Wenatchee Mountains Checker-mallow
(Sidalcea oregana var. *calva)*

5-Year Review
Summary and Evaluation

Wenatchee Mountains Checker-mallow (*Sidalcea oregana* var. *calva*)
Photo by Randi Riggs (U.S. Fish and Wildlife Service)

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U.S. Fish and Wildlife Service
Western Washington Fish and Wildlife Office
Lacey, Washington 98503

5-YEAR REVIEW

Species reviewed: Wenatchee Mountains Checker-mallow
(Sidalcea oregana* var. *calva)

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5-YEAR REVIEW
Wenatchee Mountains Checker-mallow *(Sidalcea oregana* var. *calva)*

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Field Office: Tara Callaway, Central Washington Field Office, Wenatchee, Washington, 509/665-3508 x2004

Gregg Kurz, Central Washington Field Office, Wenatchee, Washington, 509/665-3508 x2007

1.2 Methodology used to complete the review: Public notice of this review was given in the *Federal Register* and a 60-day comment period was opened on January 22, 2018 (83 FR 3014 3015). The findings of this review are based on research and monitoring of the known occurrences of the species that have been conducted since completion of the previous 5-year review (Service 2011). Population data, new information, and results of research on *Sidalcea oregana* var. *calva* subsequent to the previous 5-year review are summarized below in the Synthesis section (2.4). New information that forms the basis of this review is a combination of published papers, unpublished reports, monitoring data, and related notes of the *Sidalcea oregana* var. *calva* Technical Team (Technical Team).

Technical Team participants:
- Wendy Gibble, Botanist and Program Manager, University of Washington Center for Rare Plant Care and Conservation (Rare Care);
- Lauri Malmquist, Former Botanist, Wenatchee National Forest (WNF), Leavenworth Ranger District, U.S. Forest Service;
- Walt Fertig, Botanist, Washington Natural Heritage Program (WNHP), Washington Department of Natural Resources (WDNR);
- David Wilderman, Natural Area Ecologist, WDNR; and,
- Tara Callaway, Fish and Wildlife Biologist, U.S. Fish and Wildlife Service, Central Washington Field Office.

The participation of the Technical Team members is supported by the agency or organizations where they are employed. Participation of the WNHP is partially supported by a cooperative agreement under section 6 of the Endangered Species Act (ESA) between the WDNR and the Service. Once all known and pertinent data were collected for this species, status information was compiled and the review was completed by the species' recovery lead biologist in the U.S. Fish and Wildlife Services' (Service) Central Washington Ecological Services Field Office, Wenatchee, Washington.

1.3 Background:

1.3.1 FR Notice citation announcing initiation of this review: January 22, 2018. Endangered and Threatened Wildlife and Plants; Initiation of 5-Year Status Reviews of 18 Species in Hawaii, Oregon, Washington, Idaho, and Canada. 83 FR 3014 3015

1.3.2 Listing history
Original Listing
FR notice: 64 FR 71680
Date listed: December 22, 1999
Entity listed: Variety
Classification: Endangered

Revised Listing, if applicable: N/A

1.3.3 Associated rulemakings: Final Designation of Critical Habitat for *Sidalcea oregana* var. *calva*. (Wenatchee Mountains Checker-Mallow). 66 FR 46536. September 6, 2001.

1.3.4 Review History: Wenatchee Mountains Checker-mallow (*Sidalcea oregana var. calva*) 5-Year Review Summary and Evaluation, September 30, 2011.

1.3.5 Species' Recovery Priority Number at start of this 5-year review: 3 on a scale of 1 to 18, reflecting a high degree of threat, a high potential for recovery, and the plant's taxonomic status as a variety.

1.3.6 Current Recovery Plan or Outline
Name of plan or outline: Recovery Plan for *Sidalcea oregana* var. *calva* (Wenatchee Mountains Checker-mallow). 69 FR 58944.
Date issued: October 1, 2004
Dates of previous revisions, if applicable: Draft Recovery Plan, 68 FR 59414, published October 15, 2003.

2.0 REVIEW ANALYSIS

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

2.1.1 Is the species under review a vertebrate?
_____ ***Yes***
_X__ ***No, the DPS policy applies only to vertebrate species.***

2.2 Recovery Criteria

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

_X_ ***Yes***
____ ***No***

2.2.2 Adequacy of recovery criteria.

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

_X_ ***Yes***
____ ***No***

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)?

_X_ ***Yes***
____ ***No***

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

1. There are at least four stable, self-sustaining populations in each of the 5th field watersheds (Peshastin Creek and Icicle Creek) where the species currently occurs. Alternatively, there could be three stable, self-sustaining populations in each of these watersheds and at least three additional stable, self-sustaining populations in another drainage if populations are discovered in the future. New populations may be identified through additional surveys or established through reintroductions. To be considered separate, each population must be geographically and hydrologically separated, such that events resulting in the extinction of one population are not likely to result in the extinction of another population. To be considered stable and self-sustaining, a population should maintain a five-year average of at least 500 adult plants, show evidence of positive or neutral population growth over the same five-year period, and show evidence of natural reproduction and establishment.

This criterion has not been met to date. Currently, only two of the five extant self-sustaining populations include at least 500 flowering individuals, are stable, and are located in different watersheds (see Tables 1 and 2). The Camas Meadows population in the Peshastin watershed has been stable since monitoring began in 2000, and after monitoring in 2018, the population was estimated to be 13,000 individuals. The Mountain Home population in the Icicle Creek watershed has been found to be much larger than originally estimated. Results from a population count in 2011 estimated over 2,581 plants, including 2,508 flowering, 60 vegetative, and 13 juveniles (Arnett 2011); whereas, the recovery plan estimated only 300 plants in 2001. In 2019, there were 2,300 plants indicating a stable population since 2011.

Table 1. Revised Summary of Known Sites for *Sidalcea oregana* var. *calva*.

Site Name	Population Size (Survey Year)	Occupied Area	5-year Trend in Population Size	Land Ownership
Camas Meadows [1]	13,000 estimated [2] (2018)	14 to 20 hectares (35 to 50 acres)	stable [2]	WDNR, WNF, private
Poison Canyon [3]	> 1,315 (2019)	2 to 4 hectares (5 to 10 acres)	unknown	WNF
Camas Creek Tributary	0 (2019)	less than 0.4 hectares (less than 1 acre)	potentially extirpated	private
Pendleton Canyon	160 (2001)	less than 0.4 hectares (less than 1 acre)	unknown; discovered in 1999	private
Forest Service	43 [4] (2004)	less than 0.4 hectares (less than 1 acre)	increasing; based on occasional observations	WNF
Mountain Home [5]	2,300 (2019)	less than 0.4 hectares (greater than 1 acre)	stable	private
Mountain Home Ridge	90 (2019) [6]	1.62 hectares (4 acres)	unknown; outplanted in 2014	Chelan-Douglas Land Trust

[1] Portions of this population is in the voluntary registry program administered by The Nature Conservancy and WDNR.
[2] Beginning in 2012, a subset of polygons in this population has been monitored every year and data indicates that this population is stable or increasing (Wildernman personal communication, 2018).
[3] Poison Canyon is sub-population of Camas Meadows but is considered a separate element occurrence. In 2019, the minimum population count was estimated (Fertig pers. comm., 2019).
[4] Of the 43 individuals counted, there were only two flowering plants.
[5] This population is in the voluntary registry program administered by The Nature Conservancy and WDNR.
[6] Individual plants growing new leaves in May (Hedges pers. comm., 2018).

