Climate Change Vulnerability Index Report

Sidalcea oregana var. *calva* (Wenatchee Mountain checkermallow)

Date: October 2019

Assessor: Walter Fertig, WA Natural Heritage Program (update from Gamon 2014)

Geographic Area: Washington Heritage Rank: G5T1/S1?

Index Result: Highly Vulnerable Confidence: Very High

Climate Change Vulnerability Index Scores

Section A	**Severity**	**Scope (% of range)**
1. Temperature Severity	>6.0° F (3.3°C) warmer	0
	5.6-6.0° F (3.2-3.3°C) warmer	0
	5.0-5.5° F (2.8-3.1°C) warmer	0
	4.5-5.0° F (2.5-2.7°C) warmer	0
	3.9-4.4° F (2.2-2.4°C) warmer	100
	<3.9° F (2.2°C) warmer	0
2. Hamon AET:PET moisture	< -0.119	0
	-0.097 to -0.119	0
	-0.074 to - 0.096	60
	-0.051 to - 0.073	40
	-0.028 to -0.050	0
	>-0.028	0
Section B		**Effect on Vulnerability**
1. Sea level rise		Neutral
2a. Distribution relative to natural barriers		Neutral
2b. Distribution relative to anthropogenic barriers		Somewhat Increase
3. Impacts from climate change mitigation		Neutral
Section C		
1. Dispersal and movements		Somewhat Increase
2ai Change in historical thermal niche		Somewhat Increase
2aii. Change in physiological thermal niche		Neutral
2bi. Changes in historical hydrological niche		Neutral
2bii. Changes in physiological hydrological niche		Increase
2c. Dependence on specific disturbance regime		Neutral
2d. Dependence on ice or snow-covered habitats		Somewhat Increase
3. Restricted to uncommon landscape/geological features		Neutral
4a. Dependence on others species to generate required habitat		Neutral
4b. Dietary versatility		Not Applicable
4c. Pollinator versatility		Somewhat Increase
4d. Dependence on other species for propagule dispersal		Neutral
4e. Sensitivity to pathogens or natural enemies		Somewhat Increase
4f. Sensitivity to competition from native or non-native species		Somewhat Increase
4g. Forms part of an interspecific interaction not covered above		Unknown
5a. Measured genetic diversity		Unknown

5b. Genetic bottlenecks	Unknown
5c. Reproductive system	Neutral
6. Phenological response to changing seasonal and precipitation dynamics	Unknown
Section D	
D1. Documented response to recent climate change	Unknown
D2. Modeled future (2050) change in population or range size	Unknown
D3. Overlap of modeled future (2050) range with current range	Unknown
D4. Occurrence of protected areas in modeled future (2050) distribution	Unknown

Section A: Exposure to Local Climate Change

A1. Temperature: All ten confirmed occurrences of *Sidalcea oregana* var. *calva* in Washington occur in areas with a projected temperature increase of 3.9-4.4˚F (Figure 1).

