WASHINGTON NATURAL HERITAGE PROGRAM

Status and Conservation Assessment of *Sidalcea oregana* var. *calva* (Wenatchee Mountains checkermallow)

Prepared for
US Fish and Wildlife Service

Prepared by
Walter Fertig
April 15, 2022

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WASHINGTON STATE DEPARTMENT OF NATURAL RESOURCES

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ON THE COVER: Wenatchee Mountains checkermallow (*Sidalcea oregana* var. *calva*), Camas Meadows Natural Area Preserve, Washington.

Photograph by Walter Fertig.

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Introduction

Wenatchee Mountains checkermallow (*Sidalcea oregana* var. *calva*) is a pink-flowered perennial herb with fleshy, shallowly lobed, round basal leaf blades and smaller, deeply palmately-divided stem leaves. This taxon is restricted to montane meadows and forest edges with a high water table (at least in the spring) in the Wenatchee Mountains and vicinity in Chelan County, Washington (WNHP 2022). It was first collected by John Leiberg and John Sandberg in 1893 along Icicle Creek near Leavenworth and in Peshastin. Over the next 42 years it was collected just three additional times by Kirk Whited near Leavenworth (1904) and J. William Thompson at Camas Meadows and the slopes of Tip Top Peak (1934-35). University of Washington botanist C. Leo Hitchcock made collections at Camas Meadows in 1951 and was the first to recognize that Wenatchee Mountains checkermallow was an undescribed taxon. Hitchcock and Kruckeberg (1957) published var. *calva* as a new variety, noting its distinctive leaf, stem, and calyx features that differentiate it from the more common and widespread *S. oregana* var. *oregana* (Hitchcock and Cronquist 1961, 2018).

By 1975, Wenatchee Mountains checkermallow was known from only one extant occurrence and was included in the first group of vascular plant species proposed for listing as Threatened or Endangered under the Endangered Species Act (ESA) by the US Fish and Wildlife Service (USFWS 1975). It was not listed at that time, but was designated as a Candidate for listing in 1980 (USFWS 1980). *Sidalcea oregana* var. *calva* was also identified as a state Endangered plant by the Washington Natural Heritage Program (WNHP) in 1981 (WNHP 1981). USFWS proposed listing *S. oregana* var. *calva* as Endangered in 1997 and the listing became official on 22 December 1999 (USFWS 1997, 1999). The Service published a recovery plan for the species in 2004 (USFWS 2004).

Since 1999, USFWS has funded numerous projects focusing on surveys, monitoring, ecological condition, management actions, population biology, and threats from seed predation and climate change for Wenatchee Mountains checkermallow (Arnett 2011, Arnett and Birkhauser 2008, Bleckinger 2001, Caplow 2003, Crawford 2013, Dunwiddie 2014, Fertig 2019, 2021a, Goldsmith Zimmerman and Reichard 2005, Kleinknecht et al. 2019, University of Washington Rare Care 2021, Wilderman 2015). In 2018, USFWS contracted with WNHP to survey all known extant and historical element occurrences (i.e. distinct populations separated from other populations by significant barriers to dispersal or distances of 1.5 km, but often subdivided into two to many discrete subpopulations) of *Sidalcea oregana* var. *calva* to determine their abundance, , trends, health, and habitat condition and visit other areas of potential habitat to locate new subpopulations or identify areas that might be suitable as introduction sites. The following report is a summary of field surveys and monitoring conducted between 2019-2021 and includes an assessment of conservation actions necessary for recovery and stewardship.

Methods

Information on the distribution, habitat, population size, and life history of Wenatchee Mountains checkermallow was derived from scientific literature, unpublished reports, and WNHP databases. Maps and population data for current and historical occurrences were derived from the WNHP Biotics database. A simple habitat model (Kleinknecht et al. 2019) based on

soil types and monthly mean temperature and precipitation was used to identify other areas of potential habitat for survey or future out-plantings in the vicinity of Camas Meadows, Mountain Home, and Peshastin Creek.

Monitoring of the Camas Meadows and Mountain Home populations was done in collaboration with Washington Department of Natural Resources (DNR) Natural Areas Program (NAP) staff and University of Washington Rare Care personnel and volunteers. The Camas Meadows occurrence consists of hundreds of individual subpopulations (separated by 5-1,500 m) that were mapped with a GPS device. Individual reproductive plants (those in bud, flower, or fruit) were marked with multicolored pin flags. Multi-stemmed plants were counted as a single individual if all stems were within 6 inches. The number of plants per subpopulation was determined by counting the total number of flags. Other surveyed occurrences were small enough in area or number of plants for counts to be made without using pin flags. Data collected in the field were entered into the WNHP Biotics database.

Results

Ten occurrences and one experimental outplanting of *Sidalcea oregana* var. *calva* are currently recognized (Table 1). The status of each of these is summarized in the sections below. Occurrences are organized by whether they are extant, extirpated, or failed to be found. Exant occurrences were relocated in 2019-21 surveys or have been observed within the last 40 years and are presumed to still be present. Extirpated occurrences have not been relocated in the past 40 years and are presumed to no longer be present at the site due to significant loss or alteration of suitable habitat. One occurrence is categorized as "failed to find", though it was observed within the last 40 years. This occurrence may prove to extirpated if it remains absent in a subsequent site visit.

Three formerly recognizrd occurrences that are based on misidentified specimens are discussed in the section on "False reports". Lastly, one location with excellent potential for introduction is described under potential sites section.

Extant Occurrences

Sidalcea oregana var. *calva* is currently known from four extant native occurrences and one introduced population in Washington (Figure 1, Table 1). Three of the four native occurrences were surveyed in 2019-2021 and described below (the fourth, on private land, was not surveyed due to lack of landowner permission).

Camas Meadows (EO # 09)

Camas Meadows is the largest known occurrence of Wenatchee Mountains checkermallow. It consists of at least 345 separate subpopulations covering approximately 160 acres within an area of 2 x 4 km (1.25 x 1.45 miles). The occurrence is found primarily within a flat, shallow, sandstone basin surrounded by a rim of intrusive volcanic diabase at the head of four main creeks

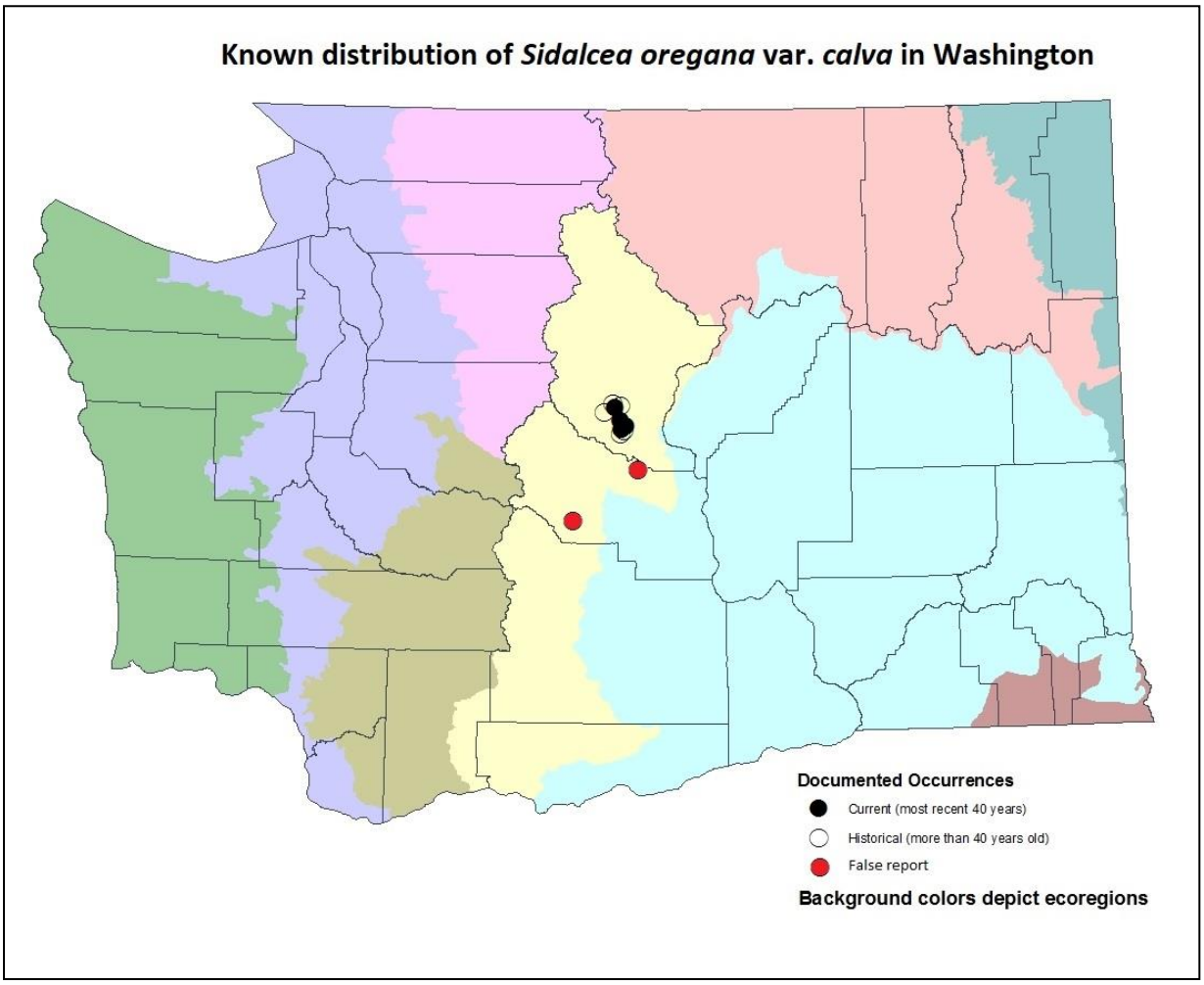

Figure 1. Rangewide Distribution of *Sidalcea oregana* var. *calva*. Map derived from WNHP (2022).

(Brender, Camas, Poison, and Sand) draining the northeast flank of the Wenatchee Mountains (Kleinknecht et al. 2019). Most of occurrence is within the 2,018 acre Camas Meadows Natural Area Preserve managed by the Washington Department of Natural Resources. Additional subpopulations are found on adjacent portions of Poison and Brushy creeks in Okanogan-Wenatchee National Forest. The entire occurrence is formally designated as critical habitat by USFWS (2001).

Sidalcea oregana var. *calva* was first collected at Camas Meadows by J.W. Thompson in 1935, and later by C.L. Hitchcock in 1951 (Hitchcock and Kruckeberg 1957). The population was revisited in 1978 by Diane Varney, but no population counts were made until 1980, when 75 plants were reported in one small area (WNHP Biotics database). The first census was attempted in 1983, when 300 plants were counted over a 120 acre area by Reid Schuller. John Gamon mapped the population in 1987 and estimated the total population to be "several thousand" (Gamon 1987). David Wilderman reported 2,470 plants in 90 acres of habitat in 1997 (USFWS

Table 1. Population data for Native and Out-Planted Occurrences of *Sidalcea oregana* var. *calva* in Washington.