Table 2. Plant counts at each site separated by watersheds from 2001 to 2019

Site Name	Year				
	2001	2005	2011	2018	2019
Peshastin Watershed					
Camas Meadows	11,240	-	11,000	13,000	13,000
Poison Canyon	-	-	-	-	1,315
Pendleton Canyon [1]	160	-	-	-	-
Camas Creek Tributary	8	-	-	-	0
Forest Service	-	43 (in 2004)	-	-	-
Icicle Creek Watershed					
Mountain Home [2]	300	2,248	2,581	1,375	2,300
Mountain Home Ridge	-	-	161 (in 2015)	100	90

[1] This population occurs solely on private property, and it is no longer possible to gain access for counts as of 2019.
[2] In 2001, the Mountain Home population was visually estimated from the road as 300 flowering plants. A population survey was developed and used to complete a census in 2005, 2011, and 2019. In 2018, the minimum population size was estimated using a less intensive monitoring method. The method used in 2005, 2011, and 2019 seems to be the most accurate method to use for counting individuals at Mountain Home and should be used in subsequent efforts.

2. All of the stable, self-sustaining populations are on protected sites secure from threats. For a site to be considered protected, it must be owned or managed by a government agency or private conservation organization that identifies perpetual maintenance of the species as the primary management objective for the site, or the site must be protected by a permanent conservation easement or covenant that commits present and future landowners to the conservation of the species.

This criterion has not been met. Currently, only one of the known populations with greater than 500 flowering plants (Camas Meadows) is stable or improving and on a legally protected site. Poison Canyon is geographically separate from Camas Meadows but is hydrologically connected, and is thus considered a sub-population of Camas Meadows.

Surveys indicate the Mountain Home population comprises the second largest known population and appears to be stable. However, this population is not currently on a protected site. However, the current landowners are considering establishing a conservation agreement with the Service.

3. Genetic material is stored in a facility approved by the Center for Plant Conservation. The stored genetic material in the form of seeds must adequately represent the species' geographic distribution and genetic diversity.

This criterion has been partially met. Genetic material collected from three populations in 1987, 1999, and 2011 (see Table 3 and 4) is stored in two approved facilities (Miller Seed Vault and Rae Selling Berry Seed Bank). Storing the seed stock at two separate facilities decreases the risk of losing the entire seed bank for the species in a single catastrophic event. However, the majority of seed stock is ageing and seed viability may be compromised or greatly diminished. Germination testing conducted in 2015 at Miller Seed Vault using seed collections from 2011 revealed 10 and 40 percent germination rates from the Mountain Home and Poison Canyon sites representing a potential seed stock of 338 to 1,352 viable seeds (Gibble pers. comm., 2018). About 75 percent of seeds from the Mountain Home site were empty, while Poison Canyon had about 10 percent empty seeds. Additionally, seed accessions stored at Rae Selling Berry Seed Bank were collected 19 to 31 years ago.

Table 3. Seed Accessions at Rae Selling Berry Seed Bank (Portland State University, Portland, Oregon) (Guerrant pers. comm., 2018)

Year	*EO #	# seeds	Site
1987	9	unknown	Little Camas Creek; Transect 3
1999	9	214	Camas Meadows; Transect 1
1999	9	189	Poison Canyon; Transect 2
1999	16	492	Pendleton Canyon
1999	9	281	Little Camas Creek; Transect 4

*EO (Element Occurrence) = population site

Table 4. Seed Accessions at the Miller Seed Vault (Center for Urban Horticulture, University of Washington, Seattle, Washington) (Gibble pers. comm., 2018)

Year	EO #	# seeds	Site
2001	9	13	Camas Meadows (Poison Canyon sub-population)
2011	9	16	Camas Meadows (Poison Canyon)
2011	20	775	Mountain Home Meadow
2011	9	2575	Camas Meadows (Poison Canyon)

Actions to address this criteria are a high priority for completion. Priority actions include increasing seed collecting efforts at all extant sites, determining initial seed viability and viability decline over time, and creating seed production beds at a local nursery. In 2019, Rare Care was funded by the Service to expand the ex situ collection of seed accessions from the Mountain Home population to be held at the Miller Seed Vault. Seed collections will be augmented if new populations are discovered, if research determines gaps in the representation of genetic diversity, or if future viability tests indicate that additional accessions are needed.

4. Adequate population and habitat monitoring has been established for all of the known populations. Population monitoring must be statistically sound and should detect a 20 percent change in the population size with a 90 percent degree of certainty. Habitat monitoring should include monitoring of shrub and tree cover, nonnative species, and hydrology.

This criterion has been partially met. There are several monitoring efforts designed and started at Camas Meadows Natural Area Preserve (NAP) to assess the response of *Sidalcea oregana* var. *calva* to WDNR management activities such as prescribed fire, fuels treatments, and restoration of hydrology within the meadow. Four transects were established by WDNR and USFS in 1999 in four different populations and were monitored annually by USFS for five years. These transects were intended to be monitored with a new protocol at an expanded interval (every 2 to 3 years); however, due to staffing and workload issues, these plots have not been visited since 2011 (Malmquist pers. comm., 2018). In an effort to implement monitoring called for in the recovery plan, WNHP and WDNR established three new plots in 2004 and 2005 at Camas Meadows NAP that are monitored annually (Wilderman pers. comm., 2018). In 2013, WDNR and Rare Care personnel began additional monitoring at Camas Meadows NAP mapping concentrations of *Sidalcea oregana* var. *calva* into polygons and that monitoring is currently on-going. The mapping provides a census of flowering plants in each polygon unit. In 2018, this effort has cumulatively accounted for 13,000 individuals; however, this effort is still incomplete as several more polygons need to be mapped and counted. Once the baseline is established and all polygons are mapped across the Camas Meadows NAP, population trends can be determined in subsequent years by sampling a select number of polygons. This baseline is anticipated to be completed in 2020. Poison Canyon, a sub-population of Camas Meadows, was monitored in 2019 and the minimum population size was estimated at 1,315 flowering individuals (Fertig pers. comm., 2019).