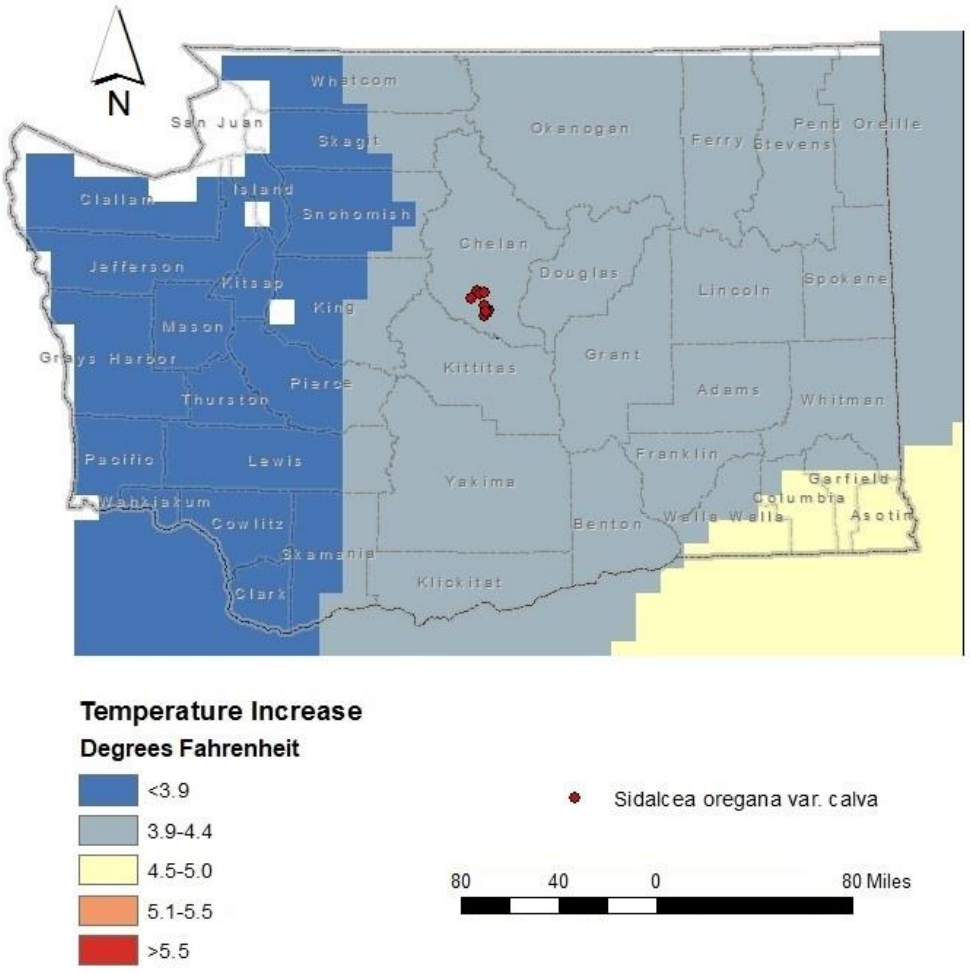

Figure 1. Exposure of *Sidalcea oregana* var. *calva* occurrences in Washington to projected local temperature change. Base map layers from www.natureserve.org/ccvi

A2. Hamon AET:PET Moisture Metric: 6 of the 10 confirmed occurrences of *Sidalcea oregana* var. *calva* in Washington (60%) are found in areas with a projected decrease in available moisture (as measured by the ratio of actual to potential evapotranspiration) in the range of - 0.074 and - 0.096 (Figure 2). The remaining 4 occurrences (40%) are from areas with a predicted decrease in available moisture between -0.051 and – 0.073.

