Climate Change Vulnerability Index Report

Carex vallicola (Valley sedge)

Date: 10 September 2021

Assessor: Walter Fertig, WA Natural Heritage Program

Geographic Area: Washington Heritage Rank: G5/S2

Index Result: Highly Vulnerable Confidence: Very High

Climate Change Vulnerability Index Scores

Section A: Local Climate	**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	27.8
	-0.074 to -0.096	61.1
	-0.051 to -0.073	11.1
	-0.028 to -0.050	0
	>-0.028	0
Section B: Indirect Exposure to Climate Change		**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: Sensitivity and Adaptive Capacity		
1. Dispersal and movements		Somewhat Increase
2ai Change in historical thermal niche		Neutral
2aii. Change in physiological thermal niche		Somewhat Increase
2bi. Changes in historical hydrological niche		Somewhat Increase
2bii. Changes in physiological hydrological niche		Somewhat Increase
2c. Dependence on specific disturbance regime		Increase
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		Neutral
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		Neutral
5a. Measured genetic diversity		Unknown

5b. Genetic bottlenecks	Unknown
5c. Reproductive system	Neutral
6. Phenological response to changing seasonal and precipitation dynamics	Neutral
Section D: Documented or Modeled Response	
D1. Documented response to recent climate change	Neutral
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 18 of the known occurrences of *Carex vallicola* in Washington (100%) occur in areas with a projected temperature increase of 3.9-4.4˚ F (Figure 1).

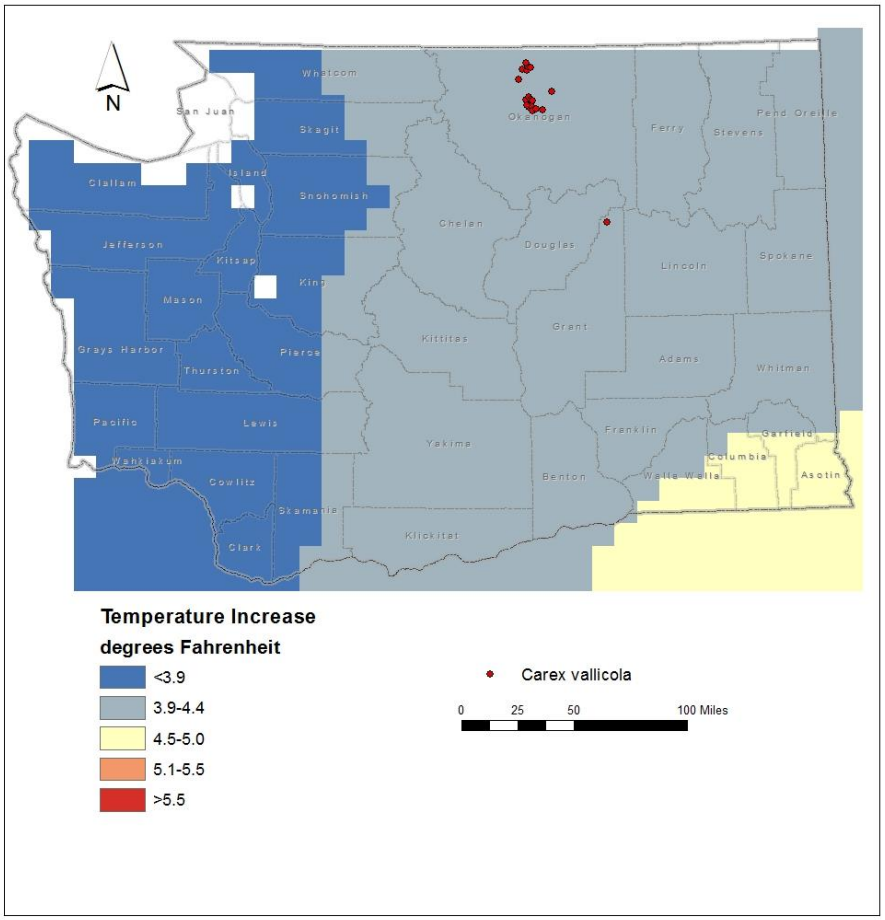

Figure 1. Exposure of *Carex vallicola* occurrences in Washington to projected local temperature change. Base map layers from www.natureserve.org/ccvi

A2. Hamon AET:PET Moisture Metric: Eleven of the 18 occurrences (61.1%) of *Carex vallicola* in Washington 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 to -0.096 (Figure 2). Another five populations are from areas with a projected decrease of -0.097 to -0.119 (27.8%). Two other occurrences have a projected decrease of -0.051 to -0.073 (11.1%) (Figure 2).