In 2019, a census conducted at the Mountain Home population indicated a 10 percent decline in population numbers since 2011 (Table 2). Results from population counts in 2011 and 2019 estimated over 2,581 plants (2,508 reproductive, 60 vegetative, and 13 juveniles) and 2,300 (2,246 reproductive and 54 vegetative and juveniles), respectively. Reproductive individuals include any plants that exerted a reproductive effort as evidenced by buds, flowers, seeds, and

aborted flowers. Vegetative and juveniles individuals were combined in 2019 to indicate the proportion of non-reproductive individuals. However, vegetative and juvenile individuals are extremely difficult to locate, so those particular counts are less accurate than flowering individuals and likely represent and underestimate. In 2019, Rare Care was funded by the Service to assess habitat conditions at Mountain Home and determine the best management treatments to enhance the *Sidalcea oregana* var. *calva* population. Habitat monitoring will include monitoring plant community composition, documenting nonnative and invasive species presence and abundance as well as vigor of *Sidalcea oregana* var. *calva* plants.

The Mountain Home Ridge site has been monitored every year since outplanting efforts began in 2014 in order to determine transplant survival rates and document potential recruitment efforts. Out of the 161 transplants, 90 transplants have survived until 2019, 48 in the lower site and 41 in the upper site (Ballinger pers. comm., 2019; see Table 5). Monitoring is conducted by relocating plant markers and noting whether a plant still exists and what stage it is in (i.e., height, number of leaves and presence/absence of a flowering stalk). Future monitoring will also include recording demographic and vigor information of outplanted *Sidalcea oregana* var. *calva* plants.

Table 5. Monitoring results from Mountain Home Ridge site in 2019.

Plant Size Class	**Number of plants**	
	Lower site	**Upper site**
No flowering stalk	43	28
Flowering stalk (with buds, flowers, and/or seeds and combinations)	6	13
Plants absent	53	18
Total transplants	102	59
Total number of surviving transplants	**49**	**41**
Survival percentage	**48**	**69**

Other population sites (Forest Service and Pendleton) have not been monitored or revisited since the last monitoring efforts over 14 and 17 years ago, respectively. Monitoring efforts have not been prioritized due to access (i.e., private lands). In 2018, the WNHP was funded through the Service's Section 6 program to investigate recently extirpated and extant populations and to assess population status and habitat quality in 2019 and 2020.

5. Management plans have been developed and implemented for all State and federally owned populations. Management plans will include provisions for monitoring, research, and habitat restoration and management, including hydrologic restoration and reporting. These plans will also define actions designed to reduce or control threats to the species.

This criterion has been partially met. The Camas Meadows population is mostly contained within a WDNR NAP, providing the agency some management flexibility for *Sidalcea oregana* var. *calva.* A final management plan for the Camas Meadows NAP was developed in 2000 and is implemented as funding allows (WDNR 2000). This plan contains provisions for monitoring, research, and restoration of habitat and hydrology. Because this is the largest population, and appears to be the most stable, this plan is adequate and will serve the species into the future at that site. However, a comprehensive management plan that includes all protected populations should be developed and implemented. A management plan for the USFS locations and habitat

for *Sidalcea oregana* var. *calva* is currently in draft but no date is set for completion (Malmquist pers. comm., 2018).

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology and life history:
Insect herbivory from adult leaf beetles (*Calligrapha sigmoidea*) was observed when the leaf beetles were feeding extensively on *Sidalcea oregana* var. *calva* leaves at Mountain Home in 2013 (Malmquist pers. comm., 2013). In 2014, adult leaf beetles were also observed at the Mountain Home Ridge site but were not observed directly consuming *Sidalcea oregana* var. *calva* leaves even though nearly all plants exhibited heavy defoliation (Hedges pers. comm., 2018). Heavy defoliation from insect herbivory can cause a wide variety of plant responses (e.g., chemical defenses), and most responses result in a decline in resources otherwise used for plant growth and reproduction; therefore depending on timing and intensity, insect herbivory may subsequently lead to reduced plant vigor, mortality and decreased reproduction.

2.3.1.2 Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:
The Mountain Home population in the Icicle Creek drainage was discovered to be much larger than originally estimated when this species was federally listed. Previously in 2001, a cursory estimate by WDNR reported 300 plants present in a small area (300 by 210 feet). A more thorough investigation in 2005 revealed approximately 2,248 plants (2,038 reproductive, 102 vegetative, and 108 juvenile plants). In 2004 and 2005, the private landowners undertook a fuels reduction project that involved mowing and clearing the dense forest understory. The next season, *Sidalcea oregana* var. *calva* plants appeared in the cleared areas and the population seemed to be increasing (Malmquist pers. comm., 2011). Results from a population survey conducted in 2011 estimated 2,548 plants (2,475 reproductive, 60 vegetative, and 30 juvenile plants) in an area over one acre (0.4 hectare; Malmquist pers. comm., 2011). The survey effort in 2011 extended north across the driveway, but it is unknown whether prior estimates from 2001 and 2005 included that area. It is possible that the reduction of shade from canopy removal and vegetative competition produced, or resulted in, a substantial increase in number of *Sidalcea oregana* var. *calva* plants and occupied habitat. Results from a population survey conducted in 2019 counted 2,300 plants indicating a 2 percent increase from 2005 but a 10 percent decline from 2011.

The Mountain Home Ridge population was created in 2014 and 2015 after approximately 161 *Sidalcea oregana* var. *calva* plants were outplanted on Chelan-Douglas Land Trust property at two different sites (Dunwiddie 2014; Hedges pers. comm., 2018). Out of the 161 transplants, 90 transplants have survived until 2019, 49 in the lower site and 41 in the upper site (Table 5; Ballinger 2019). Recruitment is being monitored and in 2019, 19 out of the 90 surviving transplants had flowering stalks (Table 5).

The Camas Meadows NAP population was estimated at 11,000 individuals in 2001-2012 using a variety of monitoring methods; in 2013, managers began an extensive mapping effort to determine the population baseline, boundaries, and future trends (Wilderman pers. comm., 2018). In 2018, the effort cumulatively accounted for 13,000 individuals; however, this effort is incomplete as several more polygons need to be mapped and counted. Once the population baseline is established and all polygons are mapped across Camas Meadows NAP, population trends can be determined in subsequent years by subsampling polygons. This baseline is expected to be completed in 2020.

The Camas Creek Tributary population was rediscovered in 2001 and contained eight individuals. Unfortunately in 2019, no plants were observed and the habitat conditions have degraded for the species as the area is completely overgrown and converted to a secondary forest (Fertig pers. comm., 2019).

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):
Based on the size and stability of the known populations, and the life history of *Sidalcea oregana* var. *calva* (a long-lived perennial that occupies relatively stable habitats), a population that maintains at least 500 reproductive plants is presumed to be viable for this taxon, although a population viability analysis has not been completed. Because our present knowledge of the biology of the species remains somewhat limited, research to gather key information about the stressors affecting population viability for this species is a key component of the recovery strategy. However, there has been no research to generate updates or changes for *Sidalcea oregana* var. *calva* related to the genome.

