitt Cemetery (EO 14). This occurrence has ranged in size from 44-56 plants since 2016 (Table 19). No plants were observed at Whelan Cemetery (EO 89) in 2020, though the survey may have occurred too late in the season (Anthony Hatcher, personal communication). Numbers at Whelan Cemetery have varied from 11-30 plants, with 17 observed by Hatcher in 2019 (Table 19).

In September, 2020, I briefly visited the Warner Gulch occurrence (EO 88) and observed 12 fruiting and vegetative plants in three subpopulations west of the county road. This was not an optimal time for survey, as the *Silene spaldingii* plants had turned light brown and were difficult to distinguish from the dry grass and dense vegetation.

2020 Monitoring of Out-plantings: Stacy Kinsell of Rare Care monitored the out-plantings at the Pine Lakes population (EO 61) on Turnbull National Wildlife Refuge in 2020. These augmentation plantings were established in October 2017 with additional out-planting and seeding in 2018 and 2019. More than 2,000 plants in all have been planted. Preliminary results have shown high rates of survival, although some plants have been lost due to vole herbivory. Survivorship has been lower in unburned plots compared to burned sites (Kinsell 2019).

In 2020, Anthony Hatcher continued monitoring out-planted populations of *Silene spaldingii* on the west and east slopes of Steptoe Butte (EO 20), just outside of Steptoe Butte State Park. These populations were first established in 2017 from seedling plugs derived from the small, native occurrence in the park. To date, 1,700 seedlings have been planted at three main sites (Hatcher 2020). The initial cohort of seedlings suffered 98% mortality in 2017, primarily from vole herbivory. Survivorship in subsequent outplantings has improved since plugs were treated

with Plantskydd granules to repel herbivores or enclosed within protective cages. Just over 10% of the 2018 cohort of seedlings were still alive in the fall of 2018 and 20-22% of 2018-2019 plants were still present in fall 2019. Monitoring in 2020 documented a drop from 491 plants in May to 239 in September (Hatcher 2020). Additional seeding or outplanting of plugs will be needed in the coming years if the Steptoe population is to achieve the long-term goal of a stable population of over 500 adult plants (US Fish and Wildlife Service 2020).

At Fairchild Air Force Base, out-planted populations were established in 2017 to augment the native population. Two of the out-planted sites formerly contained native *S. spaldingii* plants but had become locally extirpated by 2010. Three other sites with suitable habitat but no existing plants were also chosen for out-planting. The restored, formerly occupied subpopulations have been the most successful, accounting for 86% of the introduced individuals in 2020 (Rebholz 2020). In all, the outplanted subpopulations have increased from just 7 plants in 2018 to 98 in 2020 and now actually outnumber the original native population (Rebholz 2020).

**Key Conservation Areas Revised:** Key Conservation Areas (KCAs) are clusters of one to several element occurrences of *Silene spaldingii* from the same physiographic subregion of its range and that are managed collectively to attain recovery objectives for de-listing the species (US Fish and Wildlife Service 2007). To qualify as a KCA, a site needs to be comprised of intact and unfragmented habitat covering more than 40 acres, have native plant canopy cover over 80%, have adjacent habitat that supports catchfly pollinators, and contain at least 500 reproducing *S. spaldingii* plants. The 2007 recovery plan for Spalding's catchfly had a goal of protecting 27 KCAs distributed across the five physiographic subregions of its global range. This included 11 KCAs in Washington, distributed across the Channeled Scablands, Canyon Grasslands, and Palouse Grasslands subregions (US Fish and Wildlife Service 2007). In 2020, the Service revised their rangewide recovery objectives to 23 KCAs, of which 9 were in Washington (Table 20, Figure 10). The Kramer Palouse Biological Study Area KCA (EO 6) was dropped from consideration and the proposed Phileo Lake KCA was combined with the nearby Turnbull National Wildlife Refuge KCA (Eos 61 and 62) (US Fish and Wildlife Service 2020). The remaining 9 KCAs in Washington represent 18 of the state's 46 extant occurrences and approximately 84% of all known individuals (Table 20).