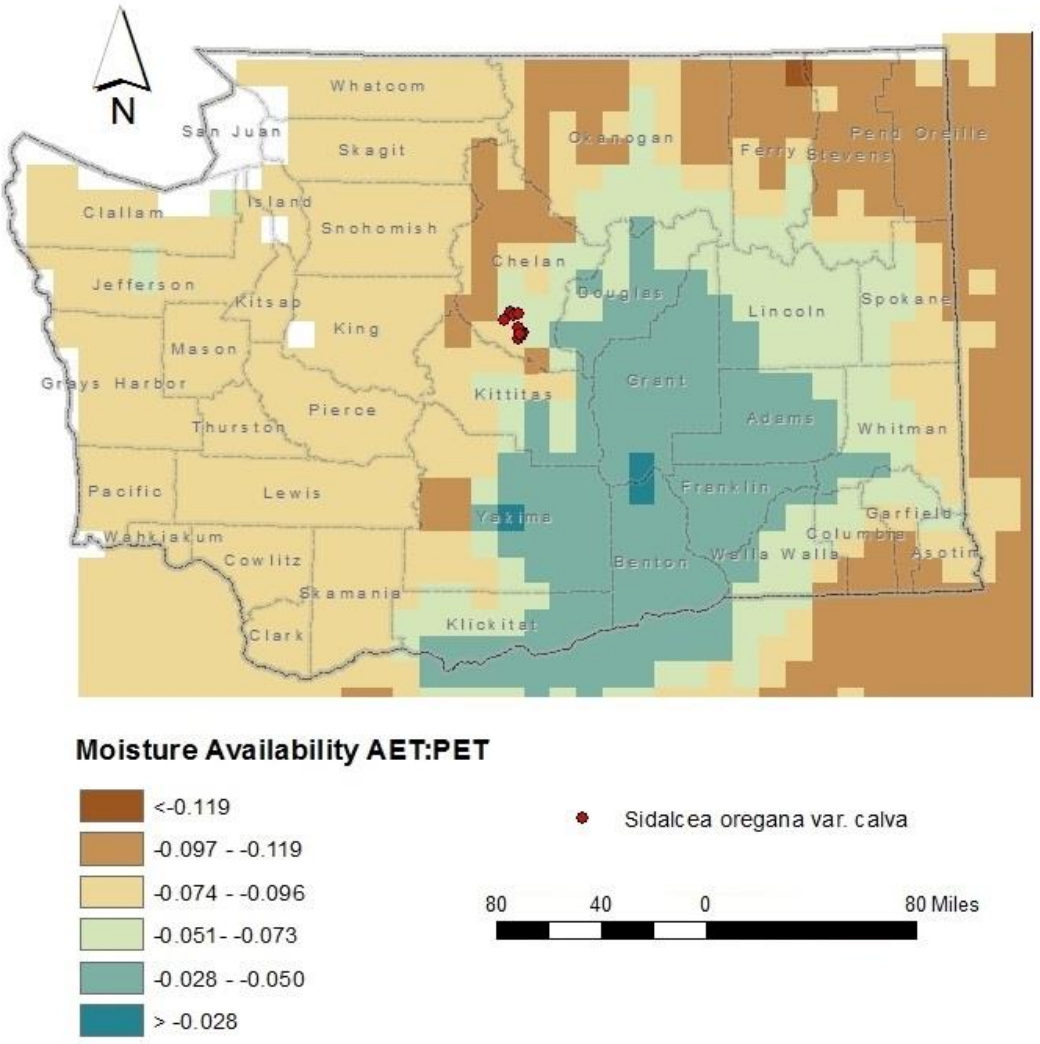

Figure 2. Exposure of *Sidalcea oregana* var. *calva* occurrences in Washington to projected moisture availability (based on ratio of actual to predicted evapotranspiration). Base map layers from www.natureserve.org/ccvi

Section B. Indirect Exposure to Climate Change

B1. Exposure to sea level rise: Neutral.
All occurrences of *Sidalcea oregana* var. *calva* are found at elevations from 335-1375m (1100-4500 ft) and would not be inundated by sea level rise.

B2a. Natural barriers: Neutral.
In Washington, *Sidalcea oregana* var. *calva* is restricted to open meadows and forest edges with poorly drained soils. These sites have a high water table or are seasonally flooded in the winter and early spring before drying out in mid summer (Arnettt 2011; Caplow 2003; USFWS 2004). These openings may have been maintained historically by fire (including anthropogenic fire by Native Americans to promote *Camassia quamash*) (USFWS 2004). The areas of suitable habitat for *S. oregana* var. *calva* are widely scattered and embedded within a matrix of unsuitable upland Douglas-fir or Ponderosa pine forest habitat, which currently limit natural dispersal. Climate change that results in increased regional drought and wildfire could reduce fragmentation or create new openings for this species to occupy.