2.3.1.4 Taxonomic classification or changes in nomenclature:
The taxon was first recognized as a distinct variety named *Sidalcea oregana* ssp. *oregana* var. *calva* by Hitchcock and Kruckeberg (1957). Hitchcock and Cronquist (1973) later simplified the nomenclature by eliminating the subspecies *oregana*, and all subordinate taxa of *Sidalcea oregana* became varieties of the species. No further revisions have been

made for *Sidalcea oregana* var. *calva* related to either taxonomy or relevant nomenclature for the species.

2.3.1.5 Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g. corrections to the historical range, change in distribution of the species' within its historic range, etc.):
In 2009, Chelan-Douglas Land Trust and the Service's Partners for Fish and Wildlife Program partnered on a restoration and reintroduction project at Mountain Home Ridge site on potential *Sidalcea oregana* var. *calva* habitat. The goal of this project is to meet recovery criterion #1 for this site, which is to maintain a stable population of at least 500 individuals over five years. The project was located on Chelan-Douglas Land Trust property 1.5-2.2 kilometers from the Mountain Home population in the Icicle Creek Watershed (Dunwiddie 2014). Site preparation and seed collection began in 2011 followed by a preliminary outplanting in the spring of 2012. The reintroduction portion of the project was completed in 2015 with a total of 161 plants being outplanted at two locations (lower and upper sites, respectively) within the Mountain Home Ridge site. Monitoring has revealed uneven success at sites depending on the year and conditions. In 2018, 100 plants were located and all were growing new leaves and some were flowering (51 and 49 plants at the upper and lower sites, respectively), indicating a 50 to 83 percent survival four years post-outplanting (Hedges pers. comm., 2018). Even though the outplanting sites were relatively close together (within a few meters to each other), microsite conditions, such as soil depth and plant community composition, can play a huge role in success of reintroductions (Dunwiddie and Martin 2016).

North of the Mountain Home population (approximately 100 meters to 0.7 miles), 43 flowering individuals were documented for the first time in 2019. No plants were observed at the Camas Creek Tributary population in 2019 after being rediscovered in 2001 with eight plants.

2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):
Sidalcea oregana var. *calva* populations are located in sites that have specific surface hydrology characteristics such as surface water or saturated upper soil profiles during spring and early summer (Service 2004). At Camas Meadows, natural drainage channels have been altered to direct water away from the primary wet meadow area for agricultural purposes (Gamon 1987; Wilderman pers. comm., 1997). Restoration work by the WDNR, in partnership with the Service, within the Camas Meadows NAP has improved the wetland habitat in the meadow more towards the historical hydrology. A pilot project implemented in 2004 slowed or stopped several headcuts in the meadow by reducing the volume

of flowing water and preventing further erosion. Temporary dikes made of staked straw bales and large straw waddles were installed perpendicular to the flow to spread out the water and reduce the erosive potential. This pilot project restored several acres of wetted habitat and numerous *Sidalcea oregana* var. *calva* plants germinated in the restored area the next spring (Wilderman pers. comm., 2011). Recently, logs have been installed similarly to staked straw bales in order to continue spreading water flow and minimize erosion in the marsh (Wilderman pers. comm., 2018).

Timber harvest, particularly large-scale removal of overstory trees, was assumed to negatively impact *Sidalcea oregana* var. *calva* by increasing erosion and modifying hydrologic function. However, recent observations by the USFS indicate that only the ground-disturbing aspects of timber harvest threaten the species, and that the attendant removal of overstory and competing vegetation appears to benefit the species and stimulate germination and growth (Malmquist pers. comm., 2018).

Prescribed fire post-timber harvest may also benefit the species as fire exclusion policies have seemed to have negative rangewide effects on *Sidalcea oregana* var. *calva* populations. A timber harvest and prescribed fire project in 2005 established "no-activity" areas where entry was restricted because of the presence of *Sidalcea oregana* var. *calva* plants. After the project was complete, plants within those areas continued to experience suppressed growth and vigor due to overstory development and vegetative competition. Outside the no-activity areas, one area was cleared and used for burning a slash pile which sprouted numerous *Sidalcea oregana* var. *calva* plants the next spring, where there were none located before (Malmquist pers. comm., 2011). On a visit to the same site in 2011, the plants were reported to be particularly dense and vigorous (Arnett pers. comm., 2011). Further support for prescribed fire treatments was recommended based on observations at the Mountain Home population, where new plants emerged as "fairy rings" growing in circles around several historic and recent burn piles (Malmquist pers. comm., 2018). In 2019, 129 flowering individuals were counted in one circle growing around a previous burn pile in a location that would not normally be considered ideal habitat for the species (i.e., dry, upland meadow).

2.3.1.7 Other: N/A

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

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

Habitat for this species may be degraded or destroyed by residential or agricultural development through modifications such as alterations in

hydrology, introduction of nonnative grasses, road construction, and conversion of meadows for agricultural uses including pasture land and gardens (Gamon 1987; Wilderman pers. comm., 1997). A restoration project by the WDNR, in partnership with the Service, at Camas Meadows has improved wetland habitat in the largest population of *Sidalcea oregana* var. *calva.* In addition, the project restored native plant diversity to several areas drained historically for agriculture. These actions appear to have reduced the threat of altered hydrology within this population. This project also established a successful method for restoring the hydrology of the wetland to benefit the species. Some areas of headcutting remain to be addressed for a future project, along with some remnant drainage ditches.

Wildfire suppression is likely both a direct and indirect source of habitat degradation or loss for *Sidalcea oregana* var. *calva*. In the absence of fire to set back succession, woody plants encroach the moist montane meadows preferred by this species, altering the hydrology, availability of sunlight, and nutrients. Fire suppression activities may also result in direct mortality by crushing or burying plants and seed. Use of heavy equipment in moist areas may easily alter the hydrology, soil structure and patterns of runoff.

Direct observations of the negative effect of fire suppression activities on *Sidalcea oregana* var. *calva* habitat by the USFS and others may have reduced the risk of this threat. It is likely in the future that prescribed fire plans will not seek to avoid areas containing *Sidalcea oregana* var. *calva*. Strategic thinning or timber harvest coupled with prescribed fire of some forest stands may benefit *Sidalcea oregana* var. *calva* if intended to decrease shrub and tree encroachment due to fire suppression, reverse plant succession, and increase light penetration at occupied sites (Wilderman pers. comm., 2004). Timber harvest planning will accordingly be allowed to remove more overstory, while limiting ground disturbance near and within the species' habitat. This can be accomplished through common alternative methods, such as logging over snow (Malmquist pers. comm., 2011), further reducing both the imminence and magnitude of these threats.