Occurrence (EO #)/ Ownership	Yr last Obs	Population Size	Population Trend	EO Rank
Peshastin (EO # 03)/ Private?	1893	0	Decrease	X (extirpated)
Leavenworth (EO # 04)/ Okanogan-Wenatchee NF? Private?	1904	0	Decrease	X (extirpated)
Tip Top/Deer Park Spring (EO # 05)/ Okanogan-Wenatchee NF	1934	0	Decrease	X (extirpated)
Camas Meadows ("Camas Lands") and Poison Creek (EO # 09)/ Camas Meadows NAP, Okanogan-Wenatchee NF	2021	2012-2021 census: 41,040 flowering plants censused in 345 sub-populations (35,508 in Camas Meadows NAP & Brushy Creek and 5,532 along Poison Creek in Okanogan-Wenatchee NF). 2000: 11,125 flowering plants 1997: 2,470 flowering plants estimated 1987: "several thousand" estimated	Increase (or stable?)	AB (excellent or good viability)
Icicle Creek (EO # 12)/ Okanogan-Wenatchee NF	1893	0	Decrease	X (extirpated)
Pendleton Canyon (EO # 16)/private (mistakenly thought to be Okanogan-Wenatchee NF in past)	2001	2001: 150-200 plants in USFS transect	Unknown	C (fair viability)
Upper Camas Land Meadow (EO # 19)/ Okanogan-Wenatchee NF	1987	1987: 3 plants. Not relocated in 1999, 2001, or 2019; considered extirpated	Decrease	X (extirpated)
Mountain Home Meadow (EO # 20)/ Private (DNR Registry)	2021	2019: 2,299 plants observed in census (2245 flowering & 54 vegetative) and 43 more to north on adjacent properties. 2018: 1,375 flowering plants observed. 2011: 2,581 flowering plants observed in census. 2005: 2,038 flowering plants observed in census. 1987: "several hundred"	Stable (oscillating)	B (good viability)
Camas Creek tributary (EO # 021)/ Private/Camas Meadows NAP	2021	2021: 5 plants observed in flower in 1 of 5 original subpopulations. 2014: 21 plants observed, all vegetative. 2001: 8 plants observed. 1990: scattered along old road.	Decrease	CD (fair or poor viability)
FS Rd 120 (EO # 022)/ Okanogan-Wenatchee NF	2008	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.	Decrease	F (failed to find)
Mountain Home Ridge (out-planting)/ Chelan-Douglas Land Trust, Okanogan-Wenatchee NF	2019	2019: 10 flowering and juvenile plants observed. 2018: 100 of 161 out-planted individuals surviving. 2015: 110 plugs planted; 2014: 51 plugs planted at 4 sites.	Decrease	CD (fair or poor viability)

mapped the population in 1987 and estimated the total population to be "several thousand" (Gamon 1987). David Wilderman reported 2,470 plants in 90 acres of habitat in 1997 (USFWS 1997). This number increased to approximately 11,000 plants in 123 subpopulations when the area was more thoroughly mapped by Wilderman and other DNR NAP staff in 1999-2000 (Caplow 2003; USFWS 2004, WNAP 2000). Monitoring plots were also established at four sites (one on DNR property and 3 on USFS lands) beginning in 1999 to assess population trends and plant vigor in response to climatic factors (Bleckinger 2001).

In 2011, Wilderman and NAP staff mapped most of the large subpopulations of *Sidalcea oregana* var. *calva* within Camas Meadows with GPS units to create a mosaic of polygons (equivalent to individual subpopulations or clusters of subpopulations), but did not estimate abundance within the polygons. Beginning in 2012, NAP staff and partners (including the University of Washington Rare Care program, WNHP, USFS, and USFWS staff, and citizen volunteers) systematically revisited and remapped existing polygons (or mapped new ones) and conducted a complete census of flowering plants within each polygon. This effort continued every year (except 2015), with new polygons being mapped and censused that had not been visited in previous years. The entire Camas Meadows and Poison Creek re-mapping and census effort was completed in 2021 (Table 2, Figure 2).

The cumulative number of *Sidalcea oregana* var. *calva* flowering plants counted at Camas Meadows and Brushy Creek (Okanogan-Wenatchee NF) from 2012-2021 is 35,508 (Tables 1, 2). In 2021, Brigitte Ranne and colleagues from USFS re-counted the Poison Creek subpopulation and observed an additional 5,532 flowering plants. The entire Camas Meadows occurrence contains at least 41,040 flowering individuals (Table 2) in 345 subpopulations. Individual subpopulations vary from 1 to 2,512 plants.

Table 2. Cumulative Number of *Sidalcea oregana* var. *calva* plants and polygons (individual or clusters of subpopulations) surveyed at the Camas Meadows Occurrence, 2012-2021

Year	# of Polygons Surveyed	# of Flowering Individuals Counted
2012 Camas Meadows NAP	11	1,757
2013 Camas Meadows NAP	21	1,810
2014 Camas Meadows NAP	11	276
2016 Camas Meadows NAP	37	2,604
2017 Camas Meadows NAP	38	8,203
2018 Camas Meadows NAP	26	4,628
2019 Camas Meadows NAP	7	8,301
2020 Camas Meadows NAP	71	3,284
2021 Camas Meadows NAP	122	4,645
2021 Poison Canyon (USFS)	1	5,532
Grand Total	**345**	**41,040**

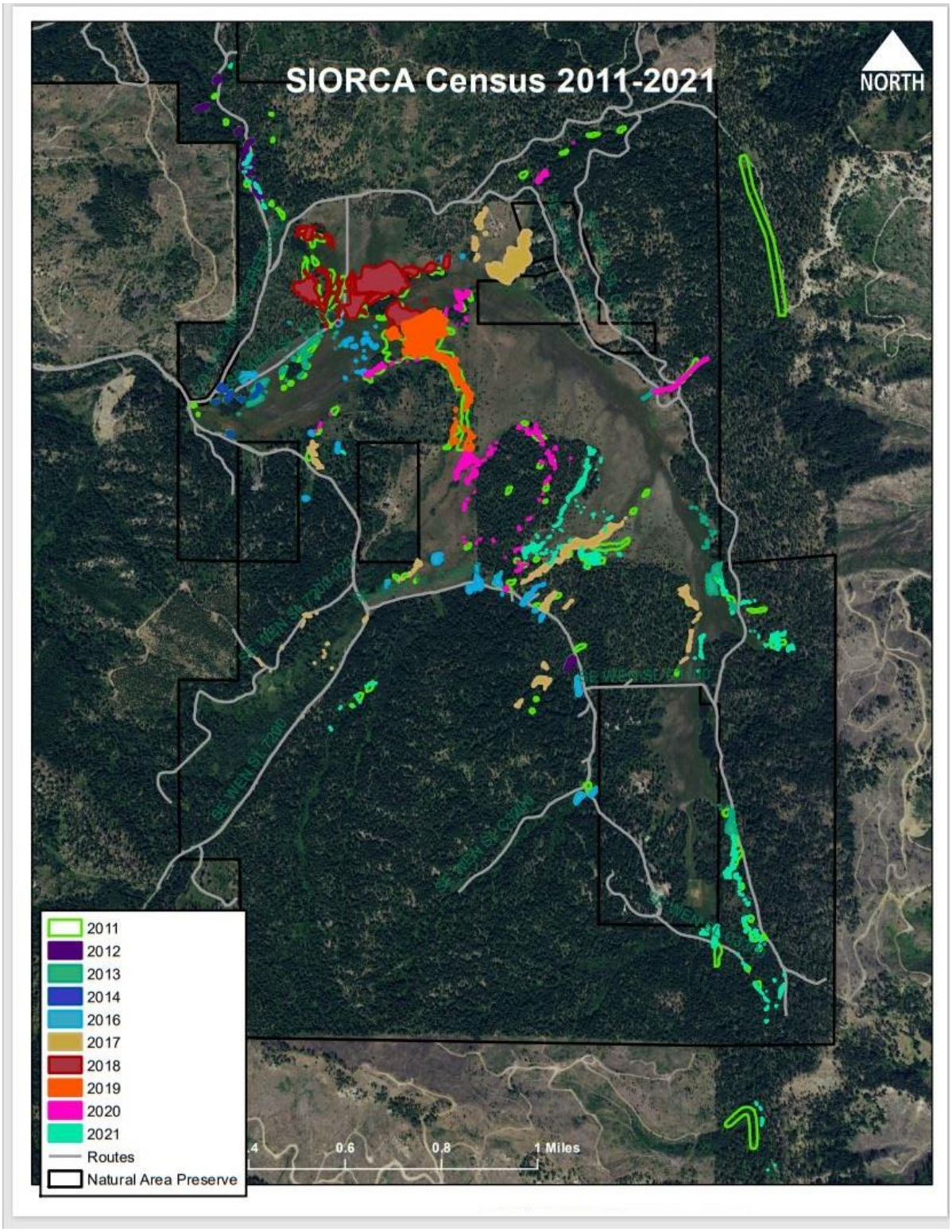

Figure 2. Distribution of *Sidalcea oregana* var. *calva* at Camas Meadows Natural Area Preserve (EO 09). Map created by Washington Natural Areas Program based on annual mapping and census work from 2012-2021. See Table 2 for yearly results.

Population numbers at Camas Meadows appear to have increased nearly four-fold from earlier estimates (Table 1). Whether this represents a true population increase is complicated by the significant differences in monitoring methods over the past 35 years. Counts in 1987, 1997, and 2000 were based on single-visit, short duration, ocular estimates of a small subset of the entire occurrence. The 2012-2021 mapping and census effort involved teams of 5-10 trained surveyors spending two 8-hour days per visit over 9 years for over 1000 hours of survey time. This level of survey effort is nearly unprecedented for rare plant species in Washington (Fertig 2021a) and unlikely to be repeated again due to funding constraints (David Wilderman, personal communication 2022).

Some trend information can be inferred from monitoring studies established in 1999 (USFS 1999) and summarized by Arnett (2011), Bleckinger (2001), Kuhlman (2004), and Wilderman (2015). Bleckinger established monitoring plots at "Bible Camp" (now part of Camas Meadows NAP and renamed transect 2721 [Wilderman, 2015]), Poison Creek, and two forks of Brushy Creek (the latter three sites on Okanogan-Wenatchee National Forest) to measure changes in the mean number and frequency of *Sidalcea oregana* var. *calva* plants in 50-100 1-m^2 plots by year and relative to mean annual precipitation and mean maximum and minimum temperatures in winter, spring, and summer. The mean number of plants increased significantly from 1999 to 2000, but then slowly declined from 2001-2003 back to 1999 levels, suggesting an overall stable pattern over 5 years (Kuhlman 2004) (Table 3). Frequency was comparable from year-to-year for each site except for some oscillation at Brushy Fork Left (Table 3). Each of these monitoring plots was located within forested habitats, rather than open, wet meadows where *S. oregana* var. *calva* more frequently occurs (D. Wilderman, personal communication 2022). Wilderman and colleagues from DNR continued and expanded frequency monitoring at additional forested sites in Camas Meadows from 2002 to 2017 (Wilderman 2015, Wilderman and Caplow 2005). These plots exhibited stable to slightly increasing frequency from 2002 to 2012, but then a decline from 2014 to 2016 (Figure 3) (Fertig 2018). No additional frequency monitoring has been done since 2017 (D. Wilderman, personal communication).

Table 3. Frequency (%) and mean number of *Sidalcea oregana* var. *calva* plants in selected populations. Data based on 100 randomly selected permanent plots, along each of six transects (Bleckinger 2001). Adapted from Arnett (2011) and Kuhlman (2004).

Year	Frequency by Transect						Mean plants per square meter (all 6 transects)
	Bible Camp, Transect #1	Poison Canyon, Transect #2	Brushy Fork Left, Transect #3	Brushy Fork Right, Transect #4	Mountain Home, Transect #5	Pendleton Canyon, Transect #6	
1999	94	60	9	15	22	20	2.8
2000	95	56	13	15	26	25	6.7*
2001	96	62	12	17	27	27	5
2002	94	63	12	18	26	23	4
2003	91	56	6	16	18	19	3.5

* statistically significantly different from data in other years

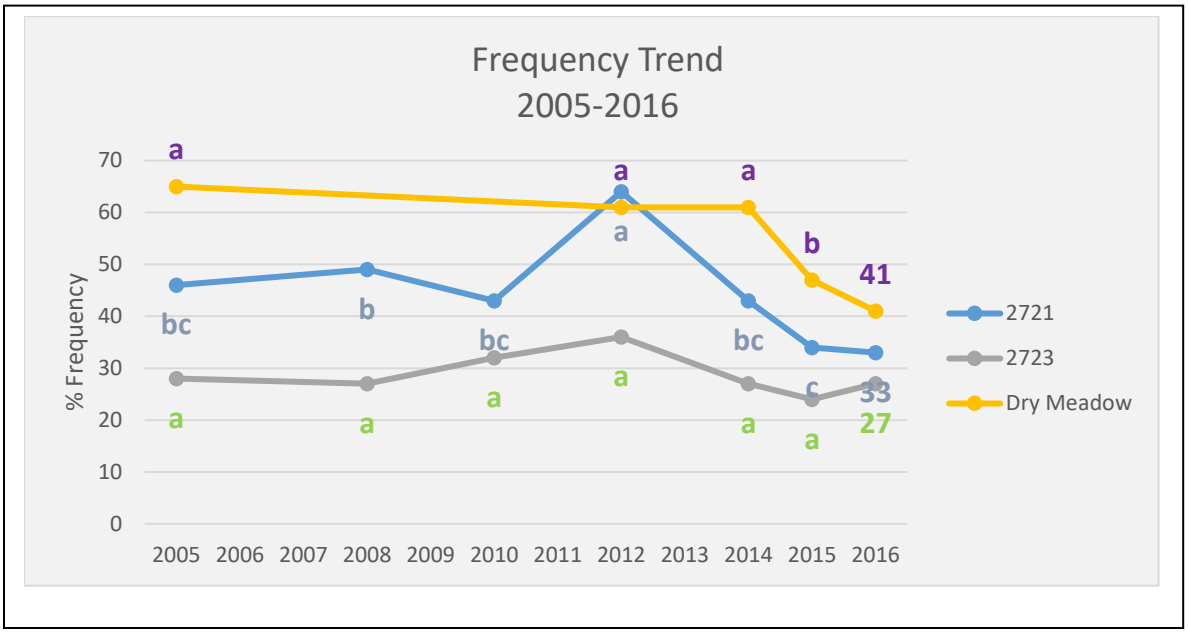

Figure 3. Frequency Monitoring of Selected *Sidalcea oregana* var. *calva* transects in forested openings in Camas Meadows Natural Area Preserve. Plot 2721 is the same as the "Bible Camp" plot in Table 3. Data points with the letter "a" were statistically significant at p = .05 (chi-square test). Adapted from Wilderman (2015).