B2b. Anthropogenic barriers: Somewhat Increase.
At least three historical occurrences of *Sidalcea oregana* var. *calva* in the Leavenworth and Peshastin areas are probably extirpated due to development of wet meadow habitat for homes or agriculture (Caplow 2003). Anthropogenic disturbances, such as roads, timber harvest, channelization of wetlands, and home construction have fragmented the range of this taxon. These impacts may be exacerbated by projected climate change.

B3. Predicted impacts of land use changes from climate change mitigation: Neutral.

Section C: Sensitive and Adaptive Capacity

C1. Dispersal and movements: Somewhat Increase.
Sidalcea oregana var. *calva* reproduces by one-seeded dry fruit wedges called mericarps (a type of schizocarp) and have no specialized structures such as wings or hooks to facilitate long distance dispersal by wind or animals. The clumped distribution pattern observed in the Camas Meadows Natural Area occurrence suggest that fruits do not disperse far from their parent plant. Limited dispersal could be possible by fruit-caching rodents or by water (Goldsmith 2003).

C2ai. Historical thermal niche: Somewhat Increase
Figure 3 depicts the distribution of known *Sidalcea oregana* var. *calva* occurrences in Washington relative to mean seasonal temperature variation for the period from 1951-2006 ("historical thermal niche"). Six of the 10 confirmed *S. oregana* var. *calva* occurrences in Washington (60%) have a 47-57˚ F (26.3-31.8˚C) average temperature variation and are considered to be somewhat increased in vulnerability for climate change (Young et al. 2016). The other four occurrences are from areas with seasonal temperature variation of >57˚ F (31.8˚C) and are considered neutral in terms of climate change. This factor is scored as "Somewhat Increase" because the majority of occurrences fall in this category.