The introduction of nonnative plants, and particularly grasses, likely pose a threat to *Sidalcea oregana* var. *calva* through competition for resources. The WDNR has undertaken several projects to control invasive species within and around the periphery of the Camas Meadows population. In 2011, the NAP received 26 acres of invasive species control (Wilderman pers. comm., 2004). Although the threat is currently reduced due to these treatments, this action appears to be an ongoing need at Camas Meadows. Currently, there are no other ongoing or future invasive plant management actions planned at any other site for *Sidalcea oregana* var. *calva*.

Other threats reported in the recovery plan (Service 2004) for this factor, such as land development, road construction, and septic systems have not had effects reported to the species since the development of the recovery plan.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:
Sidalcea oregana var. *calva* does not appear to be at risk from commercial activities. Recreational use of public areas where it is known to occur, such as Camas Meadows NAP, may continue to present a risk associated with incidental flower picking and trampling. Area managers continue to work to integrate conservation and recreational use of this and other similar sites.

Seed accessions need to be adequate in case of catastrophic population losses in the wild. Accessions currently stored in seed banks are ageing and viability is low, elevating the risk to *S Sidalcea oregana* var. *calva*. The collection and storage of a larger amount of viable seed is a top priority for recovery activities in 2019-20 and is coordinated with the Technical Team. Since seed predation levels from weevils and other insects are high, seed collection for reintroductions and augmentations could potentially be another threat to recruitment if not balanced with seed production beds.

2.3.2.3 Disease or predation:
Recruitment of new individuals to a population greatly depends on successful seed development, dispersal, and germination culminating in progression of a seedling into a reproductive adult. If few seeds succeed in becoming adult plants there is little chance of a population remaining stable or increasing. Recent studies have verified that the loss of *Sidalcea oregana* var. *calva* seeds to weevil predation is high, and may have substantial negative impacts on its reproductive capacity (Goldsmith 2003, Arnett and Birkhauser 2008). Seed predation by weevils ranged from 25.9 to 59.4 percent (Arnett and Birkhauser 2008); considerably lower than that observed by Goldsmith (2003), which ranged from 62 to 78 percent. Seed loss related to other insects, presumably aphids, ranged to above 70 percent. Of the 775 seeds collected in 2011 at the Mountain Home site, 75 percent were empty and attributed to high insect predation (Gibble pers. comm., 2018). Although this work informs our understanding of the species, it does not inform the level of threat. It is unknown if the current levels of weevil infestation are different than historic or “natural” levels, or how this relationship interacts with the host of other insects known to use *Sidalcea oregana* var. *calva*.

Although insect herbivory on plants is common, concentrated herbivory can be deleterious to the survival of individual plants and potentially result in a decline in reproduction within the population. In 2013, insect herbivory from adult leaf beetles (*Calligrapha sigmoidea*) was noted when the leaf beetles were feeding extensively on *Sidalcea. oregana* var. *calva* leaves at Mountain Home (Malmquist pers. comm., 2013). In 2014, adult leaf beetles were also observed at the Mountain Home Ridge site but were not observed directly consuming *Sidalcea oregana* var. *calva* leaves even though nearly all plants exhibited heavy defoliation (Hedges pers. comm., 2018). We do not know whether this herbivory is different than historic or "natural" levels and what effect it is having at the individual and population level for this species.

2.3.2.4 Inadequacy of existing regulatory mechanisms:
Beyond the protections afforded to the species through Section 7 consultations for proposed Federal actions that are authorized, funded, or carried out by Federal agencies, there is little additional protection given to the species through other means. The Endangered Species Act (Section 9(a)2) does not prohibit the take of listed plants on private land.

Critical habitat was determined to be prudent for *Sidalcea oregana* var. *calva* at the time of listing (Service 1999). The designation of critical habitat for *Sidalcea oregana* var. *calva* (Service 2001) did not include the Mountain Home population as essential to the survival and recovery of the species because it was thought to be limited in size, numbers, and was isolated from all other known sites. With the discovery that this population is much larger and stable, the Mountain Home population may be more important than previously concluded. Pursuing a conservation agreement with the private landowners that provides protection and stewardship for *Sidalcea oregana* var. *calva* would be beneficial to the long term survival of the species.

Although WHNP has classified *Sidalcea oregana* var. *calva* as an endangered species, this classification provides no direct protection to threatened or endangered plants or the habitats upon which they depend. The only State protections provided to plants are the prohibitions specifically related to State criminal trespass law on private lands.

2.3.2.5 Other natural or manmade factors affecting its continued existence:
In *Sidalcea oregana* var. *calva* populations where fragmentation or habitat isolation occurs, ecological functions may deteriorate when occupied patches become too small or the distance between patches exceeds the dispersal distance of pollinators and may eventually cause the extirpation of small, isolated patches. Additionally, small populations may be at risk of inbreeding depression; as patches get smaller and more reproductively

isolated from adjacent populations, the local pool of genetic diversity shrinks, potentially resulting in a loss of resilience to environmental change or deleterious allele fixation. Small populations are also at risk of extirpation due to stochastic events, such as unusually dry years and unseasonal wildfires.

The numbers of plants at two of the five *Sidalcea oregana* var. *calva* populations (Pendleton Canyon and Forest Service) remain extremely small with fewer than 200 plants total and ultimately, may not be viable. Camas Creek tributary is potentially extirpated as no plants were observed in 2019 and the habitat no longer appears suitable for the species. Also, little opportunity exists for genetic exchange to occur between most populations, except for Camas Meadows, due to habitat isolation. Therefore, the threat of impaired ecological processes and inbreeding depression remains high in *Sidalcea oregana* var. *calva* populations due to fragmentation and habitat isolation.

Potential effects to the species as a result of climate change were not addressed in the original listing rule (Service 1999) or recovery plan (Service 2004). The term "climate change" refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2014, p. 119). Various types of changes in climate can have direct or indirect effects on species and critical habitats. These effects may be positive, neutral, or negative, and they may change over time. The nature of the effect depends on the species' life history, the magnitude and speed of climate change, and other relevant considerations, such as the effects of interactions of climate with other variables (e.g., habitat fragmentation) (IPCC 2014, pp. 64, 67- 69, 94, 299).

There is growing evidence that recent climate change has impacted a wide range of ecological systems (Stenseth et al. 2002, entire; Walther et al. 2002, entire; Ådahl et al. 2006, entire; Moritz et al. 2012, entire; Westerling et al. 2011, p. S459; Marlon et al. 2012, p. E541). Climate change presents new challenges to species due to environmental variation as systems may change beyond historical ranges of variability. In some areas, changes in weather and climate may result in major shifts in vegetation communities that can persist in particular regions. The impacts of a changing climate to *Sidalcea oregana* var. *calva* are presently unclear, though they could pose a significant threat, as the species is reliant on seasonal runoff and elevated soil moisture.