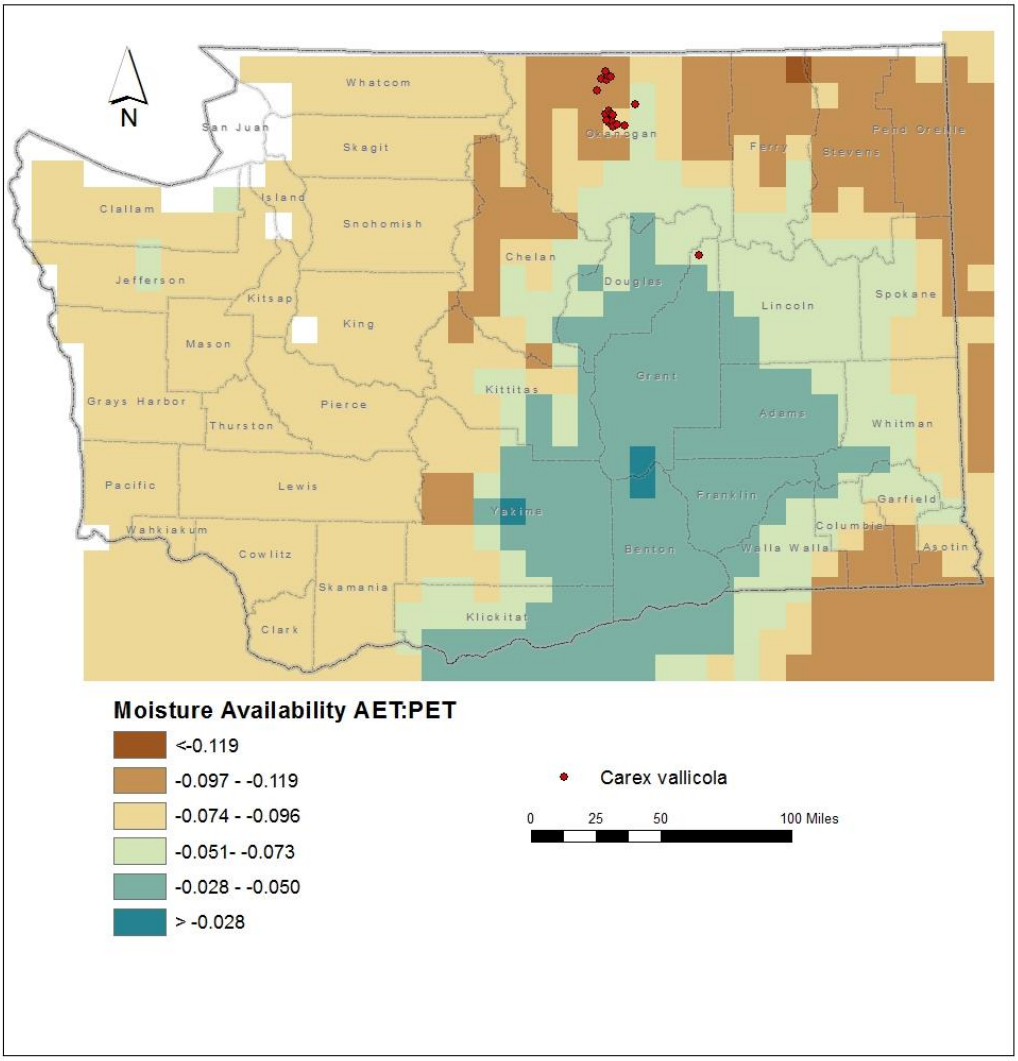

Figure 2. Exposure of *Carex vallicola* occurrences in Washington to projected moisture availability (based on ratio of actual to predicted evapotranspiration). Base map layers from www.natureserve.org/ccvi

Section B. Indirect Exposure to Climate Change

B1. Exposure to sea level rise: Neutral.
Washington occurrences of *Carex vallicola* are found at 2000-6800 feet (610-2075 m) and would not be inundated by projected sea level rise.

B2a. Natural barriers: Neutral.
Carex vallicola occurs primarily in dry thickets, open forests of Douglas-fir (*Pseudotsuga menziesii*) and ponderosa pine (*Pinus ponderosa*), or sagebrush meadows. Although it often occurs in moist microsites, it is an upland, rather than a wetland sedge species (Camp and Gamon 2011; Washington Natural Heritage Program 2021; Wilson et al. 2008). This habitat is part of the Inter-Mountain Basin Sagebrush Steppe and Northern Rocky Mountain Subalpine-Upper Montane Grassland ecological systems (Rocchio and Crawford 2015). Most populations in Washington occur within 0.8-8 miles (1.3-14 km) of each other in the Okanogan Plateau, but one disjunct occurrence from Grant County is 57.5 miles (92 km) away. Populations are separated by ridges or valleys that offer small barriers to dispersal. The one disjunct site is isolated by extensive areas of unsuitable habitat.