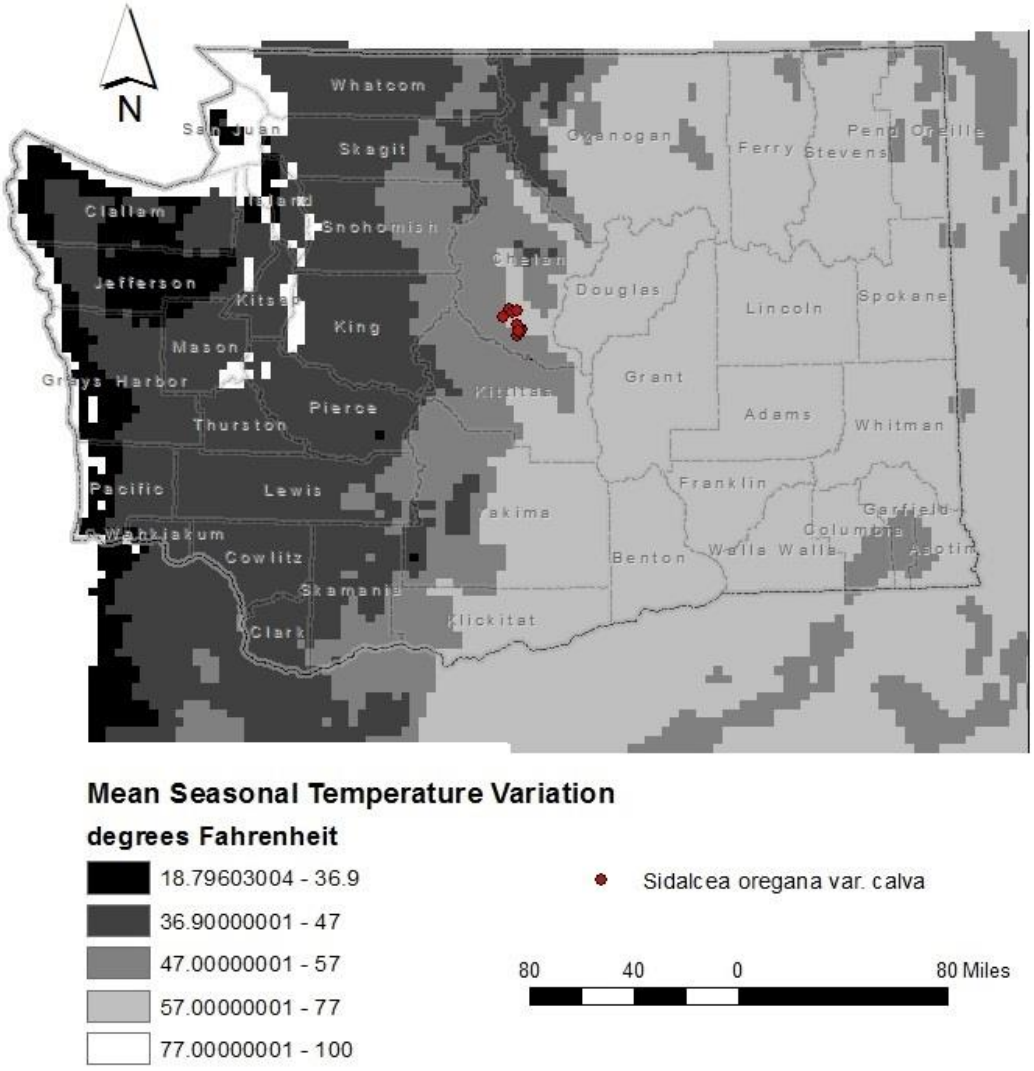

Figure 3. Historical thermal niche (exposure to past temperature variations) of *Sidalcea oregana* var. *calva* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2aii. Physiological thermal niche: Neutral.
Sidalcea oregana var. *calva* occurrences in Washington are associated with wet meadows that occur along perennial streams or ditches, often in valley bottoms that may be cold air drainages. Small populations occur in moist openings in forests - these may be short-lived due to succession. These sites may be slightly cooler microsites, though not sufficiently cold as to increase the vulnerability of this species to climate change.

C2bi. Historical hydrological niche: Neutral.
All 10 of the confirmed occurrences of *Sidalcea oregana* var. *calva* occur in areas where the mean annual precipitation variation is over 21 inches (Figure 4). These sites are scored as Neutral for climate change impacts by Young et al. (2016).