Crawford (2013) applied Ecological Integrity Assessment (EIA) methods to assess the condition of the Camas Meadows occurrence in 2012. The EIA is a standardized and repeatable tool for evaluating the current ecological conditions and processes of a site relative to what is expected for that particular ecological system in order to gauge management effects, restoration success, or overall conservation value of a site (Faber-Langendoen et al. 2019). Crawford employed a Level 2 (field-based, rapid assessment) EIA that employed qualtitative and semi-quantitative ratings of a variety of ecological attributes observed at 13 randomly chosen sites encompassing a variety of ecological conditions at Camas Meadows (e.g., narrow riparian patches within forests, wet meadow edges, and forest-meadow transitions). The measured attributes included landscape context, adjacent buffers, relative patch sizes, cover of native, invasive, and non-native plant species, species composition, relative cover of native species, vegetation structure, and soil surface conditions (Crawford 2013). In addition, an assessment of stressor (type, scope, and severity) was applied to each of the 13 sites. Five of the 13 sample sites at Camas Meadows were given an overall EIA rank of A (excellent estimated ecological integrity) and 8 were assigned a score of B (good estimated ecological integrity). The primary landscape and vegetation stressors were invasive exotic plant species, altered natural disturbance regimes, removal of trees, hydrological obstructions, and soil disturbance (Crawford 2013).

Based on ecological conditions and population size, the Camas Meadows occurrence has an EO rank of AB (Hammerson et al. 2020), indicating the population has excellent or good estimated

viability (Table 1). This occurrence has the highest EO rank score of any population of *Sidalcea oregana* var. *calva*.

Starting in 2014, DNR began treatments to restore pre-settlement hydrologic conditions, manage competing woody vegetation and improve seedbed conditions for *Sidalcea oregana* var. *calva* through prescribed fire, and control populations of invasive weed species at Camas Meadows NAP (Wilderman 2015). Three frequency monitoring plots were present within or adjacent to forested areas that were burned in 2014 and 2015 in the northwestern corner of the main meadow. Two burned plots (2721 and dry meadow) and one unburned contol (2723) all experienced declines in frequency immediately following the burn in 2015. The two burned plots also had stable to lower frequency in 2016, but the unburned plot increased. Additional monitoring data are not available. Anecdotal evidence from census counts of this area in 2018 indicated a robust population of flowering plants was present, but no baseline numbers were available for comparison. Wilderman (personal communication 2022) observed seedling *S. oregana* var. *calva* plants in the years following the prescribed burns for the only time in his 20 years studying the Camas Meadows occurrence. Likewise, seedlings appeared in fairy rings surrounding burned slash piles in a treatment area along Poison Creek in spring 2018, providing further evidence of the importance of fire in seedling emergence.

Camas Creek Tributary (EO 21)

This small occurrence is located along a separate tributary of Camas Creek (Figure 4) about 1 km west of the large occurrence at Camas Meadows (EO 09). Based on current EO standards, this area could be considered an extension of the Camas Meadows occurrence, though it is in a different subdrainage and isolated by unsuitable habitat. The occurrence is mostly on private lands, but at least one subpopulation extends on to Camas Meadows NAP. Most of the private lands were clearcut approximately 20 years ago. Sidalcea oregana var. calva plants are restricted to small patches within brushy riparian habitat dominated by serviceberry (*Amelanchier alnifolia*), aspen (*Populus tremuloides*), and black hawthorn (*Crataegus douglasii*).

John Gamon discovered this occurrence along an old spur road in 1990, but did not make an estimate of its abundance. Tracy Rush was unable to relocate the occurrence in 1999. Florence Caplow (2003) discovered a second subpopulation in 2001 in a small drainage north of Gamon's original location with 8 fruiting plants in an area of 25 x 75 feet. Wendy Gibble and a group of Rare Care volunteers found 21 plants in 3 small patches along the Section 16/21 boundary line in July 2014. On 7 July 2021, property owner Daniel Steele and I visited each of the known subpopulations but only found 5 flowering plants in a small wooded drainage that corresponds with Gamon's original locality (Figure 4). The other reported sites may be too densely vegetated to support this species at present. A prescribed burn might help thin the brush and expose any persisting seeds to heat treatment neccesary to break dormancy. Due to its small size and poor habitat quality, this occurrence has an EO rank of C (fair estimated viability) (Table 1).

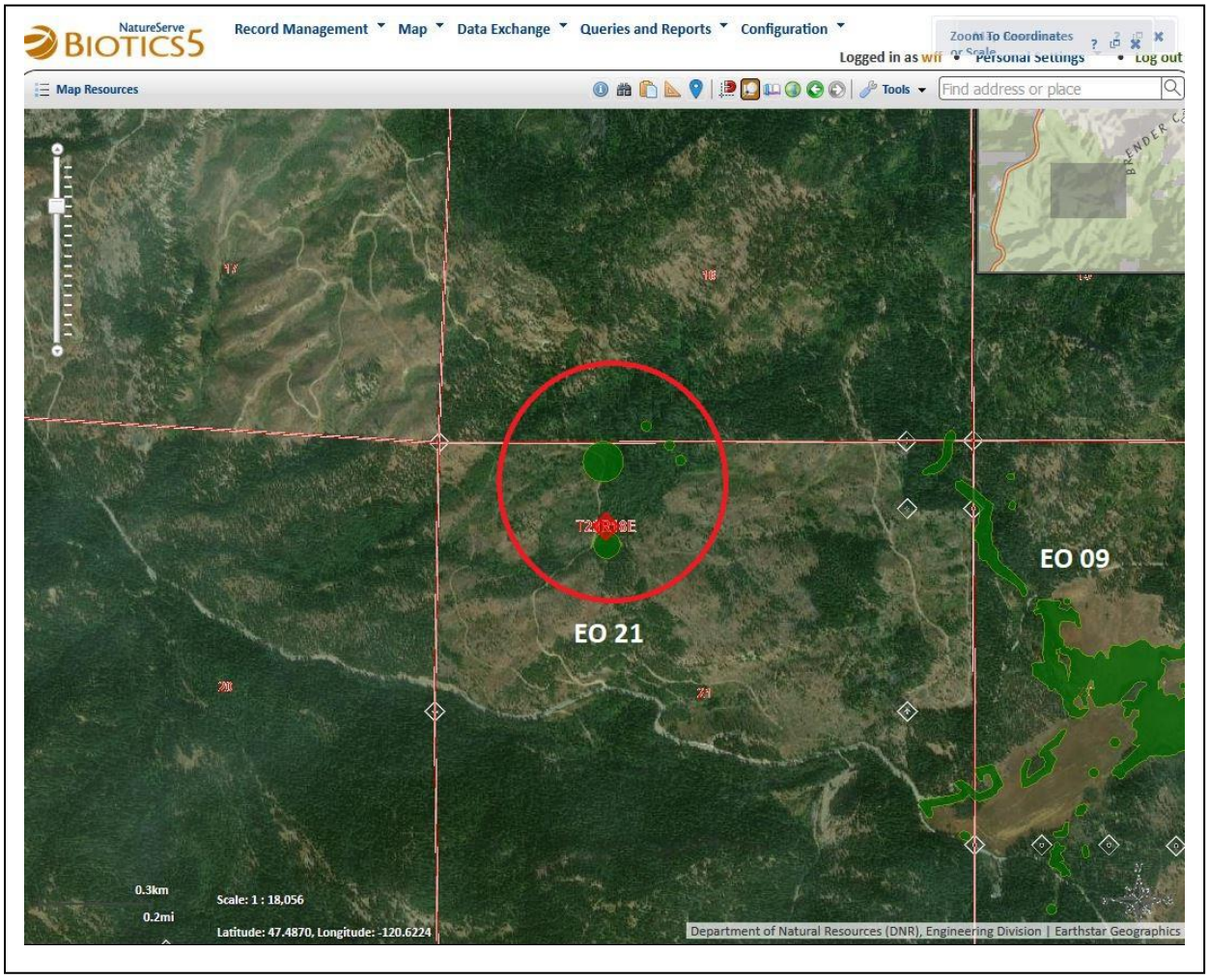

Figure 4. Distribution of *Sidalcea oregana* var. *calva* at Camas Creek Tributary (EO 21). Red diamond indicates location of population found in 2021; other green circular polygons within the red circle were previously documented subpopulations that were not relocated in 2021. EO 09 (Camas Meadows) is located about 0.5 miles to the east in a separate subdrainage of Camas Creek.

Mountain Home (EO 20)

The Mountain Home occurrence is located on private lands on the east side of the Mountain Home Road, about 2 miles south of Leavenworth (Figure 5). This site is a gently sloping, vernally wet meadow and small flat within an open forest of *Populus tremuloides*. The area is periodically burned and mowed by the landowners to maintain meadow conditions and contain the spread of shrub species, such as common snowberry (*Symphoricarpos albus*).

John Gamon discovered this occurrence while conducting a range-wide survey of *Sidalcea oregana* var. *calva* in 1987 (Gamon 1987). The population consisted of "several hundred" plants at that time (Table 1). The area was revisited by Gamon and Tracy Richter in 1990 and Tracy

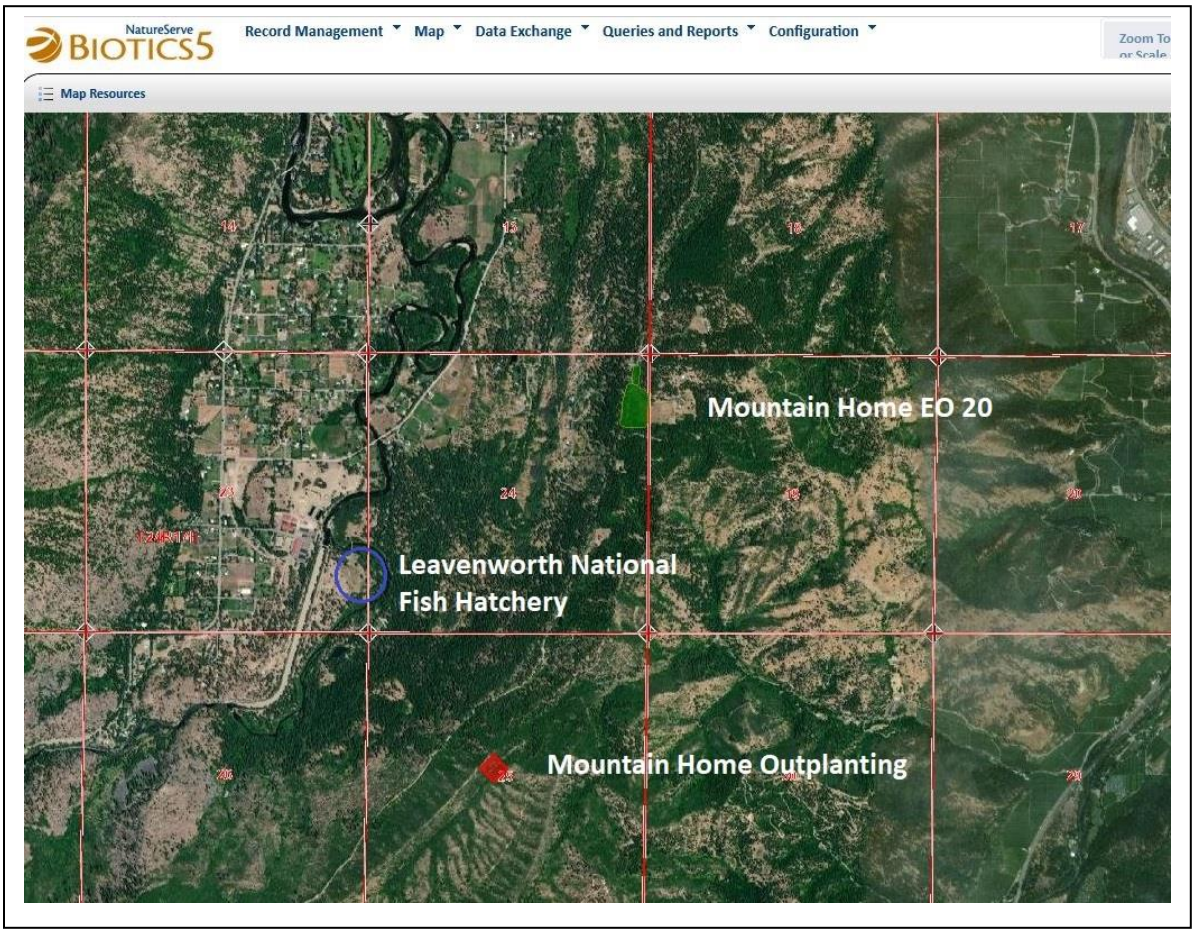

Figure 5. Distribution of *Sidalcea oregana* var. *calva* at Mountain Home and vicinity (EO 20). Mountain Home Out-planting is indicated by red diamond. A potential out-planting site at the Leavenworth National Fish Hatchery on Icicle Creek is shown in blue.