B2b. Anthropogenic barriers: Somewhat Increase.
The low elevation sagebrush meadow and open conifer forest habitat of *Carex vallicola* in northern Washington is intersected by roads, farmland, logged areas, and other examples of human infrastructure that create a barrier to dispersal.

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

Section C: Sensitive and Adaptive Capacity

C1. Dispersal and movements: Somewhat Increase.
Carex vallicola produces 1-seeded dry fruits contained within winged sac-like perigynia. These are passively dispersed by gravity, water, or high winds, mostly within a short distance of the parent plant (< 1000 m). Under rare circumstances, the perigynia are capable of longer-distance dispersal.

C2ai. Historical thermal niche: Neutral.
Figure 3 depicts the distribution of *Carex vallicola* in Washington relative to mean seasonal temperature variation for the period from 1951-2006 ("historical thermal niche"). Thirteen of the 18 known occurrences in the state (72.2%) are found in areas that have experienced average (57.1-77˚F/31.8-43.0˚C) temperature variations during the past 50 years and are considered at neutral vulnerability to climate change (Young et al. 2016). The 5 other populations (27.8%) have experienced slightly lower than average (47.1-57˚F/26.3-31.8˚C) variation in temperature over the same period and are at somewhat increased vulnerability to climate change.

C2aii. Physiological thermal niche: Somewhat Increase.
The dry meadow, conifer forest, and sagebrush habitats of *Carex vallicola* are often in valleys that would have colder air drainage than surrounding slopes or exposed areas.