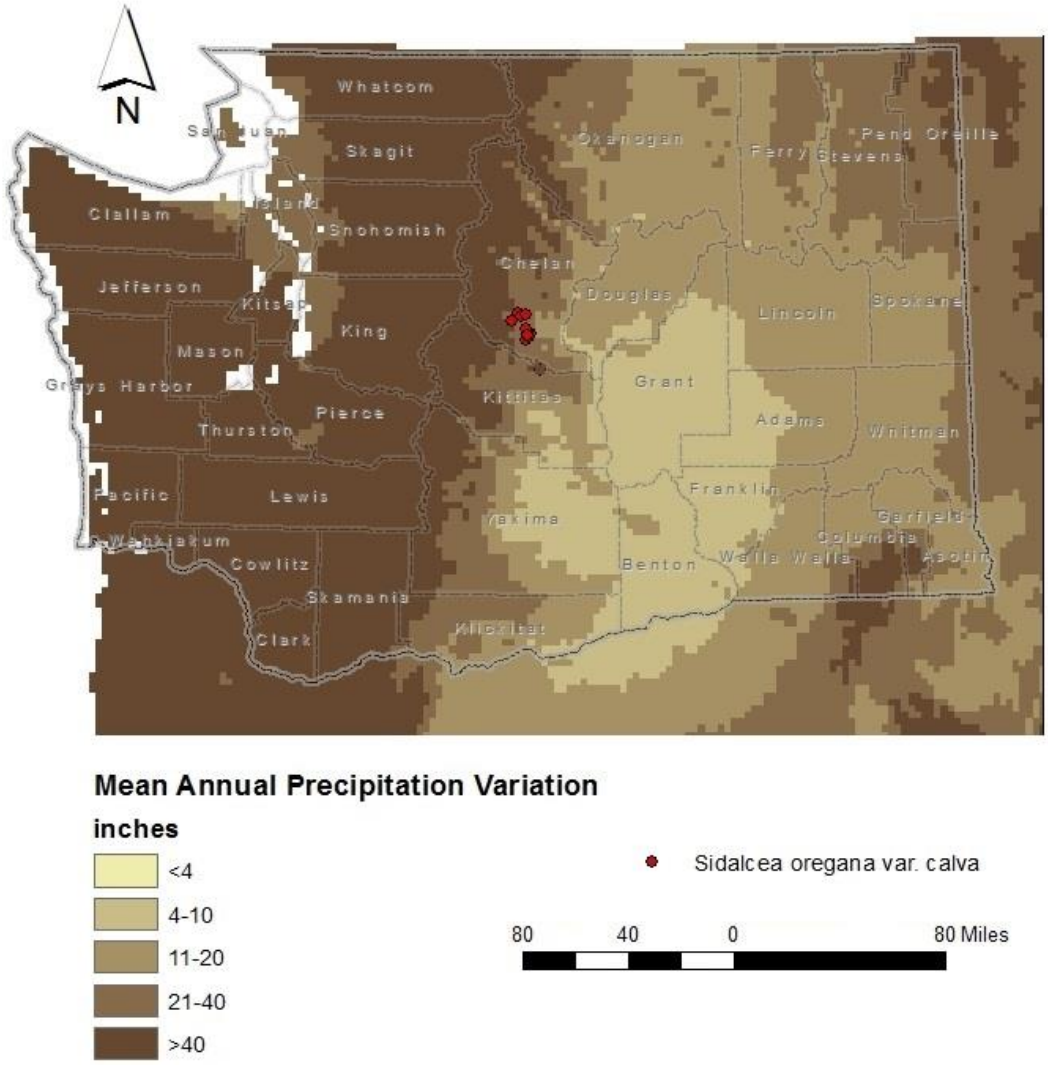

Figure 4. Historical hydrological niche (exposure to past variations in precipitation) of *Sidalcea oregana* var. *calva* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2bii. Physiological hydrological niche: Increase.
Sidalcea oregana var. *calva* has a specialized hydrological niche dependent on seasonal flooding early in the growing season followed by summer drought (Caplow 2003). Change in hydrology

is considered one of the primary threats to this taxon (USFWS 2004) and one of the main reasons it was listed under the Endangered Species Act. Reduction in the amount or seasonality of available moisture due to climate change will continue to be a significant threat in the future.

C2c. Dependence on a specific disturbance regime: Neutral.
Historically, fire helped maintain the open meadow conditions favored by *Sidalcea oregana* var. *calva* by controlling the spread of trees and shrubs. In addition, the species may be adapted to low intensity fire. In 2018, a new subpopulation of *S. oregana* var. *calva* appeared in the Poison Canyon area following burning of slash piles in a formerly forested area that had been thinned (W. Fertig, personal observation). The population at Camas Meadows has also responded with more vigorous growth following wildfire, and fire management has been used to improve habitat conditions in the preserve (Caplow 2003). Climate change will likely increase the frequency of fire in most of the range of this taxon, which may have a net positive effect.

C2d. Dependence on ice or snow-cover habitats: Somewhat Increase.
Sidalcea oregana var. *calva* occurrences in Washington are found at a sufficient elevation where winter snow contributes at least one-quarter of the annual precipitation total. Warmer temperatures associated with climate change is likely to reduce the amount of snowfall, though it may increase the amount of rain.

C3. Restricted to uncommon landscape/geological features: Neutral.
The largest *Sidalcea oregana* var. *calva* occurrence is found in a broad, flat montane valley (Arnett 2011). Other occurrences tend to be associated with openings and small perennial streams or springs. None of these sites are in areas with atypical soil, geologic, or water chemistry characteristics that would be impacted by climate change.

