Climate Change Vulnerability Index Report

Astragalus columbianus (Columbia milkvetch)

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Assessor: Walter Fertig, WA Natural Heritage Program

Geographic Area: Washington Heritage Rank: G2G3/S2S3

Index Result: Moderately 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	0
	-0.051 to - 0.073	0
	-0.028 to -0.050	100
	>-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		Neutral
2aii. Change in physiological thermal niche		Neutral
2bi. Changes in historical hydrological niche		Increase
2bii. Changes in physiological hydrological niche		Somewhat Increase
2c. Dependence on specific disturbance regime		Somewhat Increase
2d. Dependence on ice or snow-covered habitats		Neutral
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		Unknown
4d. Dependence on other species for propagule dispersal		Neutral
4e. Sensitivity to pathogens or natural enemies		Neutral
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	
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 20 occurrences of *Astragalus columbianus* in Washington (100%) occur in an area with a projected temperature increase of 3.9-4.4˚ F (Figure 1).

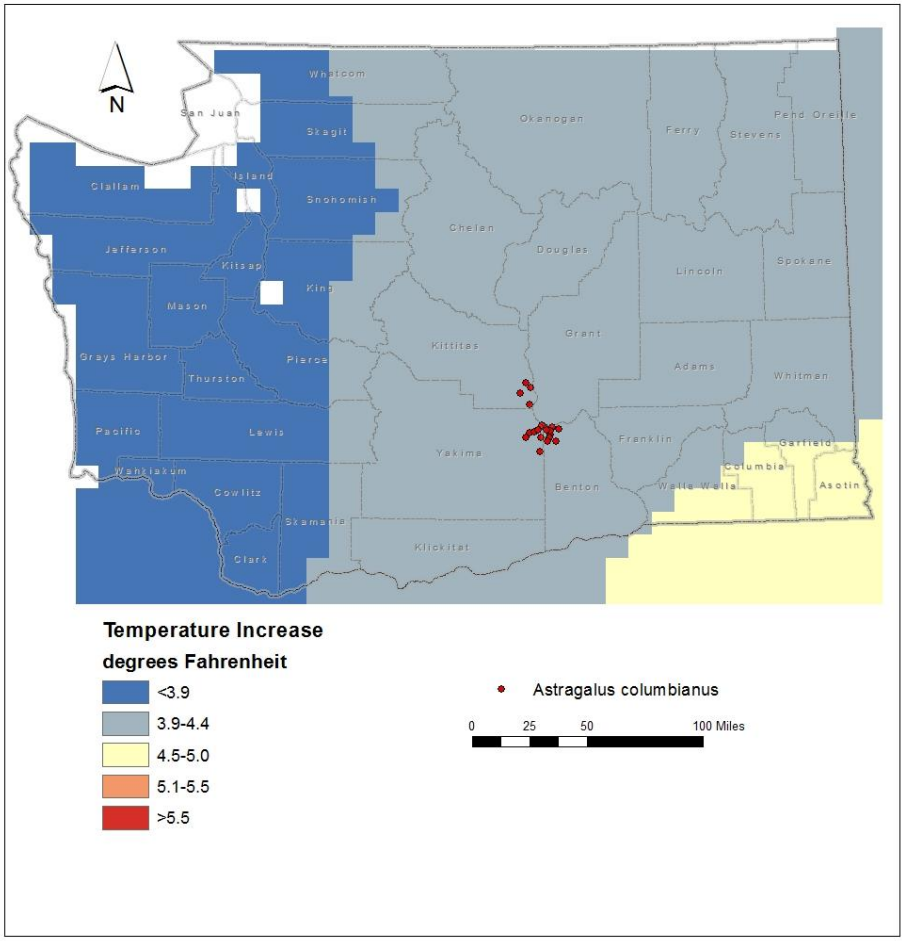

Figure 1. Exposure of *Astragalus columbianus* occurrences in Washington to projected local temperature change. Base map layers from www.natureserve.org/ccvi

A2. Hamon AET:PET Moisture Metric: All 20 of the occurrences of *Astragalus columbianus* (100%) 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 -0.028 to -0.050 (Figure 2).