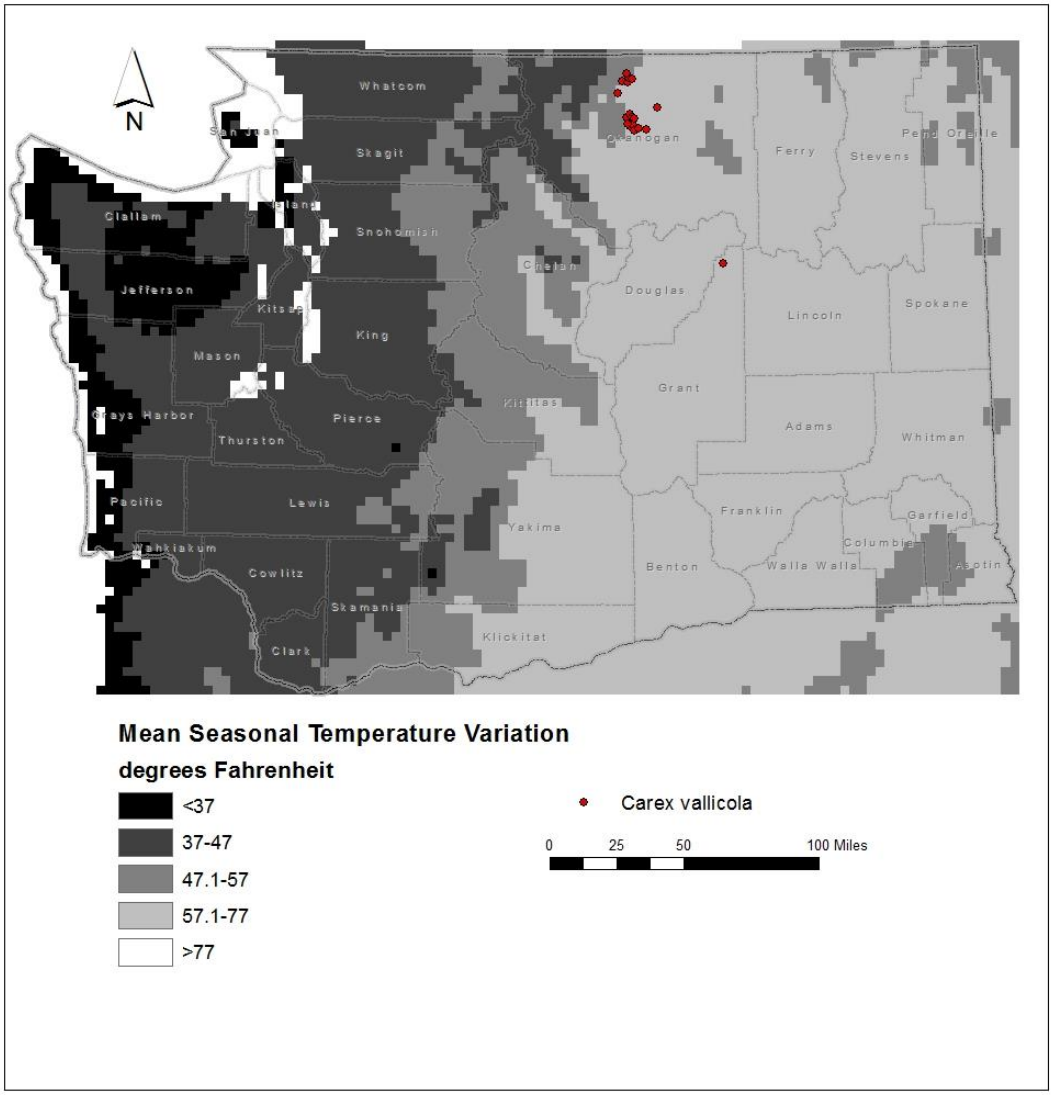

Figure 3. Historical thermal niche (exposure to past temperature variations) of *Carex vallicola* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2bi. Historical hydrological niche: Somewhat Increase.

Ten of the 18 populations of *Carex vallicola* in Washington (55.6%) are found in areas that have experienced slightly lower than average precipitation variation in the past 50 years (11-20 inches/255-508 mm) (Figure 4). According to Young et al. (2016), these occurrences are at somewhat increased vulnerability to climate change. Eight other occurrences (44.4%) are from areas with average precipitation variation (21-40 inches/508-1016 mm) in the same period and are at neutral risk from climate change.