C4a. Dependence on other species to generate required habitat: Neutral.
The wet meadow habitats occupied by *Sidalcea oregana* var. *calva* in Washington are primarily a consequence of local geomorphology and hydrologic patterns. Beaver may have played a role historically in reducing tree and shrub cover in wet meadow habitats (Caplow 2003).

C4b. Dietary versatility: Not applicable for plants.

C4c. Pollinator versatility: Somewhat Increase.
Goldsmith (2003) observed the native ground bee *Diadasia nigrifrons* to be the primary pollinator of *Sidalcea oregana* var. *calva*. This species is a specialist on other species in the genus *Sidalcea*. As a ground-nesting species, *Diadasia* may be vulnerable to ground-disturbing activities and fire (Caplow 2003). Goldsmith noted at least seven other bee species (including *Bombus, Hoplitis*, and *Osmia*) visiting *Sidalcea* flowers collecting nectar, but not pollen. Weevils may pollinate some flowers incidentally while they are consuming fruits (Caplow 2003). Goldsmith (2003) found fruit production to be relatively low (32-36%) and observed little difference between bee pollination and hand pollination in reproductive success. If *S. oregana* var. *calva* is dependent on a single species for pollination, it would be at increased (rather than somewhat increased) vulnerability to climate change.

C4d. Dependence on other species for propagule dispersal: Neutral.
Fruit dispersal in *Sidalcea oregana* var. *calva* appears to be primarily passive and does not depend on animal species (Gamon 1987).

C4e. Sensitivity to pathogens or natural enemies: Somewhat Increase.
Some herbivory of *Sidalcea oregana* var. *calva* has been observed at Camas Meadows NAP, but is not considered detrimental (Caplow 2003). Seed predation can be significant, accounting for 26-70% loss of seeds (Caplow 2003). The most important seed predators are two species of weevils (*Macrorhoptus niger* and *Anthonomus sphaeralcea*) and aphids (Arnett and Birkhauser 2008; Goldsmith 2003, Goldsmith-Zimmerman & Reichard 2005).

C4f. Sensitivity to competition from native or non-native species: Somewhat Increase.
One of the factors contributing to listing *Sidalcea oregana* var. *calva* as Endangered is competition from other plant species (USFWS 2004). This includes encroachment of trees and shrubs into wetland habitats and impacts from invasive non-native species, such as reed canarygrass (*Phalaris arundinacea*). Climate change could have a net positive impact on the spread and vigor of reed canarygrass. Increased drought conditions could result in more wildfire, however, which could reduce competing tree cover.

C4g. Forms part of an interspecific interaction not covered above: Unknown.

C5a. Measured genetic variation: Unknown.
Data appear to be lacking on genetic diversity in *Sidalcea oregana* var. *calva*.

C5b. Genetic bottlenecks: Unknown.

C5c. Reproductive System: Neutral.
Sidalcea oregana var. *calva* is a facultative outcrosser and is pollinated by ground-nesting bees. Fruit production is lower than might be expected and seed predation is high (Goldsmith-Zimmermann and Reichard 2005). Based on current data, reproduction by seed does not appear to be a limiting factor in the life history of this species.

C6. Phenological response to changing seasonal and precipitation dynamics: Unknown.

Section D: Documented or Modeled Response to Climate Change

D1. Documented response to recent climate change: Unknown.
Trend data are mixed for *Sidalcea oregana* var. *calva*. The two largest occurrences (Camas Meadows and Mountain Home) appear to be increasing, though this could be due to more thorough monitoring efforts (Fertig 2019 and unpublished data). Several small occurrences, however, appear to be extirpated due to loss of habitat from succession (Fertig unpublished data). The impact of climate change on these population dynamics is not known.

D2. Modeled future (2050) change in population or range size: Unknown.

D3. Overlap of modeled future (2050) range with current range: Unknown.

D4. Occurrence of protected areas in modeled future (2050) distribution: Unknown.

References

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