Rush in 1999. Caplow (2003) conducted the first formal monitoring of the Mountain Home site and reported 300 individuals in a 300 x 210 foot area in 2001. Lauri Malmquist of Okanogan-Wenatchee National Forest, David Wilderman, and Florence Caplow mapped and censused three subpopulations (main meadow, roadside ditch, and aspen forest) in 2005 and found 2,038 flowering, 101 vegetative, and 108 juvenile plants. The population reached its highest number in 2011, when 2,548 flowering plants were observed. In 2018, only 1,375 flowering plants were counted in a survey by Tara Callaway and Randi Riggs of USFWS and Lauri Malmquist. A more thorough survey in 2019 by Wendy Gibble, Tara Callaway, Randi Riggs, and myself documented 2,245 flowering and 54 vegetative plants at Mountain Home and another 43 plants on adjacent properties to the north (Table 1).

A single monitoring plot was established at Mountain Home in 1999 and read each year through 2003 (Arnett 2011, Bleckinger 2001, Kuhlman 2004). The Mountain Home plot was relatively

stable over the entire duration of the study, starting with 22 plants in 1999, increasing to 27 in 2002 and dropping to 18 in 2003 (Arnett 2011).

Starting in 2020, Wendy Gibble, Jon Bakker (professor at University of Washington), and other Rare Care staff established 6 treatment blocks at Mountain Home population to study the effects of clipping snowberry, prescribed fire, and herbicide treatments on maintaining suitable habitat for *Sidalcea oregana* var. *calva* (Fertig 2021a).

Mountain Home is the second largest occurrence of Wenatchee Mountains checkermallow and has an EO rank of B (good estimated viability). The current landowners have entered the property in the DNR voluntary natural area registry program. Seed from Mountain Home has been collected for use in establishing a new occurrence in the vicinity (see below).

Mountain Home Out-Planting

In 2014, the Chelan-Douglas Land Trust (CDLT) contracted with Peter Dunwiddie (botanical consultant affiliated with University of Washington) to oversee an experimental out-planting on Trust property off the Mountain Home Road, about 1.2 miles south of the Mountain Home occurrence (EO 20) (Figure 5). The original planting consisted of 51 plugs established at four wet forested sites near the boundary of Okanogan-Wenatchee National Forest (Dunwiddie 2014). Another 110 plugs were planted in 2015. Monitoring in 2018 documented 100 surviving plants (USFWS 2020). In 2019, Susan Ballinger and other staff from CDLT and I revisited the out-planting and found only 6 flowering and 4 juvenile plants (Fertig 2021a). The forest at this site may need to be thinned in the future to create a more open, meadow-like habitat for this species. Augmentation with additional plugs or seeds may be necessary before the population can be considered successfully established. The site is informally given an EO rank of CD (fair or poor estimated vulnerability) (Table 1), but is not technically considered an element occurrence in the WNHP's Biotics database because of its introduced status.

Pendleton Canyon (EO 16)

Pendleton Canyon is a tributary of Peshastin Creek and is in the drainage north of Camas Creek, 2.9 km northwest of Camas Meadows (Figure 6). The canyon contains some forested wetland habitat that is seasonally wet in the spring. Tony Basabe of the US Forest Service discovered two small patches of *Sidalcea oregana* var. *calva* in the canyon in 1984, separated by 0.7 km. These sites were not relocated by Gamon (1987) in 1987. Tracy Rush found several hundred plants in a 50 x 10 meter area along a dirt road in 1999. Florence Caplow revisited the site and counted 160 plants in one-quarter acre in 2001 and noted the population appeared to be contracting (Caplow 2003). Bleckinger (2001) established one of her 6 monitoring transects in Pendleton Canyon and data were recorded from 1999-2003 (Kuhlman 2004). The transect averaged 2 plants per square meter and 19-27 plants total during the study and had a small increase in 2000, matching the results observed at Camas Meadows and Mountain Home (Kuhlman 2004).

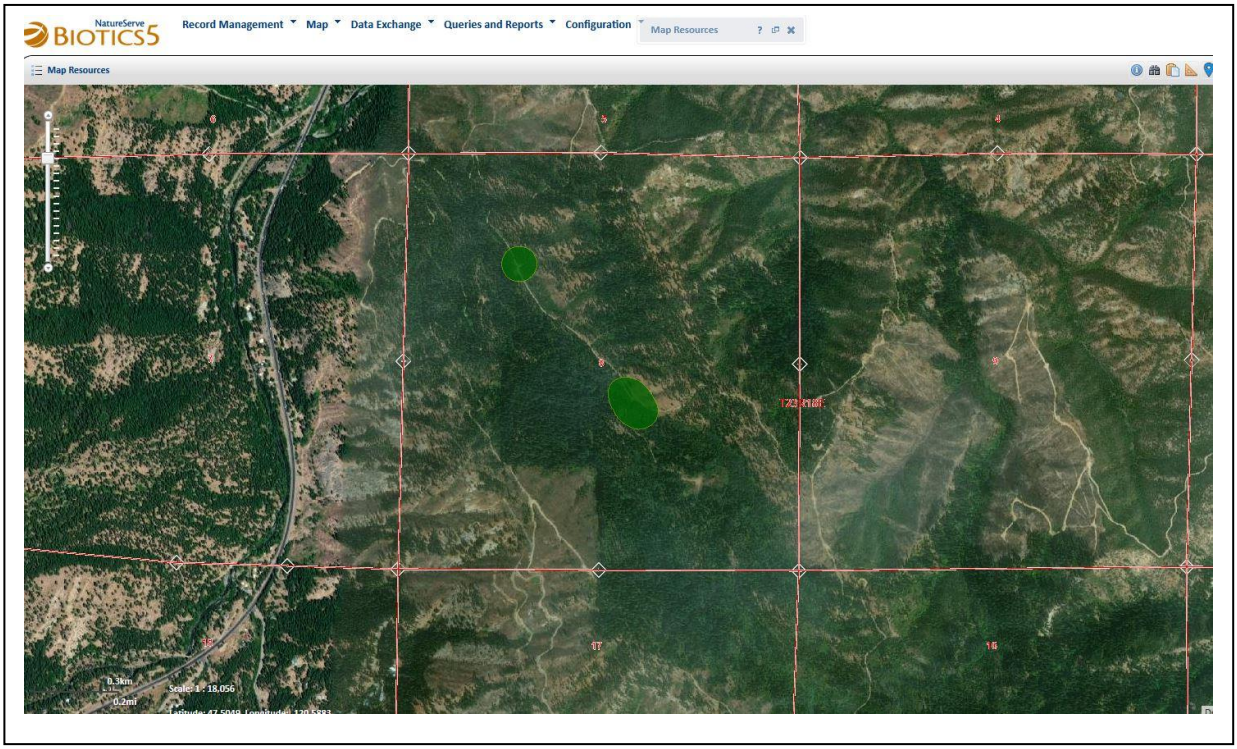

Figure 6. Distribution of *Sidalcea oregana* var. *calva* at Pendleton Canyon (EO 16).

The Pendleton Canyon occurrence was initially thought to occur on Okanogan-Wenatchee National Forest, but is actually in a private inholding. Much of the area has been logged. The site has not been revisited since 2003 and access was not allowed in 2019. The current status of the population is not known. The site was given an EO rank of C (fair estimated viability) based on the small number of plants and limited area of suitable habitat reported by Caplow (2003).

Extirpated and Failed to Find Occurrences

FS Road 120 (EO 22)

This population of *Sidalcea oregana* var. *calva* is found on Okanogan-Wenatchee National Forest lands along Forest Service Road 120 near its junction with FS Road 124, less than one mile south of the quarry on the south side of the Camas Creek Road, just west of Camas Meadows (Figure 7). Ellen Kuhlman and Allen Yen found a single flowering plant in the middle of the road in July 1991. The site was revisited in 1999 and one reproductive plant, several vegetative juveniles, and numerous seedlings were observed. Florence Caplow observed 2 adult plants, 24 juveniles, and 17 seedlings in 2001 and noted that the road had been closed and the population marked by three large metal posts as mitigation for a timber sale at Tip Top (Caplow 2003). Joe Arnett surveyed the site in 2008 and reported 1 flowering plant, 12 vegetative plants, and several seedlings.

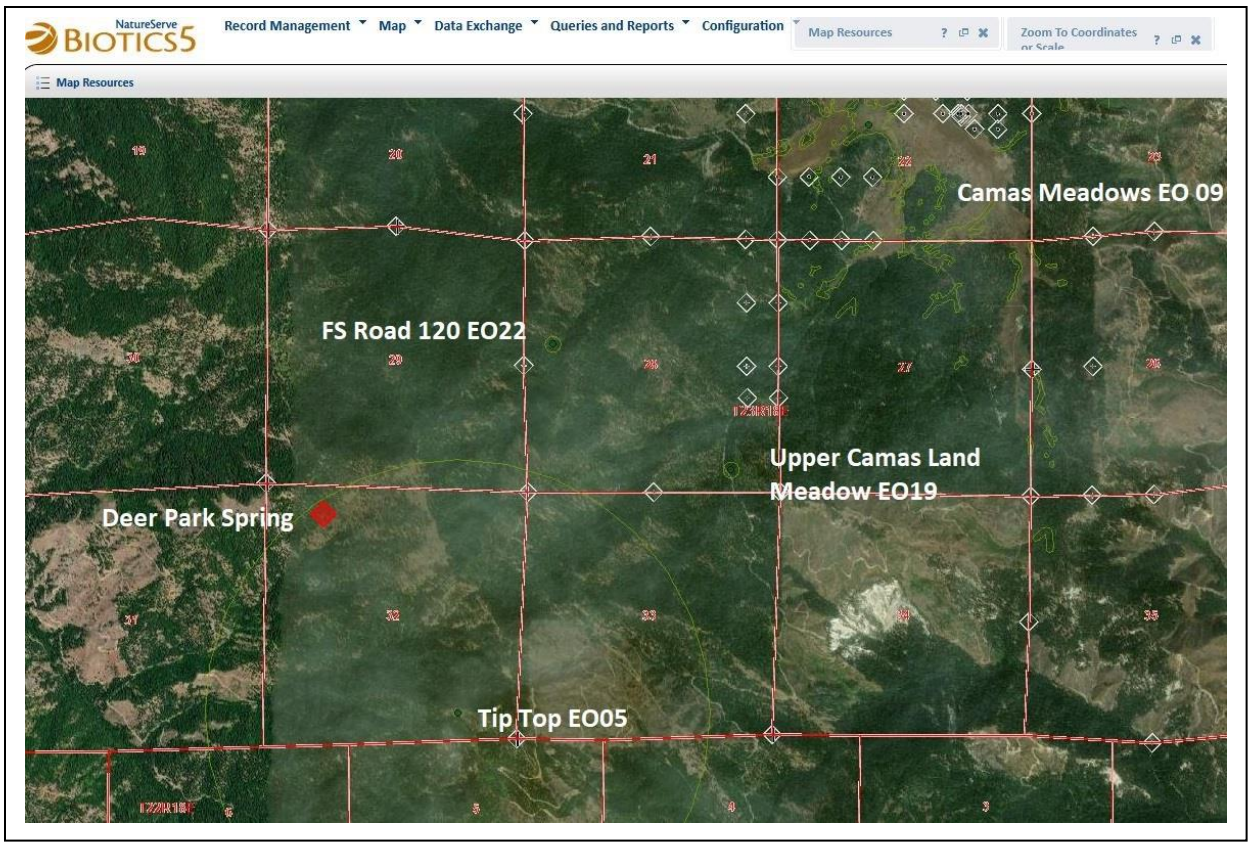

Figure 7. Distribution of *Sidalcea oregana* var. *calva* in vicinity of Tip Top, FS Road 120, and Upper Camas Meadows (EOs 05, 22, 19).