Regional models of climate change indicate that future climate in the Pacific Northwest and Cascade Mountains will be warmer, have less spring snowpack, and have less summer soil moisture than the past and

suggest that rates of warming will be greater in the 21st century than those observed in the 20th century (Littell, et al. 2009a and Gergel et al., 2017). Projected changes in annual precipitation, averaged over all models, are small (+1 to +2 percent), but some models project an increased seasonal precipitation cycle defined by changes toward wetter autumns and winters and drier summers (Littell, et al. 2009a).

The projected warming trend will increase the number of frost-free days throughout the state, increasing the growing season for plants, which will generally be limited in eastern Washington by water availability (Dalton et al., 2013). Weeds and insects are expected to adapt to the longer season with more favorable conditions (Stöckle et al. 2009). However, regional climate models suggest that some local changes in temperature and precipitation may be quite different than average regional changes projected by the global models (Littell, et al. 2009a).

Despite the lack of site-specific data, increased average temperatures and reduced average rainfall may further exacerbate the current decline of the species and result in additional loss of habitat. Hotter and drier summer conditions may also increase the frequency and intensity of fires in the area, and invasive plants may respond positively as they may be better competitors for resources than *Sidalcea oregana* var. *calva*. In general, fire promotes *Sidalcea oregana* var. *calva* growth and reproduction, but when fires occur at the wrong time of year or burn too hot, plants may perish and seeds may be destroyed. Warmer, wet winters could benefit the species by extending the growing season and providing additional moisture to the soil in the spring. If frequency, intensity, and timing of the predicted changes in climate for eastern Washington are not aligned with the phenology of *Sidalcea oregana* var. *calva*, the survival and recovery of the species may be vulnerable to climate change over time.

Other threats reported in the recovery plan (Service 2004) for this factor, such as recreational trampling, and dust from gravel roads have not been observed to negatively affect the number of plants reported to the Technical Team since publication of the recovery plan in 2004.

2.4 Synthesis

The greatest challenges to survival for *Sidalcea oregana var. calva* are: (1) low numbers of individuals in most of the populations; (2) vulnerability of the species to competition from nonnative invasive plants and native overstory and understory plants; (3) landscape-level fire suppression; and, (4) the potential loss of habitat due to human development. The cumulative effect of these on-going threats to establishing plants in the wild is a challenge for this species, even on lands that are dedicated to conservation of this species, such as the Camas Meadows NAP.

The status of *Sidalcea oregana var. calva* has remained stable since the publication of the 5-year review in 2011. Large populations that have been monitored have either increased (Camas Meadows) or remained relatively stable (Mountain Home) and monitoring does not indicate whether individuals within populations are increasing or decreasing in size or vigor. However, the status of small populations reveal a decline (Camas Creek Tributary) or are unknown (Pendleton and Forest Service). The population at Camas Meadows remains the largest with around 13,000 individuals while the Camas Creek Tributary remains the smallest population with zero plants. The Mountain Home population was discovered to be much larger than previously thought, which suggests that additional properties may contain undetected populations of *Sidalcea oregana var. calva* as demonstrated by the 2019 discovery of 43 additional individuals at a site north of the Mountain Home population.

Despite seed predation by weevils and leaf defoliation by leaf beetles, the species has demonstrated an ability to positively respond to improvements in habitat conditions (i.e., Camas Meadows hydrologic restoration project), potentially due to the fact that the species is capable of reproducing through rhizomatous growth.

Since the development of the recovery plan (Service 2004), our understanding of the ecology and biology of *Sidalcea oregana* var. *calva* has increased. In 2014, a recovery project conducted in the Icicle Watershed attempted to establish *Sidalcea oregana* var. *calva* seedlings in restored suitable habitat under the stewardship of the Chelan-Douglas Land Trust. Outplantings occurred at the Mountain Home Ridge site in two locations, lower and upper sites; outplanting locations were only separated by a quarter mile but each location displayed divergent survival results. Survival was 50 and 83 percent in 2018 at the lower and upper sites, respectively, indicating that even within a relatively small area, microsite conditions can dramatically affect survival (Dunwiddie and Martin 2016). These results indicate that habitat and microsite conditions needed for successful reintroductions and augmentations still need to be explored further.

Sidalcea oregana var. *calva* is relatively easy to propagate from seed in a nursery using cold stratification; however, establishing plants in the field from seed has not been attempted (Gibble pers. comm., 2011). This species is also now thought to be fire-adapted based on observations after controlled burns (Malmquist pers. comm., 2011). Prescribed fires remove understory and competing vegetation and seem to benefit the species by stimulating germination and growth as well as likely improving hydrology. Similarly, grass, shrub, and tree removal (either due to fire or mechanical removal) has increased the amount of suitable habitat and the number of *Sidalcea oregana* var. *calva* plants. Tree and shrub removal at Camas Meadows, USFS, and Mountain Home sites has increased population sizes overall.

Research on weevil predation has demonstrated how little is known about the ecological relationships of *Sidalcea oregana* var. *calva* and the insects responsible for causing high seed loss. Research and monitoring of this relationship should continue to help determine

the level of impact on recruitment. Habitat conditions that are not as suitable for weevils and aphids, yet remain useful and attractive to pollinators, need to be determined to facilitate successful reintroductions and subsequent recruitment of new individuals. Research is also needed on insect herbivory to determine the impact on the survival of individuals and recruitment within populations. Although insect herbivory can be common, we do not know whether this herbivory is different than historic or "natural" levels and what effect it is having at the individual and population level for this species.

Given the present distribution, abundance, and threats, *Sidalcea oregana* var. *calva* is still at risk of becoming extinct in the foreseeable future. The likelihood that this species can be recovered remains moderately high. The best opportunity to recover this species appears to be a multifaceted approach of conserving all extant populations, augmenting extant populations below 500 reproductive individuals, and establishing three to four additional viable populations in each watershed within its historical range.

3.0 RESULTS

3.1 Recommended Classification:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
____ *Extinction*
____ *Recovery*
____ *Original data for classification in error*
_X_ No change is needed

3.2 New Recovery Priority Number: N/A

Brief Rationale:

3.3 Listing and Reclassification Priority Number: N/A

Reclassification (from Threatened to Endangered) Priority Number: ____
Reclassification (from Endangered to Threatened) Priority Number: ____
Delisting (regardless of current classification) Priority Number: ____

Brief Rationale:

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

A comprehensive listing of actions such that, if implemented, are expected to lead to the downlisting or delisting of *Sidalcea oregana* var. *calva* is discussed in the recovery plan (Service 2004) and appendices, including the recovery implementation schedule. New or enhanced actions, including adaptive management actions created as a result of this review are recommended as follows (in order of priority):

A. Census and monitor all populations
There has not been a full species census conducted in a single year to serve as a baseline for future comparisons and to allow the detection of trends. It is important to design a census that is efficient and comprehensive yet flexible to continue into the future in the face of uncertain funding. In 2018, the Service provided funding to WDNR to complete this action in 2019 and 2020.