## **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

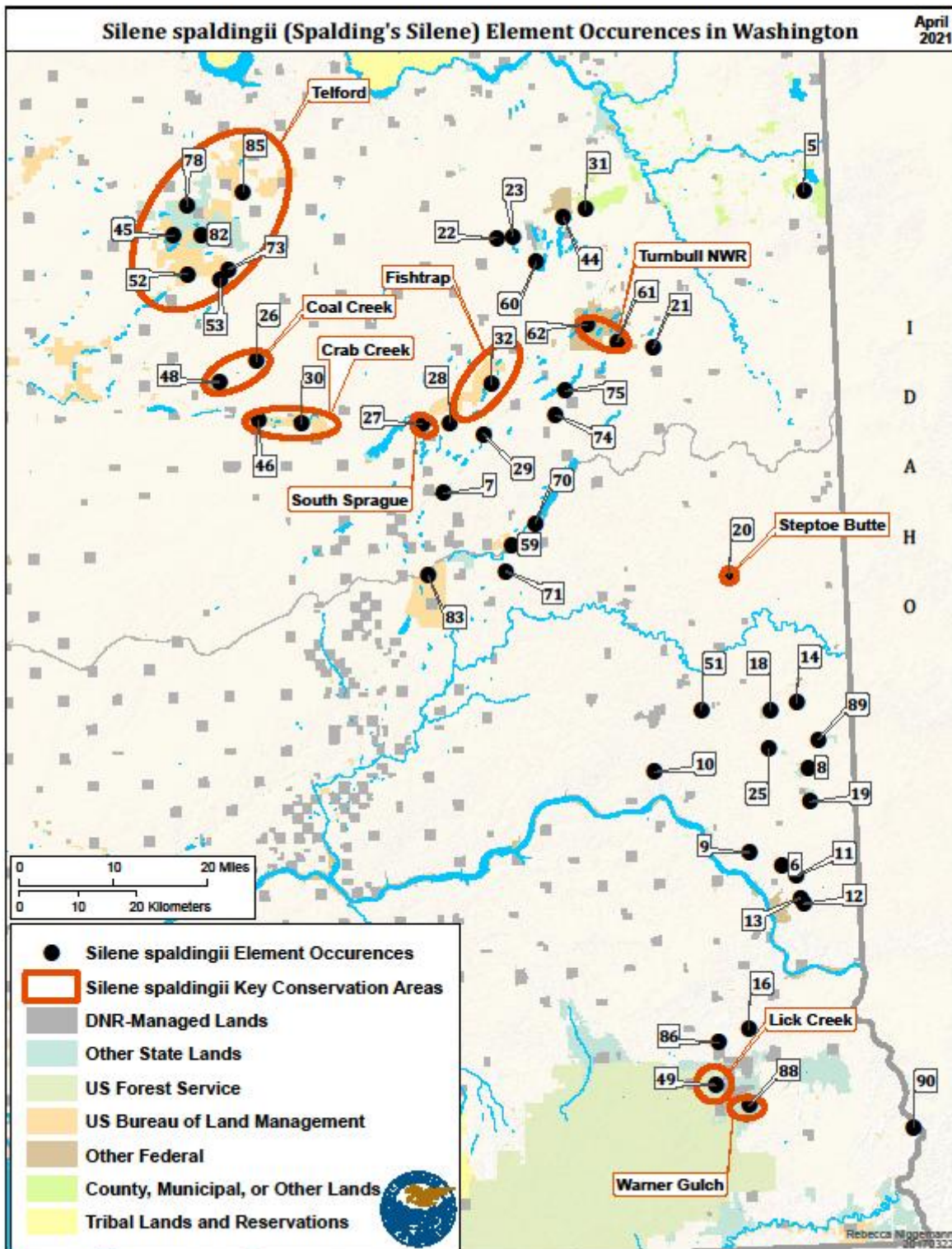
**Table 20. *Silene spaldingii* Revised Key Conservation Areas in Washington.**

From USFWS (2020).

<b>Key Conservation Area Name/Element Occurrences</b>	<b>Ownership</b>	<b>Physiographic Province</b>	<b>Number of Plants</b>
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
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). Includes Philleo Lake.	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 10. *Silene spaldingii* occurrences and Key Conservation Areas in Washington.** Revised from US Fish and Wildlife Service (2020).



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 and 8 potentially extirpated or historical occurrences in Washington (Table 19). Thirty-six occurrences have been relocated or discovered since 2000, with 21 documented since 2018. The 54 occurrences in Washington are comprised of over 500 discrete sub-populations (Niggemann and Fertig 2018). Element occurrences are aggregated into 9 "Key Conservation Areas" (KCA) divided among three main physiographic provinces: Canyon Grasslands, Channeled Scablands, and Palouse Grasslands (Table 20, Figure 10) (Arnett and Goldner 2017). KCAs are the main focus of recovery efforts for the species across its range (US Fish and Wildlife Service 2020).

**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 6,000 plants. Based on the maximum number of plants reported from each extant occurrence, the total population size in Washington is estimated at nearly 25,000 (US Fish and Wildlife Service 2020). Individual subpopulations range in size from 1 to 2,000 individuals (Niggemann and Fertig 2018). Precise population counts are difficult to determine due to an unknown number of individuals that may be dormant below ground for one or more consecutive years (Lesica and Steele 1994).

**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 by livestock, herbicides, and off-road vehicle recreation (Crawford and Rocchio 2012; 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.