I visited the site on 26 June 2019 and relocated the three metal posts, but found no *S. oregana* var. *calva* flowering plants, juveniles, or seedlings. The roadbed is now impassable with sapling trees and the understory is crowded with Scouler's willow (*Salix scouleriana*), oceanspray (*Holodiscus discolor*), thimbleberry (*Rubus parviflorus* or *R. nutkanus*), hardhack (*Spiraea douglasii*), and bracken fern (*Pteridium aquilinum*). The area also appears to be too dry to support *S. oregana* var. *calva.* The occurrence rank has changed from D (poor estimated viability) to F (failed to find) and may ultimately be rescored as X (extirpated) if plants are not found again in a subsequent site visit. As with other sites that were formerly occupied but are now too brushy to support this species, controlled burning could be attempted to reduce cover, create an open canopy, and potentially heat scarify any remaining seed in the seed bank. If restored, the area could also be a potential reintroduction site.

Icicle Creek (EO 12)

This occurrence was documented by John Sandberg (*Sandberg 586*, CAS and UC) in July 1893 but has not been relocated since. The precise locality is not known. It has traditionally been mapped along the south base of Icicle Ridge in Okanogan-Wenatchee National Forest (Figure 8),

although this shady, narrow, rocky canyon is not similar to any other known occurrences. A more plausible locality could be the wet meadow area off of Snow Creek below the Forest Service trail along the northwest flank of Wedge Mountain (about 0.2 miles southwest of the foot bridge). This privately owned site has not been surveyed. Icicle Creek joins the Wenatchee River in a broad valley just south of Leavenworth, where the species was also collected by Kirk Whited in 1904. It is possible that the Icicle Creek and Leavenworth collections were from the same general area at the confluence of the two waterways. The lower valley of Icicle Creek has been converted to agricultural fields and homesites and no longer has suitable habitat for *Sidalcea oregana* var. *calva*. The occurrence is ranked as X and considered extirpated (Table 1). A potential site for restoration or introduction would be the grounds of the Leavenworth National Fish Hatchery, located along the banks of Icicle Creek, 2 miles south of Leavenworth (Figures 5, 8).

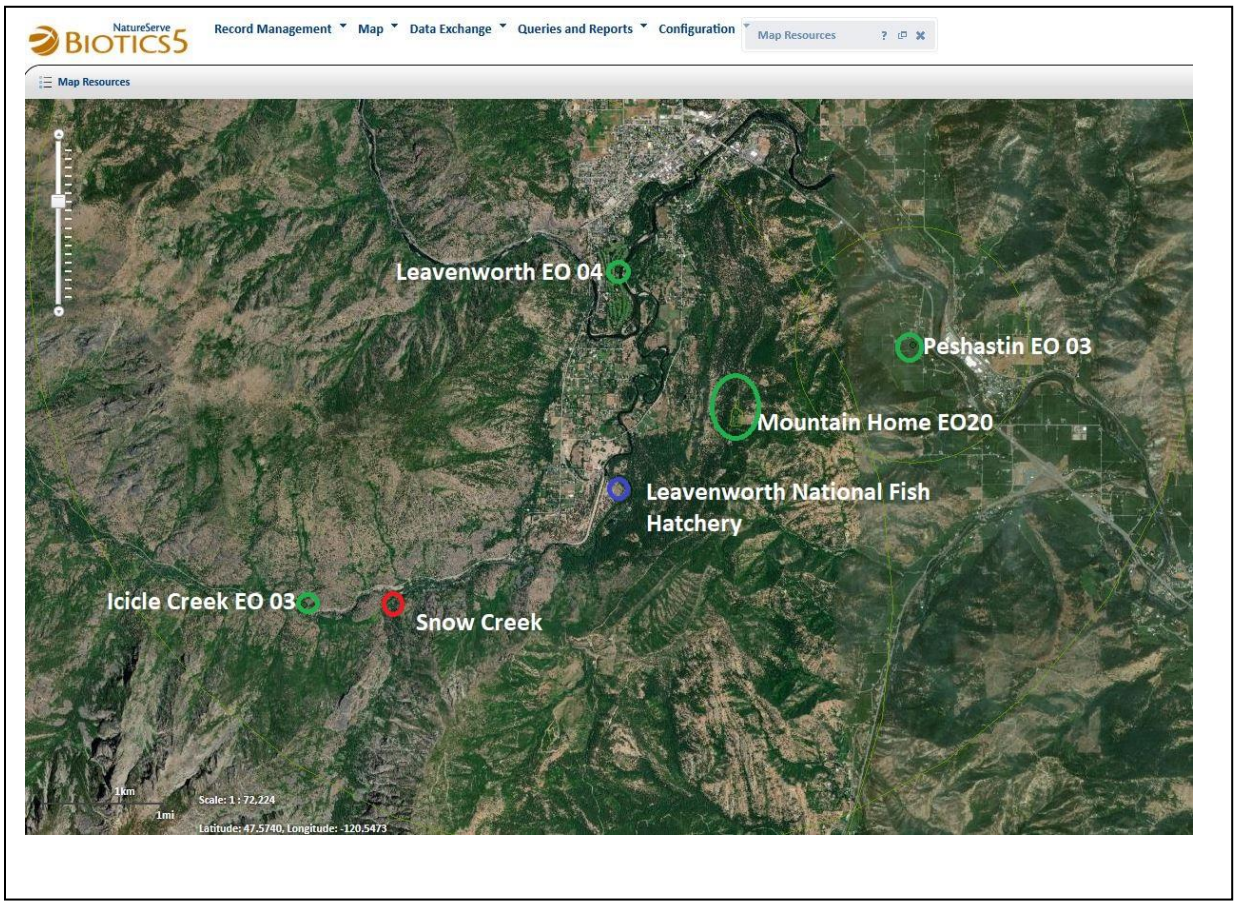

Figure 8. Distribution of *Sidalcea oregana* var. *calva* in vicinity of Icicle Creek, Leavenworth, and Peshastin (EOs 12, 04, 03). All three of these occurrences are imprecise and historical and could potentially represent the same occurrence (see text). Figure includes other potential out-planting or survey sites at Leavenworth Fish Hatchery (blue circle) and Snow Creek (red circle).

Leavenworth (EO 04)

The Leavenworth occurrence was discovered by Kirk Whited (*Whited 2559*, OSC; not "Whitehead" as cited by Hitchcock and Kruckeberg 1957) in 1904 along a "wet border of stream" (Figure 8). The population has not been relocated since the initial observation. As with other historical collections from the 1890s and early 1900s, the exact location where the population was collected is not known. Potential habitat could have existed on the wide floodplain of the Wenatchee River and its tributary, Icicle Creek, in the general Leavenworth area but would likely have been lost once homesteaders settled the valley. As mentioned previously, this occurrence may represent the same population as the Icicle Creek population found by Sandberg in 1893. Collectors from this era were not working with modern maps and often used the closest town as their collection locality, even if the town was several miles away. Thus it is possible that sites like "Leavenworth" could have represented known populations from the vicinity, such as Mountain Home or even Camas Meadows. The Leavenworth occurrence is ranked X and considered extirpated.

Peshastin (EO 03)

Sandberg and Leiberg collected *Sidalcea oregana* var. *calva* at "wet meadows, Peshastin" in July 1893 (*Sandberg and Leiberg 586* OSC) (Figure 8). Potential habitat could have been present at that time near the banks of the Wenatchee River, but has since been converted to agriculture or human development. As with historical reports from Icicle Creek and Leavenworth, Peshastin might have also been a general collecting place name for specimens gathered from the vicinity, including Mountain Home or Camas Land. Complicating matters, the town of Peshastin was originally located along the Blewett cutoff, and moved to its present location in 1892. No populations are known from the area today and the population is ranked X for extirpated.

Tip Top/Deer Park Spring (EO 05)

J.W. Thompson collected *Sidalcea oregana* var. *calva* on "yellow pine slopes on the Tip Top" on 26 June 1934 (*Thompson 10794* WTU) (Table 1, Figure 7). John Gamon revisited the Tip Top area in 1987 but failed to relocate the population. Gamon (1987) noted that "it is difficult to ascertain exactly where the collection was made." The summit of Tip Top lacks suitable wetland habitat. A more likely location for Thompson's collection is Deer Park Spring, located on the northwest flank of Tip Top peak, about 0.9 miles from the summit. Deer Park Spring is located in a bowl-shaped valley at the head of a tributary of Ruby Creek (itself a tributary of Peshastin Creek). The area includes a flat meadow that appears to be a filled-in pond and surrounding slopes with a series of springs. The wet meadow is dominated by arrowleaf balsamroot (*Balsamorhiza sagittata*), slender wheatgrass (*Elymus trachycaulus*), common camas (*Camassia quamash*), northern mule's ears (*Wyethia amplexicaulis*), lupine (*Lupinus* sp.), bare-stemmed biscuitroot (*Lomatium nudicaule*), Rocky Mountain sunflower (*Helianthella uniflora*), and common snowberry (*Symphoricarpos albus*). Two rare Wenatchee Mountains endemics often associated with *S. oregana* var. *calva* are also present: Wenatchee larkspur (*Delphinium viridescens*) and Wenatchee Mountain black-eyed Susan (*Rudbeckia alpicola*). The wetland is surrounded by open ponderosa pine forests. I surveyed Deer Park Spring on 26 June 2019, and others (including Wendy Gibble and Lori Malmquist) have visited the area in recent years, but

no populations of *S. oregana* var. *calva* have been found, despite the quality of the habitat and its proximity to Camas Meadows. The population is presently ranked as X (extirpated) but has excellent potential as a reintroduction site (see next section).

Upper Camas Land Meadow (EO 19)

A small population of *Sidalcea oregana* var. *calva* was discovered by Tony Basabe in a swampy area along FS Road 7200 on Okanogan-Wenatchee National Forest about 1.5 km southeast of Camas Meadows in 1984 (Figure 7). John Gamon revisited the site in 1987 and counted 3 plants co-occurring with *Delphinium viridescens* (Gamon 1987). Repeat visits were made in 1999 and 2001, but no plants were observed and the area was noted as becoming densely brushy and shaded. I revisited the area on 18 June 2019 and failed to document any *S. oregana* var. *calva* plants. The area where it was observed in 1987 is now overgrown with Scouler's willow (*Salix scouleriana*), Cascade mountain-ash (*Sorbus scopulina*), thimbleberry (*Rubus parviflorus*), serviceberry (*Amelanchier alnifolia*), woodland cinquefoil (*Drymocallis argutta*), and common horsetail (*Equisetum arvense*). The occurrence is now ranked as X for being likely extirpated.

This population is located less than 1.2 km from the nearest subpopulation of the extensive Camas Meadows occurrence (EO 09) and could be included as another subpopulation of that occurrence based on current EO definitions (1.5 km is the standard cutoff used to differentiate occurrences that otherwise lack significant barriers to dispersal). Forested sites south of Camas Meadows (but still within the Camas Meadows EO) have become similarly brushy and some have not been relocated in recent years. The 2017 controlled burn in brushy, seemingly unoccupied, sites at the north end of Poison Creek resulted in an unexpected emergence of seedling *S. oregana* var. *calva* in spring 2018. Similar controlled burning treatments at the FS Road 120 occurrence could improve habitat conditions for a future reintroduction of this species or result in germination of any seed persisting in the seedbank.

False Reports

Colockum Spur

This site is located on private lands east of Colockum Pass in the southern Wenatchee Mountains of Kittitas County. A purported population of *S. oregana* var. *calva* was documented in 1982. John Gamon revisited this area in 1987 and collected specimens that match the characters of *S. oregana* var. *procera* (now lumped with var. *oregana*). Gamon (1987) considered this population to be erroneous. Florence Caplow also collected a specimen from the site in 2001 (*Caplow 200102* WTU) that has been annotated as var. *oregana*. This occurrence is no longer recognized in the WNHP Biotics database.

Grouse Spring area (former EO 11)

Diane Varney discovered a population of *Sidalcea oregana* in a wetland north of Naneum Creek and south of Grouse Spring on the Colockum Wildlife Area in Kittitas County in 1978. She returned in 1980 and observed 42 plants in a 0.25 mile square area. The population was reported as var. *calva*, but no specimen was collected for verification. No var. *calva* plants have been

found at this site in subsequent surveys in 1981, 1987, 2001, 2007, 2009, or 2010. Specimens collected from the vicinity by Gamon (1987) have technical features of var. *procera* (now lumped with var. *oregana*). I relocated Gamon's 1987 specimens and can corroborate that they are not var. *calva*. This occurrence is considered a false report and no longer used in modeling or climate change studies (Fertig 2021a, Kleinknecht et al. 2019).