B. Collect, distribute, and store seed in an approved Center for Plant Conservation Seed Bank facility
Given that the majority of accessions are ageing and of low viability, this action remains a high priority. The seed stock should be refreshed in order to ensure seed collections are of high quality and viability. Seed stock should also contain accessions from all populations to ensure the genetic diversity of *Sidalcea oregana* var. *calva* is represented and preserved. In 2019, the Service funded Rare Care to expand the ex situ collection of seed accessions in 2020 to be held at the Miller Seed Vault.

C. Establish seed production beds for reintroductions and augmentations
Seed production beds should be established at a nursery to aid future recovery projects, such as reintroductions and augmentations. Seed production beds can yield much more seed than could be sustainably collected at natural populations, and it is vitally important that natural populations are allowed to maintain their seed bank for recruitment purposes. However with high seed predation levels from weevils and other insects, seed collecting for reintroductions and augmentations could potentially be another threat to recruitment if not balanced with seed production beds. Seed production should be setup to ensure the conservation and enhancement of the genetic diversity of *Sidalcea oregana* var. *calva.*

D. Determine best management practices for suitable habitat
Before augmenting or reintroducing populations in suitable habitat, it is imperative to determine how these habitats need to be managed for *Sidalcea oregana* var. *calva*. Management methods such as fire or overstory thinning should be tested at occupied sites with a sound experimental design to determine causation to ensure accuracy of results. Additionally, climate change should be taken in to account for future management of sites and populations. Subsequently, management methods should be clarified for specific habitat conditions and land management types.

E. Refine methods and complete reintroductions and augmentations
The reintroduction project at Mountain Home Ridge was completed in 2015 by Chelan-Douglas Land Trust where 161 *Sidalcea oregana* var. *calva* plants were outplanted at two

sites. Microsite conditions resulted in low overall survival at one site and relatively high survival at the other site. Using lessons learned from this project, new reintroduction sites as well as augmentation sites for extant populations below 500 individuals should be identified and projects should be developed and implemented. Subsequent projects should identify whether outplanting or direct seeding is the best method for reintroductions and augmentations in addition to determining the most suitable habitat and microsite conditions for the preferred method.

F. Reassess value of Mountain Home population to survival and recovery

With the discovery in 2011 that the Mountain Home population was much larger than originally thought, the Technical Team may reassess the value of this population to the recovery of the species and the Service may pursue a conservation agreement with the current landowners. Securing a conservation agreement would allow the population to contribute toward recovery criteria #1, which is a minimum of 500 plants in a stable or increasing population on a protected site for a period of at least five years. Furthermore, this population may represent a significant source of genetic diversity for *Sidalcea oregana* var. *calva*, which elevates its importance for species persistence and reintroduction efforts as a seed source. In February 2019, the WDNR Natural Heritage Program advisory council recognized the Mountain Home landowners for their good stewardship by registering Mountain Home in the Register of Natural Areas. This voluntary agreement acknowledges the Mountain Home property as ecologically valuable for *Sidalcea oregana* var. *calva* and encourages conservation at this site.

G. Continue research into insect predation and herbivory

Arnett and Birkhauser (2008) recommend repeating the proposed weevil protocol at several sites in order to develop an understanding of the annual variation in insect infestation and phenology. Trial runs early and late in the season may yield a better understanding of the different behavior of the two weevil species and leaf beetles. A single late season monitoring was also suggested, as it may give the best estimate of the total level of insect damage as long as it is conducted before seed dispersal begins and the plant senesces. Arnett and Birkhauser (2008) also suggested conducting a prescribed fire at one of the *Sidalcea oregana* var. *calva* populations. The plant and weevil likely evolved together under conditions of a higher fire frequency than current, and Arnett and Birkhauser's (2008) suggestion offers an opportunity to measure the effects of prescribed fires as a management treatment. Because *S. oregana* var. *calva* is historically located in areas where late-season, low-intensity burns occurred frequently (Caplow 2003; Zimmerman and Reichard 2005), it could be predicted that the plant species would respond positively to fire. Fire would reduce competition with encroaching shrubs and trees and increase plant vigor as well as possibly keep populations of the weevil and other harmful insects in check.

H. Complete hydrologic restoration in Camas Meadows

The success of a hydrologic restoration project at Camas Meadows NAP has greatly improved the wetland function and increased the amount of suitable habitat for the largest population of *Sidalcea oregana* var. *calva.* The hydrologic restoration project also increased native plant diversity and reduced the threat of altered hydrology within in the

Camas Meadows population. This project successfully demonstrated a technique for restoring the hydrologic function to wetlands benefiting *S. oregana* var. *calva*. However, there is still an area of deep headcutting that requires restoration in a remnant drainage ditch and should be addressed to help alleviate threats to *S. oregana* var. *calva*. Invasive species management and native plant restoration should accompany any hydrologic projects.

5.0 REFERENCES

Ådahl, E., P. Lundberg, N. Jonzén et al. 2006. From climate change to population change: the need to consider annual life cycles. Global Change Biology. [Abstract] V. 12(9), pp. 1627-1633.

Arnett, J. and K. Birkhauser. 2008. Monitoring Seed Predation of *Sidalcea oregana* (Nutt.) Gray var. *calva* C.L. Hitchcock. Washington Department of Natural Resources. Natural Heritage Program. Report prepared for U.S. Fish and Wildlife Service. Region 1. 18 pp. + Appendix.

Arnett, J. 2011. *Sidalcea oregana* var. *calva* (Wenatchee Mountains checker-mallow) Monitoring and Inventory. Washington Department of Natural Resources. Natural Heritage Program. Report prepared for U.S. Fish and Wildlife Service. Region 1. 11 pp. + Appendix.

Caplow, F. 2003. Report on the status of *Sidalcea oregana* (Nutt.) Gray var. *calva* C.L. Hitchcock. Natural Heritage Report 2003-1, Washington State Dept. of Natural Resources, Olympia, Washington. 33 pp.

Dalton, M.M., P.W. Mote, and A.K. Snover. 2013. Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities. Washington, DC: Island Press.

Dunwiddie, P., and R. A. Martin. 2016. Microsites Matter: Improving the Success of Rare Species Reintroductions. PLoS One 11(3):e0150417. doi:10.1371/journal.pone.0150417.

Dunwiddie, P. 2014. Plan for establishment and monitoring of Sidalcea oregana var. calva at Mountain Home Ridge, Washington. Report prepared for Chelan-Douglas Land Trust. 27 pp. + Appendix.