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

### **2020 Research and Monitoring Updates**

Annual Monitoring at Rocky Reach: The Rocky Reach occurrence was monitored for the 21st consecutive year in 2020 by staff of Public Utility District Number 1 of Chelan County (Pope and Cordell 2020). The number of flowering plants was essentially stable, dropping from 249 in 2019 to 245 (Table 21). For the sixth consecutive year the population was below the long-term average of 403 plants (Pope and Cordell 2020) and has not fully recovered from the 2015 wildfire. Counts in 2020 were 25% lower than the maximum number of 959 plants recorded in 2007. The actual number of plants in the Rocky Reach population is likely higher, however, as dormant individuals and non-flowering plants are not included in the annual census.

*Spiranthes diluvialis* plants experienced their peak bloom in September, rather than in late July or August, and were still flowering into October (Pope and Cordell 2020). The later flowering may have resulted from higher than normal water flows in the June-July period.

Five of the seven subpopulations within the Rocky Reach occurrence have lower total numbers than the 21-year average (Table 21) and population counts oscillate from year to year. No pure *S. diluvialis* plants were observed at the Gallagher Flats subpopulation in 2020, though 5 putative hybrids with *S. romanzoffiana* were found\* (Fertig 2019, Pope and Cordell 2019). The PUD Beebe subpopulation has not been relocated since 2010 and is likely extirpated. The recently discovered subpopulation from Hendricks Draw on the east shore of the reservoir in Douglas County has ranged from 4-6 flowering plants (Pope and Cordell 2020).

Wannacut Lake: This occurrence was briefly visited (but not formally surveyed) by Bridgette Glass of the WA Department of Fish and Wildlife (DFW) and local botanist George Thornton,



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

\*The suspected hybrids are morphologically intermediate in the shape of the sepals and lip petal. The necessary genetic work to confirm their hybrid origin has not been conducted. *S. romanzoffiana* is the most common *Spiranthes* species in Washington, but is usually found in montane wetlands north and west of the Columbia River. *S. diluvialis* is presumed to be of hybrid origin between *S. romanzoffiana* and the Great Plains species *S. magnicamporum* (Arft and Ranker 1998).

who observed 8 plants in August 2020 (Table 22). Glass and Thornton also surveyed potential habitat on DFW land at nearby Blue Lake, but did not find *S. diluvialis*. The last formal survey of Wannacut Lake was made by George Thornton in September 2018 when he observed 92 reproductive plants (Fertig 2019).

**Vantage Substation:** Nate Dietrich, Joe LeMoine, and others with the Grant County Public Utility District censused the Vantage Substation population on 18 August 2020 and documented 58 flowering plants, up slightly from 54 observed in 2019, but higher than the 23 plants when the population was discovered in 2017 (Table 22). Of the 54 tagged plants found in 2019, 25 were still present and flowering in 2020, while 29 were not located and are either dormant below ground or dead. If dormant, the total number of plants at the substation may be greater than 87 individuals.

**Table 21. Summary of *Spiranthes diluvialis* monitoring on the Rocky Reach Reservoir, 2000-2020.** From Pope and Cordell (2020).

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
2019	59	2	16	98	69	0	5	249
2020	24	0	54	89	72	0	6	245
2000-2020 Average	109	28	146	133	33	0	5	403

**Table 22. Summary of *Spiranthes diluvialis* occurrences in Washington.**

Population	County	Ecoregion	Ownership	Year last Obs	Status
<b>Wannacut Lake (EO # 01)</b>	Okanogan	Okanogan	private	2020	2020: Brief site visit, not a through survey; 8 plants observed. 2018: 92 plants observed. 2011: 15 plants observed in brief survey. 2009: not found. 2007: not found. 2000: 200+ plants observed. 1997: 27 plants observed.
<b>Columbia River-Rocky Reach (EO # 02)</b>	Chelan, Douglas	Columbia Plateau, East Cascades	Chelan County PUD, Spokane BLM, Colockum SWA, private	2020	See Table 21 for details
<b>Vantage Substation (EO # 05)</b>	Grant	Columbia Plateau	Grant County PUD	2020	2020: 58 plants observed; 2019: 54 plants observed; 2017: 23 plants observed.