Lost Lake Trail (former EO 15)

Tony Basabe reported finding *Sidalcea oregana* var. *calva* on the Lost Lake (or Manastash Lake) Trail in 1982 south of Taneum Ridge and Cle Elum in Kittitas County (Okanogan-Wenatchee National Forest), but did not collect a voucher specimen. John Gamon revisited the area in 1987 and failed to find any *Sidalcea*. He did collect samples in the vicinity which all keyed to var. *procera* (today included in var. *oregana*). These specimens lacked the ciliate hairs on the margins of the calyx and fleshy leaves typical of var. *calva*. In 2019, I relocated Gamon's unmounted specimens and re-verified that they represent var. *oregana*. As with other reports from Kittitas County, this population is no longer considered a credible record of var. *calva* (Fertig 2021a).

Potential Sites

Deer Park Spring

As discussed previously, Deer Park Spring in the Wenatchee Mountains in the Ruby Creek drainage may represent the actual location of Thompson's historical report from "slopes of the Tip Top". Although no *Sidalcea oregana* var. *calva* plants were observed at Deer Park Spring in 2019 (Figure 7), the area is similar hydrologically and topographically to Camas Meadows and has many of the same associated species (Fertig 2021a). This site has the best potential for establishing a new occurrence of *S. oregana* var. *calva* of any known areas in the Wenatchee Mountains. Okanogan-Wenatchee National Forest has been actively managing the area in recent years to restore natural ecological processes in the surrounding ponderosa pine forest. Given the presence of the USFS Sensitive species *Delphinium viridescens* (G2/S2) and potential for introduction of *Sidalcea oregana* var. *calva*, this area could be considered for designation as a Special Botanical Area or Research Natural Area (Fertig 2022a). Such designations would contribute to the recovery goals of *Sidalcea oregana* var. *calva* (USFWS 2004). Presently, the road in to Deer Park Spring is washed out in several places and impassable by a rock slide, which could complicate efforts to bring in checkermallow plugs for out-planting (Wendy Gibble, personal communication 2022).

Discussion

Current Conservation Assessment

The 2004 Recovery Plan for *Sidalcea oregana* var. *calva* identified 12 known occurrences in Chelan and Kittitas counties, Washington, of which 5 were considered extant (USFWS 2004). Since then, the two populations from Kittitas County have been recognized as belonging to var.

oregana, rather than var. *calva* (Fertig 2021a). Five of the remaining 10 verified occurrences of var. *calva* are extirpated (suitable habitat is no longer present) and a sixth could not be relocated in 2019 and may also be extirpated (Table 1). One of the extant occurrences (Pendleton Canyon) is on private land and has not been observed since 2001. Three other extant occurrences were all relocated from 2019-2021. Camas Meadows is the largest occurrence, with 41,040 flowering plants counted in 345 subpopulations from 2012-2021. Mountain Home contained 2,342 flowering and vegetative plants in 2019. Camas Creek South had only 5 flowering plants in 2021 (Table 1). One additional out-planted population was established on Chelan-Douglas Land Trust property in 2014 with 161 plugs, of which only 10 were still alive in 2019 (Table 1).

The number of flowering individuals of *Sidalcea oregana* var. *calva* has improved from approximately 11,500 in 2004 to more than 43,500 in 2021, an increase of nearly 74%. Much of this increase may be due to more rigorous and thorough census and mapping efforts, especially at Camas Meadows where more than 1,000 person-hours were expended over a 10-year period to map and count plants across the entire Natural Area Preserve. The Camas Meadows and Mountain Home occurrences are probably stable to increasing over the past two decades. At the same time, the number of extant occurrences has dropped from six to four with the apparent extirpation of two small occurrences on Okanogan-Wenatchee National Forest west and south of Camas Meadows. Abundance data for other extant occurrences are either lacking (Pendleton Canyon) or show a pronounced downward trend (Camas Creek South Fork) (Table 1).

Results from surveys in 2019-21 support the recommendations of the most recent five-year review to keep Wenatchee Mountains checkermallow listed as Endangered (USFWS 2020). Of the five delisting benchmarks identified in the species' recovery plan (USFWS 2004), three have been partially met and two have not been met (Table 4). Progress towards meeting recovery goals is summarized in Table 4, as well as additional conservation actions that are needed. While overall abundance is greater than previously known, other threats still persist, such as competition from non-native species, seed predation by weevils, landscape-level fire suppression, and loss of habitat (USFWS 2020). An insufficient number of large, protected occurrences, is also hampering recovery of the species (Table 4).

Future Monitoring & Conservation Actions

Based on new information from monitoring and surveys conducted from 2019-21, the following actions are recommended to meet conservation goals for *Sidalcea oregana* var. *calva* identified in the USFWS recovery plan (USFWS 2004, 2020):

1. <u>Initiate long-term monitoring at Camas Meadows and other occurrences to assess population trends and demographic changes</u>. Previous monitoring at Camas Meadows, Mountain Home, and Pendleton Canyon focused on documenting changes in density or frequency of plants in small plots established primarily in forested wetlands (Arnett 2011, Bleckinger 2001, Kuhlman 2004, Wilderman 2015). Large areas of open canopy wet meadows were not included, despite these providing significant habitat for *Sidalcea oregana* var. *calva*. Most of these studies have not been repeated since the early 2000s and should be replaced by new monitoring that focuses on detecting population trends and demographic structure (longevity, recruitment, and intrinsic

Table 4. Recovery Criteria for *Sidalcea oregana* var. *calva*. Derived from USFWS (2004, 2020).

Recovery Criteria	Progress Towards Completion	Actions Still Needed
1. There are at least 4 stable, self-sustaining populations (> 500 flowering plants) in each of the 5th field watersheds (Peshastin Creek and Icicle Creek) where the species currently occurs (or as an alternative, 3 self-sustaining populations in these two watersheds and 3 more in another watershed).	Not met. One stable, self-sustaining population present in Peshastin Creek watershed (Camas Meadows) and one in Icicle Creek watershed (Mountain Home). No populations are currently known from other watersheds. Other populations from Peshastin Creek watershed are too small or may no longer be extant. Other occurrences from Icicle Creek watershed are historical and extirpated, or too small and perhaps not self-sustaining (Mountain Home Out-planting).	Three additional stable and self-sustaining populations are needed in both the Peshastin Creek and Icicle Creek watersheds. Meeting this criterion will require augmenting existing occurrences or creating new ones through out-planting.
2. All of the stable, self-sustaining populations are on protected sites secure from threats.	Not met. One stable, self-sustaining population with over 500 flowering plants (Camas Meadows) is fully protected within Camas Meadows NAP. The Mountain Home population is on private lands in the DNR voluntary registry program, but is not considered fully protected at present. The Mountain Home Out-planting is protected by the Chelan-Douglas LT, but is too small (and perhaps not self-sustaining) to meet recovery criteria. Other occurrences are on unprotected National Forest or private lands and are too small to meet recovery objectives.	Three additional occurrences in the Peshastin Creek watershed and four in the Icicle Creek watershed need to be augmented or created through out-planting to meet minimum population size requirements and be afforded formal protection.
3. Genetic material is stored in a facility approved by the Center for Plant Conservation.	Partially Met. Seed accessions are held at the Miller Seed Vault at the University of Washington for plants from Camas Meadows and Mountain Home. Additional seed from Camas Meadows and Pendleton Canyon are stored at the Rae Selling Berry Seed Bank at Portland State University (USFWS 2020).	Seed accessions are not available for other extant and historical occurrences of *Sidalcea oregana* var. *calva*. Extant sites may be too small to sustainably harvest seed at this time. Seed stocks for other populations are aging and may need to be augmented.

Recovery Criteria	Progress Towards Completion	Actions Still Needed
4. Adequate population and habitat monitoring has been established for all of the known populations.	Partially Met. Monitoring transects were established at sites in Camas Meadows, Pendleton Canyon, and Mountain Home in 1999 to assess changes in frequency and density but have not been revisited since 2003. Wilderman (2015) also established plots to measure frequency of plants in forested openings at Camas Meadows and their response to fire and hydrological restoration. Full population censuses have been done at all of the extant sites except Pendleton Canyon since 2019.	Formal monitoring plots are needed in each of the extant occurrences to assess population trends through changes in density or frequency. These should be established in a stratified random manner to encompass environmental variability. New monitoring is needed to assess demographic changes to answer questions about survivorship and seedling recruitment.
5. Management plans have been developed and implemented for all state and federally owned populations.	Partially Met. Camas Meadows NAP has an existing management plan (WDNR 2000). Lauri Malmquist began a draft management plan for Okanogan-Wenatchee NF sites, but this has not been finalized (USFWS 2020).	Management plans are needed for Mountain Home and other extant occurrences.

population growth) and are more representative of all habitats and geographic areas in which the species occurs.

At Camas Meadows, NAP staff have suggested implementing a new program of monitoring 9-12 large polygons (macroplots covering 4-40 acres) distributed across the area to represent wet and dry meadows, forest openings, and ecotones between aspen woods and meadows. Each of these polygons would be marked in the field by fenceposts or rebar. During each visit, every flowering plant of *S. oregana* var. *calva* would be counted and the perimeter of each subpopulation within the polygon mapped with GPS. Two to three polygons would be monitored every year, with all polygons revisited every 3-4 years. Trends could be detected by comparing the number and distribution of flowering individuals over time. Significant changes in numbers could trigger potential management responses (such as implementing controlled fire, weed control, population augmentation, etc.). Comparable monitoring techniques could be applied to other occurrences to assess trends and potential management actions.

Demographic monitoring should be implemented at a subset of sites to answer important life history questions and calculate a population growth rate for the species (Elzinga et al. 1998). Tagging individuals is necessary to determine their longevity and to document whether *S. oregana* var. *calva* exhibits prolonged dormancy in which mature individuals remain below-ground some years, creating a false impression of population decrease (see Appendix A). It is also necessary to identify recruitment events and determine whether new seedlings are being produced or surviving to maturity in the absence of disturbance. Demographic plots could also be used to monitor impacts of weevils, aphids, and other insects on fruit production, expanding on studies by Goldsmith (2003) and Arnett and Birkhauser (2008). Demographic monitoring is more time and labor intensive than trend monitoring and might be limited to larger populations (like Camas Meadows and Mountain Home) that have dedicated staff available. Wendy Gibble (personal communication, 2022) has implemented 24 4x4 meter monitoring plots at Mountain Home to capture information on number of plants, number of stems, and number of flowers which could be easily modified to include new seedlings.

Monitoring of habitat condition with permanent photo points could be implemented at selected polygons at Camas Meadows in conjunction with yearly trend monitoring. Additional photo points could also be established at Mountain Home and other occurrences to capture changes in vegetation cover and structure over time.

2. Periodically monitor or survey known occurrences. Besides the Camas Meadows occurrence, the other extant populations of *Sidalcea oregana* var. *calva* are small enough that a complete census could be done periodically (every 3-5 years) to assess population size, trends, and vigor. The Camas Meadows occurrence is too large to be easily censused in one year. Abundance data from trend monitoring polygons could be used to infer changes in overall population size for the entire occurrence (as discussed previously under bullet # 1). Extrapolations from small subsamples should be done cautiously, however, and only if the polygons are truly selected at random (Elzinga et al. 1998).

3. Identify additional sites for introducing new populations through modeling and field validation. The Wenatchee Mountains checkermallow Recovery Plan (USFWS 2004) calls for the protection of at least 4 viable occurrences (>500 flowering plants) in both the Icicle Creek and Peshastin Creek watersheds. To reach this goal, additional populations need to be discovered or created through out-planting or augmentation. Habitat distribution modeling and expert knowledge of the Wenatchee Mountains area will be necessary to identify potential sites for out-planting. Initial modeling work by Kleinknecht et al. (2019) focused on potential future mismatches between soil and climate variables under different climate scenarios. Several potential "conservation opportunity" sites were identified in this report, including areas on Okanogan-Wenatchee National Forest west of Peshastin Creek, south of Camas Meadows, and in the southern Wenatchee Mountains (Figures 9, 10), outside its current range (Kleinknecht et al. 2019). WNHP has funding from USFWS to revise these models in 2022 by incorporating additional environmental and climate layers, such as LiDAR, bedrock geology, monthly temperature and precipitation, and snow accumulation. These revised models will need to be verified in the field to ensure that suitable conditions are present and other varieties of *Sidalcea oregana* are not already established. Wendy Gibble and Jon Bakker of the University of Washington have a USFWS grant to identify new areas for reintroduction over the next several years.