Gamon, J.G. 1987. Report on the status of *Sidalcea oregana* (Nutt.) Gray var. *calva* C.L. Hitchcock. Unpublished report to the U.S. Fish and Wildlife Service, Olympia,Washington. 41 pp.

Gergel, D.R., Nijssen, B., Abatzoglou, J.T. et al. 2017. Climatic Change 141:287. http://doi.org/10.1007/s10584-017-1899-y

Goldsmith, T. 2003. Factors affecting population growth and persistence of *Sidalcea oregana* (Nutt.) Gray var. *calva* C.L. Hitchcock (Malvaceae), a taxon endemic to Chelan County, Washington. Unpublished M.S. thesis. University of Washington. 61 pp.

Hitchcock, C.L., and A. Cronquist. 1973. Flora of the Pacific Northwest. University of Washington Press, Seattle, Washington. 730 pp.

Hitchcock, C.L., and A.R. Kruckeberg. 1957. A study of the perennial species of *Sidalcea*. University of Washington Publications in Biology, Number 18. University of Washington Press, Seattle, Washington. 96 pp.

IPCC, 2014: Climate Change 2014: Synthesis Report, Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

Littell, J.S., M. McGuire Elsner, L.C. Whitely Binder, and A.K. Snover (eds). 2009a. The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate - Executive Summary. *In:* The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate. Climate Impacts Group. University of Washington. Seattle, Washington. Available at: www.cses.washington.edu/db/pdf/wacciaexecsummary638.pdf

Littell, J.S., E. Oneil, D. McKenzie, J. Hicke, J. Lutz, R. Norheim, M. Elsner. 2009b. Forest Ecosystems, Disturbances, and Climatic Change in Washington State, USA. *In:* The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate. Climate Impacts Group. University of Washington. Seattle, Washington. Available at: www.cses.washington.edu/db/pdf/wacciaexecsummary638.pdf

Marlon, J.R., P. J. Bartleinb, D. G. Gavinb, C. J. Long, R. S. Anderson, C. E. Brilese, K. J. Brown, D. Colombaroli, D. J. Hallett, M. J. Power, E. A. Scharf, and M. K. Walsh. 2012. Long-term perspective on wildfires in the western USA. Proceedings of the National Academy of Sciences of the United States of America. 2012. Vol. 109 no. 9. Edited by B. L. Turner, Arizona State University, Tempe, AZ. pp. E535-E543.

Moritz, M.A., M.A. Parisien, E. Batllori, M.A. Krawchuk, J. VanDorn, D.J. Ganz, and K. Hayhoe. 2012. Climate change and disruptions to global fire activity. Ecosphere 3(6): 1-29.

[Service] U.S. Fish and Wildlife Service. 1999. Determination of Endangered Status for *Sidalcea oregana* var. *calva* (Wenatchee Mountains Checker-Mallow). Federal Register 64:71680-71687.

[Service] U.S. Fish and Wildlife Service. 2001. Final Designation of Critical Habitat for *Sidalcea oregana* var. *calva* (Wenatchee Mountains Checker-Mallow). Federal Register 66:46536-46548.

[Service] U.S. Fish and Wildlife Service. 2004. Recovery plan for *Sidalcea oregana* var. *calva* (Wenatchee Mountains checker-mallow). U.S. Fish and Wildlife Service, Portland, Oregon. 55 pp.

[Service] U.S. Fish and Wildlife Service. 2009. Spotlight Species Action Plan for Wenatchee Mountains checker-mallow (*Sidalcea oregana* var. *calva*). Central Washington Field Office. Wenatchee, Washington. 2 pp.

[Service] U.S. Fish and Wildlife Service. 2011. 5-Year Review Summary and Evaluation for Wenatchee Mountains checker-mallow (*Sidalcea oregana* var. *calva*). U.S. Fish and Wildlife Service, Portland, Oregon. 23 pp.

Stenseth, N.C, A. Mysterud, G. Ottersen, J.W. Hurrell, K. Chan, M. Lima. 2002. Ecological Effects of Climate Fluctuations. Science 297(5585):1292-1296.

Stöckle, C.O., R. L. Nelson, S. Higgins, J. Brunner, G. Grove, R. Boydston, M.Whiting, and C. Kruger. Assessment of Climate Change Impact on Eastern Washington Agriculture. *In:* The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate. Climate Impacts Group. University of Washington. Seattle, Washington. Available at: www.cses.washington.edu/db/pdf/wacciaexecsummary638.pdf

Walther, G. R., E. Post, P. Convoy, A. Menzel, C. Parmesan, T. J. C. Beebee, J. Fromentin, O. Hoegh-Guldberg, and F. Bairlein. 2002. Ecological responses to recent climate change. Nature 416:389-395.

[WDNR] Washington Department of Natural Resources. 2000. Management Plan for Camas Meadows Natural Area Preserve. 112 pp.

Westerling, A. L., H. Hidalgo, D.R. Cayan, and T. Swetnam. 2006. Warming and Earlier Spring Increases Western US Forest Wildfire Activity. Science 313:940-943.

Zimmerman, T.G., and S.H. Reichard. 2005. Factors affecting persistence of Wenatchee Mountains Checker-Mallow: an exploratory look at a rare endemic. Northwest Science 79(2 and 3):172-178.

PERSONAL COMMUNICATIONS

Arnett, Joseph. Rare Plant Botanist. 2007-2011. Washington State Department of Natural Resources, Natural Heritage Division, Olympia, Washington.

Ballinger, Susan. 2019. Conservation Fellow, Chelan-Douglas Land Trust, Wenatchee, Washington.

Fertig, Walt. Rare Plant Botanist. 2019. Washington State Department of Natural Resources, Natural Heritage Division, Olympia, Washington.

Gibble, Wendy. 2011 and 2018. Botanist and Program Manager, University of Washington Center for Rare Plant Care and Conservation [Rare Care], Seattle, Washington.

Guerrant, Ed. 2018. Director, Portland State University Science Research and Teaching Center, Portland, Oregon.

Hedges, Neal. 2018. Stewardship Director, Chelan-Douglas Land Trust, Wenatchee, Washington.

Malmquist, Lauri. 2001, 2004, 2011, 2013 2018. Botanist, Wenatchee National Forest, Leavenworth Ranger District, Leavenworth, Washington.

Wilderman, David. 1997, 2004, 2011, and 2018. Natural Area Preserve Scientist, Washington Department of Natural Resources, Olympia, Washington.

Signature Page

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of:
Wenatchee Mountains Checker-mallow *(Sidalcea oregana* var. *calva)*

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
_X_ No change needed

Appropriate Listing/Reclassification Priority Number, if applicable:__N/A__

Review Conducted By: Tara Callaway, Central Washington Field Office, Wenatchee, Washington

FIELD OFFICE APPROVAL:

_____ Date 1/9/2020
State Supervisor, Washington Fish and Wildlife Office,
U.S. Fish and Wildlife Service