### Current Status Summary

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

Natural Heritage Rank: G2G3/S1; WA Endangered

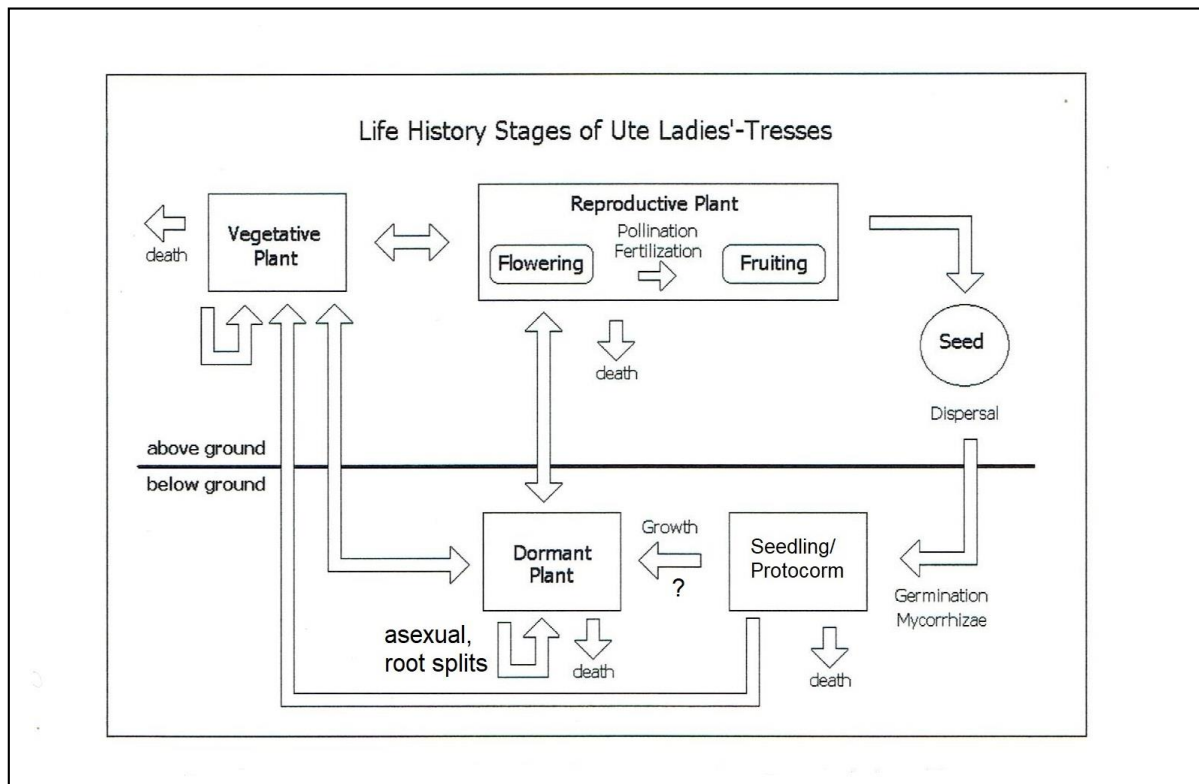
Key Characteristics: *Spiranthes diluvialis* is a perennial herb with glandular-pubescent stems 12-60 cm tall from tuberous roots. Basal leaves are narrowly linear, up to 1 cm wide and 28 cm long. Leaves become progressively smaller up the stem and are alternate. The inflorescence is a sparsely pubescent 3-15 cm long spike of numerous white to ivory-colored flowers arranged in a gradual spiral. The lip petal is 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 relocated from 1998-2000. The population could not be relocated in surveys from 2007-2009 and was thought to be possibly extirpated before being rediscovered in 2011 and most recently in 2020. 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 2000-2020. In 2017, a new population was discovered by Ken McDonald east of the Columbia River near the Vantage substation in Grant County (Fertig 2018) and has been resurveyed yearly since 2019.

**Abundance:** The minimum number of *Spiranthes diluvialis* flowering plants in Washington is between 395 and 1200. As a perennial geophyte with prolonged dormancy, an unknown number of additional plants remain below ground each year (Figure 11), making it difficult to assess population size and trend (Fertig et al. 2005). Individual populations in Washington ranged from 54 to 249 flowering plants in 2019, the last year with complete data for all three occurrences.

**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 small, subirrigated meadows of *Agrostis stolonifera*, *Juncus torreyi*, and *Distichlis spicata* in depressions within sagebrush communities. Elevation ranges from 720-1830 ft (220-560 m).



**Figure 11. Life History Model of *Spiranthes diluvialis*.** Arrows indicate transitions from one life stage to another. Specific actions (i.e. dissemination, germination, pollination) driving each transition are indicated above the arrow. Reversible transitions are indicated by a double-headed arrow. Several stages can persist in the same form for multiple seasons, as indicated by an arrow circling back on itself. Revised from original model in Fertig et al. (2005) and Arft (1995).

Threats: Changes in hydrology (such as permanent inundation under reservoirs or water withdrawal), loss of habitat to development or agriculture, herbicides, competition from invasive weeds, and vegetation succession are the primary threats (Fertig et al. 2005). 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 oscillate in response to climate conditions.

Managed Areas/Ownership: Spokane District Bureau of Land Management, Chelan County Public Utility District, Beebee Springs Natural Area (WA Dept of Fish and Wildlife), Grant County Public Utility District, private.

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