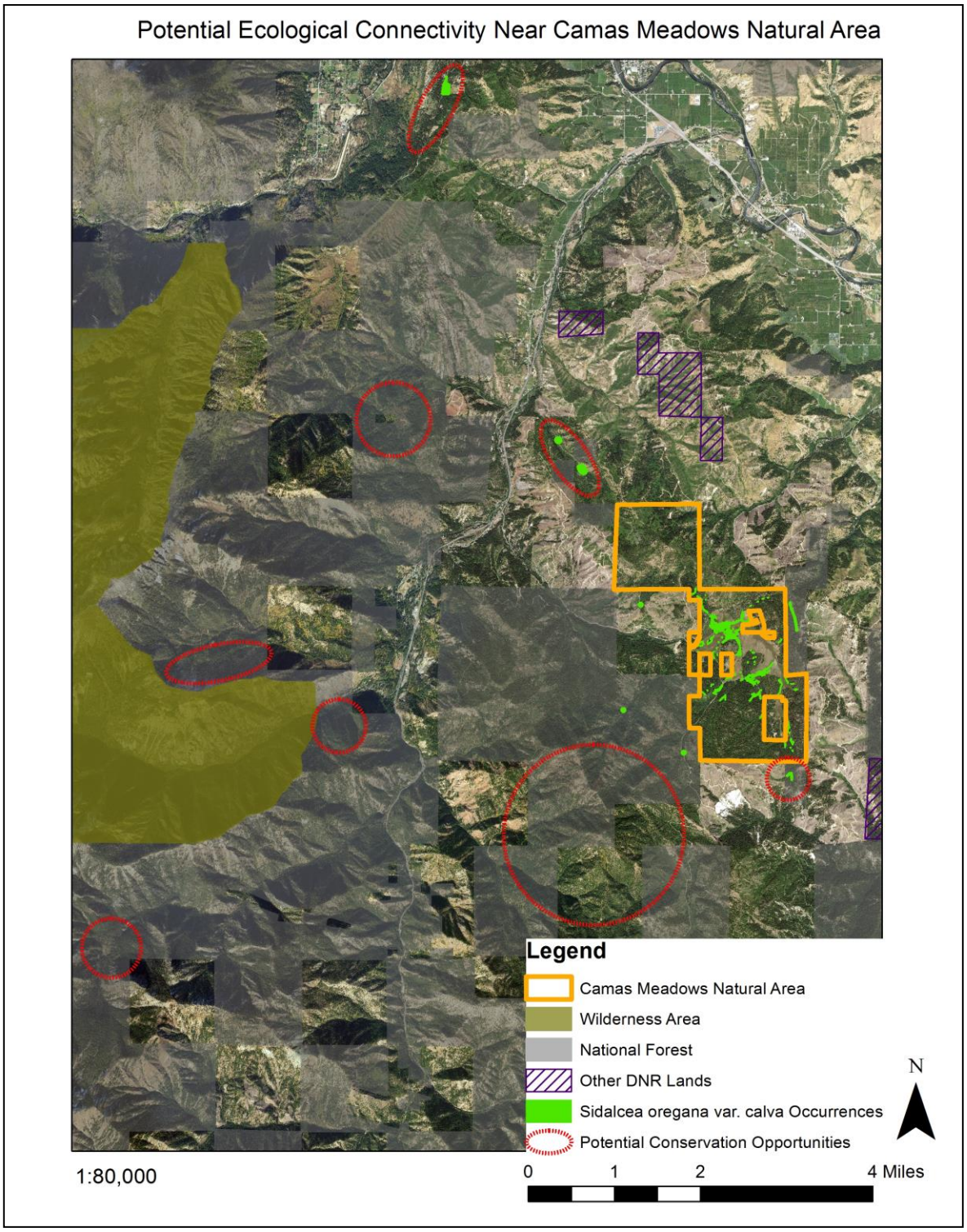

Figure 9. Potential *Sidalcea oregana* var. *calva* conservation areas identified by modeling. From Kleinknecht et al. (2019).

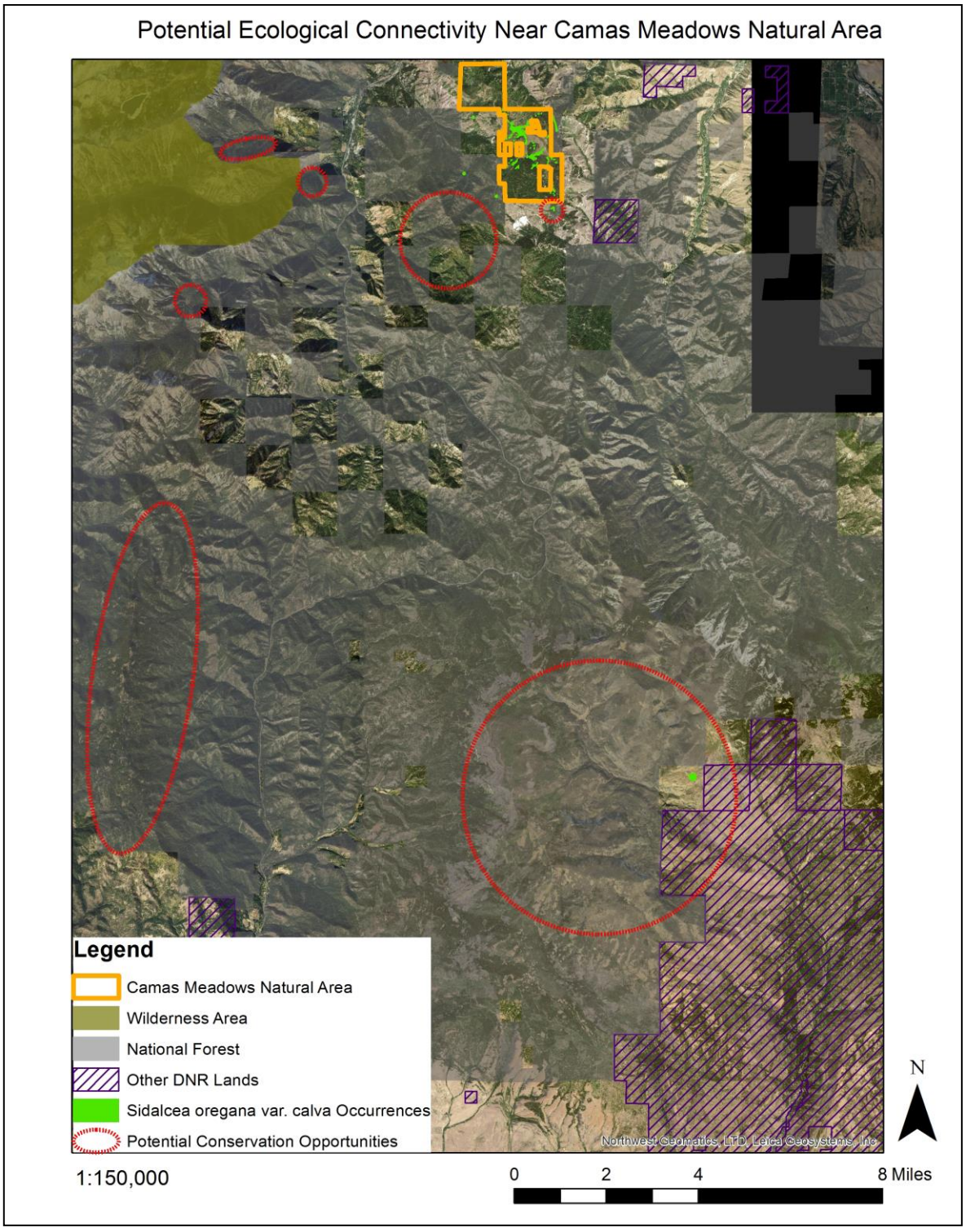

Figure 10. Potential *Sidalcea oregana* var. *calva* conservation areas identified by modeling. From Kleinknecht et al. (2019).

4. Implement Stewardship Actions. Natural Area Preserve staff conducted a pilot study in the early 2000s to reintroduce controlled wildfire and restore former drainage canals to improve hydrological functioning at Camas Meadows NAP (Wilderman 2015). Prescribed fire has also been incorporated at Poison Canyon on Okanogan-Wenatchee National Forest and at Mountain Home. Preliminary results suggest these efforts are improving *Sidalcea oregana* var. *calva* habitat and encouraging seedling establishment (USFWS 2020). Controlled burning or thinning may be needed to improve habitat conditions for populations that are recently extirpated or which have declined significantly over the past 30 years at the south end of Camas Lands, south Poison Canyon, along FS Road 120, Upper Camas Land Meadows, and the Camas Creek tributary (Tables 1, 4). Monitoring will be needed to determine if these treatments are successful and if additional management steps (such as introduction of new plants) are necessary to bolster populations.

5. Protect Additional Populations. Currently, only three occurrences of *Sidalcea oregana* var. *calva* are afforded formal protection (Fertig 2022a). The Camas Meadows NAP encompasses most of the Camas Meadows occurrence, as well as a sliver of the adjacent Camas Creek tributary occurrence (EO 21) in an area where plants have not been relocated in recent years. The Chelan-Douglas Land Trust protects a third population in the Mountain Home area that is an experimental out-planting that may need further augmentation and management to become successfully established. The Mountain Home occurrence is in DNR's voluntary natural area registry program, but does not currently have a formal conservation easement and is not afforded permanent, long-term protection. Other occurrences on private lands and Okanogan-Wenatchee National Forest are not formally protected. The Poison Canyon and Deer Spring Park areas on the Okanogan-Wenatchee National Forest have potential for designation as special botanical areas or research natural areas in the future (Fertig 2022a). Ideally, any newly established out-plantings would be afforded permanent protection in order to fulfill delisting criteria (Table 4) (USFWS 2004, 2020).

Overall, the conservation prospects for *Sidalcea oregana* var. *calva* appear to be better than they were when the species was listed as Endangered in 1999. Population counts are nearly four times higher than when the species was listed, although this may be the result of more thorough census work. Research on applied management, such as controlled fire and restoration of hydrologic functioning, has improved habitat conditions at Camas Meadows NAP and serves as a model for comparable management of other populations. At least one new population has been established through out-planting, although additional augmentation may still be necessary. Habitat modeling has identified additional areas where new populations might be established. Some problems persist, however. Threats remain high from weevil predation and habitat degradation from competing forest vegetation, weed invasion, and alteration of hydrologic conditions. Climate change is also a long-term threat, especially if the species is unable to adapt or migrate under projected hotter and drier conditions. Much work remains to be done to ensure the survival of Wenatchee Mountains checkermallow.

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Appendix A. Species Abstract for *Sidalcea oregana* var. *calva*

Classification:

Scientific Name: *Sidalcea oregana* (Nutt. ex Torr. & A. Gray) A. Gray var. *calva* C.L. Hitchc. (Hitchcock and Kruckeberg 1957).

Common Names: Wenatchee Mountains checkermallow, Wenatchee Mountain checkermallow, Wenatchee Mountains checker-mallow, Wenatchee Mountains checker-bloom.

Family: Malvaceae (mallow family).

Synonyms: Included in *Sidalcea oregana* ssp. *oregana* by Hill (2015) in the *Flora of North America*. Hill notes however "[a] case can be made for recognition of var. *calva* C.L. Hitchcock, which has been listed as endangered both federally and in Washington, where it is endemic. Found in the Wenatchee Mountains, an area of high endemism, var. *calva* does not appear to be much different from other, nearly glabrous populations elsewhere. This treatment does not accept both subspecies and varieties within *Sidalcea*; therefore it has been placed here into synonymy with the wide-ranging, variable typical subspecies [ssp. *oregana*]." Hill's treatment is not followed in the second edition of the *Flora of the Pacific Northwes*t (Hitchcock and Cronquist 2018).

Phylogenetic Relationships: The genus *Sidalcea* contains 49 taxa (31 full species and 18 varieties or subspecies), all restricted to western North America and Mexico (Hill 2015). Forty-two taxa are found only in California, Oregon, and Washington. Var. *calva* is one of 5-6 subspecies or varieties recognized within *S. oregana*, one of the most variable and widespread *Sidalcea* species in western North America. The base chromosome number of *S. oregana* is $2n = 20$ and var. *calva* is the only taxon in the group with a hexaploid count of $2n = 60$ (Hill 2015). While capable of crossing with other subspecies/varieties of *S. oregana*, subsequent back-crosses would have reduced fertility. Hybridization and back-crossing may account for some of the difficulty in distinguishing var. *calva* from var. *oregana* where their ranges come into close proximity, such as the Teanaway Forest, Lost Creek, and Colockum Ridge areas of Kittitas County.

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

Natural Heritage Rank: G5T1/S1?; WA Endangered (Fertig 2021b)

Description: *Sidalcea oregana* var. *calva* is a perennial herb with several stems from a branched rootcrown. Stems are 20-150 cm tall, bluish-green (glaucous) and glabrous at the base but sparsely pubescent with appressed, star-like hairs higher up the stem. The thick, fleshy, glabrous leaves have long petioles. Basal leaf blades are rounded and shallowly lobed into palmate segments, while stem leaves are more deeply divided into more finger-like 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. Flowering occurs from mid-June to early July (Camp and Gamon 2011; Fertig 2021a; WNHP 2022).