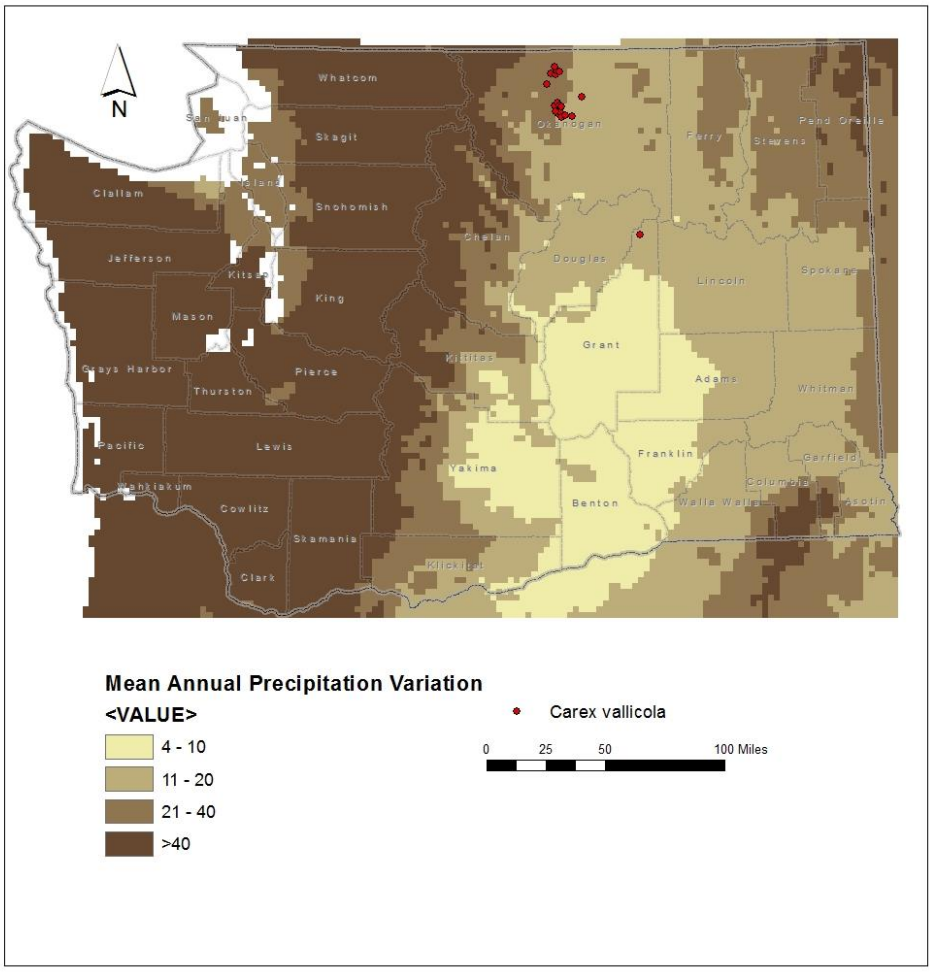

Figure 4. Historical hydrological niche (exposure to past variations in precipitation) of *Carex vallicola* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2bii. Physiological hydrological niche: Somewhat Increase.
The dry meadow, lower montane conifer forest, and sagebrush grassland habitats of *Carex vallicola* are usually not associated with perennial water sources or a high water table and so are sensitive to reductions in snowpack or precipitation. Higher temperatures and drought make these habitats more vulnerable to wildfire (Rocchio and Ramm-Granberg 2017).

C2c. Dependence on a specific disturbance regime: Increase.
The dry meadow habitats of *Carex vallicola* may be maintained by periodic low-intensity fire. Under climate change, this community and other sagebrush and lower montane conifer woodland habitats used by this species are likely to experience more frequent or higher intensity wildfires that could result in shifts in species composition towards herbaceous or weedy annual species (Rocchio and Crawford 2015, Rocchio and Ramm-Granberg 2017). Fire suppression, by

contrast, could increase the density of woody vegetation, making these sites more vulnerable to catastrophic wildfire.

C2d. Dependence on ice or snow-cover habitats: Somewhat Increase.
The populations of *Carex vallicola* in Washington are found mostly in lower montane meadows, sagebrush steppe, and conifer forests with moderate snowfall. Changes in the amount of snow or in the timing of melt due to climate change are likely to make these habitats drier and more susceptible to fire or displacement by non-native species (Rocchio and Ramm-Granberg 2017).

C3. Restricted to uncommon landscape/geological features: Neutral.
In the Okanogan region, *Carex vallicola* is found primarily on outcrops of heterogeneous metamorphic and igneous rocks of the Tiffany and Conconully complexes or felsic intrusives of the Cathedral Batholith. These formations are relatively widespread in western Okanogan County. The disjunct Grant County occurrence is on the widespread Grande Ronde Basalt (Washington Division of Geology and Earth Resources 2016).

C4a. Dependence on other species to generate required habitat: Neutral.
The dry meadow, sagebrush, and open conifer woodland habitats occupied by *Carex vallicola* are partly maintained by grazing (Rocchio and Crawford 2015), but are mostly the product of natural abiotic conditions or disturbance history.

C4b. Dietary versatility: Not applicable for plants

C4c. Pollinator versatility: Neutral.
Carex species are entirely wind pollinated.

C4d. Dependence on other species for propagule dispersal: Neutral.
Dispersal of fruits is predominantly passive by gravity or high winds. Secondary dispersal over short distances may occur by insects or rodents.

C4e. Sensitivity to pathogens or natural enemies: Somewhat Increase.
Carex vallicola is palatable to livestock and native grazers and decreases when heavily utilized (Wilson et al. 2008).

C4f. Sensitivity to competition from native or non-native species: Somewhat Increase.
Habitats occupied by *Carex vallicola* are already vulnerable to invasion by non-native species following disturbance. These areas are likely to be even more vulnerable to competition from weedy species if fire frequency or intensity increases with climate change (Rocchio and Ramm-Granberg 2017). Loss of sagebrush or conifer cover following wildfire, or drought-induced mortality in meadows, could lead to increased competition with other plant species better adapted to drier conditions.

C4g. Forms part of an interspecific interaction not covered above: Neutral.
Does not require an interspecific interaction.

C5a. Measured genetic variation: Unknown.
Genetic data are not available from Washington populations.

C5b. Genetic bottlenecks: Unknown.
Not known.

C5c. Reproductive System: Neutral.
Carex vallicola is a wind-pollinated, obligate out-crosser to be an obligate outcrosser. Washington populations are near the northern edge of the species' range and are somewhat disjunct from occurrences in northern British Columbia, eastern Oregon and southern Idaho, and so might be expected to have lower genetic diversity due to founder effects or inbreeding.

C6. Phenological response to changing seasonal and precipitation dynamics: Neutral.
Based on herbarium records in the Consortium of Pacific Northwest Herbaria website (pnwherbaria.org), *Carex vallicola* has not changed its typical blooming time.

Section D: Documented or Modeled Response to Climate Change

D1. Documented response to recent climate change: Neutral.
No major changes have been detected in the distribution of *Carex vallicola* in Washington since it was first discovered in the state in the 1930s.

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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