Similar Species: Oregon checkermallow (*Sidalcea oregana* var. *oregana*) differs in having stems with simple to forked hairs and calyces lacking ciliate margins but having dense star-shaped hairs covering the back. Hitchcock and Cronquist (1961) recognized var. *procera* as having spreading rather than appressed hairs on the lower stem; this taxon is now lumped with var. *oregana* by Hill (2015) and Hitchcock and Cronquist (2018). Long-sepal globemallow (*Iliamna longisepala*) has larger, maple-like leaves and fruit segments that are hairy on the back (Camp and Gamon 2011; Fertig 2021a).

Geographic Range: Var. *calva* is endemic to the Wenatchee Mountains and vicinity in Chelan County, Washington. The entire range of this taxon is restricted to an area of approximately 7 x 10 miles (11 x 16 km). Additional reports from Kittitas County are now believed to be misidentified occurrences of *S. oregana* var. *oregana* (Fertig 2021a, WNHP 2022). Reports from Hood River and Umatilla counties, Oregon on the Consortium of Pacific Northwest Herbaria website (www.pnwherbaria.org) are based on misidentifications of other varieties of *S. oregana*.

Habitat**:** *Sidalcea oregana* var. *calva* occurs primarily 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. It is also found in openings in Douglas-fir (*Pseudotsuga menziesii*), ponderosa pine (*Pinus ponderosa*), or aspen *(Populus tremuloides*) forests and the edges of shrub thickets (Caplow 2003, Gamon 1987). Confirmed populations are found at elevations between 335-1160m (1100-3800 ft). Reported occurrences from Kittitas County were found up to 1555 m (5100 ft), but these populations are now believed to be misidentified.

Crawford (2013) reported *Sidalcea oregana* var. *calva* occurring in the Rocky Mountain Alpine-Montane Wet Meadow and Northern Rocky Mountain Lower Montane Riparian Wetland and Shrubland ecological systems.

This species is mostly found on flats or benches, but occasionally also occurs in shallow ravines and gentle slopes (Caplow 2003). Soils at Camas Meadows are 33% sand, 32% silt, and 35% clay loam (Loomis 1985) and are classified as the Stemilt-Scotties-Nard soil association. These soils are deep, well-drained residuum and colluvium derived from sandstone and volcanic ash (Aho and Beieler 2007, Kleinknecht et al. 2019). The soils at Camas Meadows are derived from the Eocene Chumstick Formation, a continental sandstone deposit, and rimmed by the Camas Land Diabase, an intrusive volcanic dike (WDGER 2016). Other *Sidalcea oregana* var. *calva* occurrences are found on alluvial soils derived from Quaternary landslides and terraces (WDGER 2016).

The climate at Camas Meadows is characterized by cold, relatively wet winters and warm and dry summers (Figure 11) (Kleinknecht et al. 2019). The nearest climate station is located at Leavenworth where mean annual temperature is 49˚F (9.4˚C), mean January temperature is 16˚F (-8.8 ˚C) and mean July temperature is 88 ˚F (31 ˚C) (WNAP 2000).

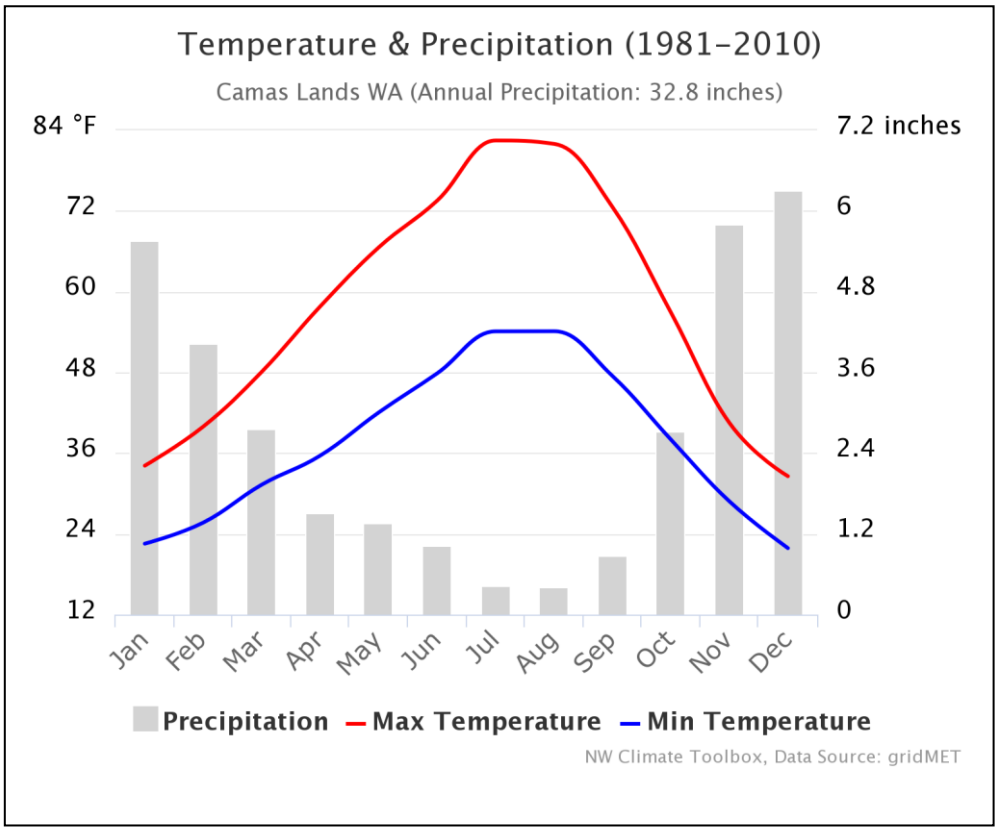

Figure 11. Average annual temperature and precipitation (1981-2010) at Camas Meadows NAP. Derived from NW Climate Toolbox (Hegewisch and Abatzoglou 2019). From Kleinknecht et al. 2019.

Population Size and Trends: Currently, Wenatchee Mountains checkermallow is known from 4 extant and 6 historical or extirpated native occurrences, all in Chelan County, Washington. Two additional reports from Kittitas County (Camp and Gamon 2011) are now believed to be based on misidentified specimens of var. *oregana* and are excluded. A fifth population was established as an experimental out-planting by the Chelan-Douglas Land Trust in 2014 (Dunwiddie 2014) and contained 10 surviving plants in 2019. Three of the 4 extant occurrences were last observed in 2021, while the fourth (located on private lands) was last seen in 2001.

The extant native occurrences contained 43,587 flowering plants as of 2021. The two largest occurences (Camas Lands and Mountain Home) contained 94.2% and 5.3% of the total number of plants, respectively (Table 1). Overall population trends appear to be upward, compared to the rangewide estimate of approximately 30,000 plants in 2004 (USFWS 2004). This increase has been driven entirely by the high number of plants documented at Camas Meadows Natural Area Preserve over the past 10 years. Numbers at Mountain Home have oscillated over the last 15 years from 1,614 plants in 2005 to 2,548 in 2011 and 2,342 in 2019. The variation in numbers could be related to environmental changes from year-to-year, or differences in sampling methods. Other occurrences have experienced downward trends, including the apparent extirpation of at least two small occurrences, last observed between 1987 and 2008 and now apparently lacking suitable habitat due to ongoing successional changes.

Population Biology and Ecology: *Sidalcea oregana* var. *calva* is a long-lived perennial that typically flowers from mid-June to early July, though flowering may occur as late as mid-August some years. Plants may produce several stems from a branched rootcrown, but it is not rhizomatous. The species apparently reproduces only by seed. Goldsmith Zimmerman and Reichard (2005) observed 9 bee species in the genera *Diadasia, Bombus* (*Pyrobombus*), *Hoplitis*, and *Osmia* visiting *S. oregana* var. *calva* plants in a study at Camas Meadows. Of these species, *Diadasia nigrifrons* is known to specialize on *Sidalcea oregana* in northern Utah (Kuta 2003) and may be an important pollinator for var. *calva* too. Goldsmith (2003) tested three pollinator treatments at Camas Meadows (unrestricted pollination by insects, hand-pollination, and bagging inflorescences to exclude pollinators) and found no significant difference in the rate of flowering to fruiting success (about 36% across the three treatments). Bagged inflorescences may have been self-pollinated or pollinated by small weevils (Goldsmith 2003). Drought may have been more significant in reducing seed production than a lack of available pollinators (Goldsmith 2003).

Seed predation by weevils (family Curculionidae) and other insects is high in *Sidalcea oregana* var. *calva* and considered a threat to its long-term persistence (Arnett and Birkhauser 2008, USFWS 2004). Goldsmith (2003) and Goldsmith Zimmerman and Reichard (2005) found that 62-78% of seeds at plots at Camas Meadows were damaged by weevils in 2001-2002 and only 17% of all seeds were undamaged. Arnett and Birkhauser (2008) found carpel loss due to weevils to average 46% and damage from aphids and other insects to average 28% at Camas Meadows. Only about 32% of the carpels they analyzed appeared to be undamaged. In 2021, Susan Waters observed 95-99% of Sidalcea fruits to be damaged by weevil predation at Camas Meadows and suggested that perhaps only 5% were viable (S. Waters, personal communication).

Greenhouse studies suggest that *Sidalcea oregana* var. *calva* requires cold stratification for 1.5 to 3 months (Huseby 2000). Jones and Kaye (2015) found that a related species, *S. malviflora* ssp. *virgata*, had higher germination success when the hard seed coat was scarified, followed by cold stratification. Goldsmith Zimmerman and Reichard (2005) found that controlled burning in the fall did not seem to affect germination, though surviving plants had a significantly higher leaf area and were more vigorous. Lauri Malmquist and David Wilderman observed var. *calva* seedlings around the perimeter of burned slash piles at Poison Canyon and Camas Meadows, but not in unburned areas. More research is needed on the effects of fire on potentially breaking seed dormancy and reducing competing vegetation as a means of increasing population numbers for this species.

Monitoring studies have shown variations in the number of mature plants from year to year (Arnett 2011, Bleckinger 2001, Kuhlman 2004, and Wilderman 2015) but not obvious recruitment events (with newly established seedlings maturing into reproductive plants). In part, this is an artifact of study design in which individual plants were not marked to record their survival across years. Long-term demographic monitoring is needed to resolve this question. It is possible that *S. oregana* var. *calva* could exhibit prolonged dormancy, in which a subset of mature plants do not emerge above ground for one or more years (Gremer et al. 2012). Prolonged dormancy could explain how some populations have responded quickly to large-scale ground disturbance, such as happened at Mountain Home following bulldozing associated with a fire line in 1994. This occurrence was feared to be extirpated, but returned to normal by 2001 (USFWS 2004).

Managed Areas/Ownership: Found in Camas Meadows Natural Area Preserve, Wenatchee National Forest, Chelan-Douglas Land Trust (Mountain Ridge introduction), private. One private occurrence is on the DNR state registry list. Past reports from Colockum Wildlife Area are based on misidentified specimens.

Existing and Potential Threats: Historically, conversion of wetland habitat for agriculture or residential development was the primary threat to Wenatchee Mountains checkermallow (Caplow 2003, Goldsmith Zimmerman and Reichard 2005) and probably resulted in the extirpation of occurrences at Icicle Creek, Leavenworth, and Peshastin (assuming these occurrences were not general collecting localities for nearby sites in Mountain Home or Camas Lands). Changes in hydrology through ditches and drainage diversions, or removal of water by residential wells, has resulted in drying of some formerly wet meadow sites at Camas Meadows (Wilderman 2015). Introduction of non-native pasture grasses occurred at Camas Meadows and Mountain Home, making some areas less suitable for *Sidalcea oregana* var. *calva* (USFWS 2004).

More recently, ecological succession due to suppression of wildfire has increased woody cover and shade at several small subpopulations within Camas Meadows Natural Area Preserve and occurrences at Camas Creek tributary, FS Road 120, and Upper Camas Meadow (the latter two sites may now be extirpated). Seed predation by weevils is also a significant threat, reducing viable seed production by up to 83% (Goldsmith Zimmerman and Reichard 2005), which may be exacerbated by fire suppression (Arnett and Birkhauser 2008).

Sidalcea oregana var. *calva* was identified as highly vulnerable to future climate change based on the Climate Change Vulnerability Index (CCVI) protocol developed by NatureServe (Fertig 2022b, Kleinknecht et al. 2019). The CCVI is a tool for rating plant and animal species and vegetation types 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) (Young et al. 2016). *S. oregana* var. *calva* is vulnerable to climate change 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).