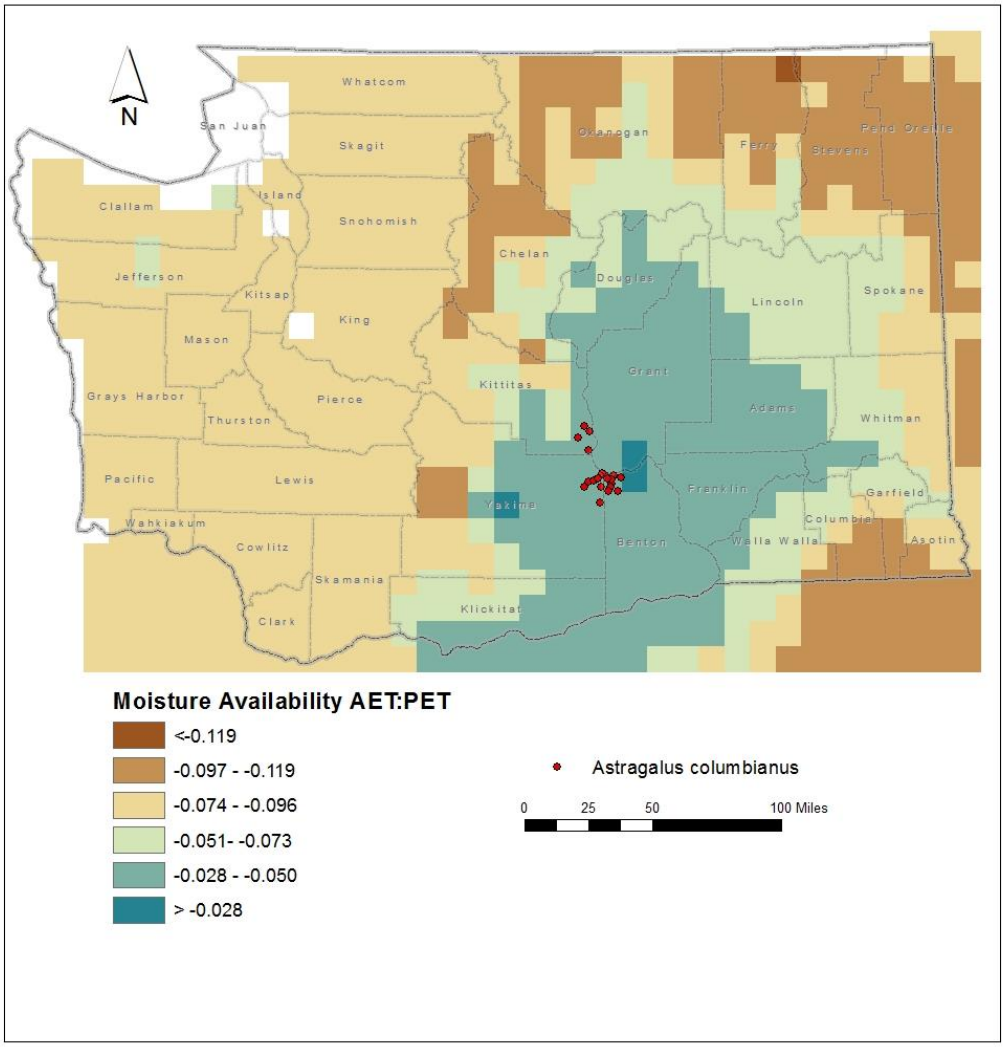

Figure 2. Exposure of *Astragalus columbianus* occurrences in Washington to projected moisture availability (based on ratio of actual to predicted evapotranspiration). Base map layers from www.natureserve.org/ccvi

Section B. Indirect Exposure to Climate Change

B1. Exposure to sea level rise: Neutral.
The Washington occurrences of *Astragalus columbianus* are found at 420-2320 feet (130-700 m) and would not be inundated by projected sea level rise.

B2a. Natural barriers: Neutral.
In Washington, *Astragalus columbianus* is found in sagebrush steppe communities dominated by *Artemisia tridentata, Artemisia rigida*, *Poa secunda*, and *Pseudoroegneria spicata* on ridgecrests, slopes, riverbanks, and roadcuts with sandy, gravelly, or lithic loams (Camp and Gamon 2011, WNHP records). This habitat is a component of the Inter-Mountain Basins Big Sagebrush Steppe ecological system (Rocchio and Crawford 2015). The entire range of the species is limited to an area of 15 x 30 miles (25 x 50 km) with individual populations separated by less than 5 miles (8 km) (WNHP records). Historically, this habitat was probably more continuous prior to European settlement and there were relatively few barriers to dispersal

B2b. Anthropogenic barriers: Somewhat Increase.
The range of *Astragalus columbianus* in Washington is bisected by roads, agricultural fields, and industrial development and the formerly continuously distributed sagebrush steppe vegetation is now sufficiently fragmented to provide 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.
The fruits of *Astragalus columbianus* are dry legumes that dehisce at maturity along two sutures to release seeds passively by gravity. Individual seeds lack wings, barbs, hooks or other adornments to enhance their dispersal by wind or animals. Dispersal distances are probably relatively short (no more than 100 m).

C2ai. Historical thermal niche: Neutral.
Figure 3 depicts the distribution of *Astragalus columbianus* in Washington relative to mean seasonal temperature variation for the period from 1951-2006 ("historical thermal niche"). All 20 occurrences (100%) are found in areas that have experienced average (57.1-77˚F/31.8-43.0˚C) temperature variation during the past 50 years and are considered at neutral vulnerability to climate change (Young et al. 2016).

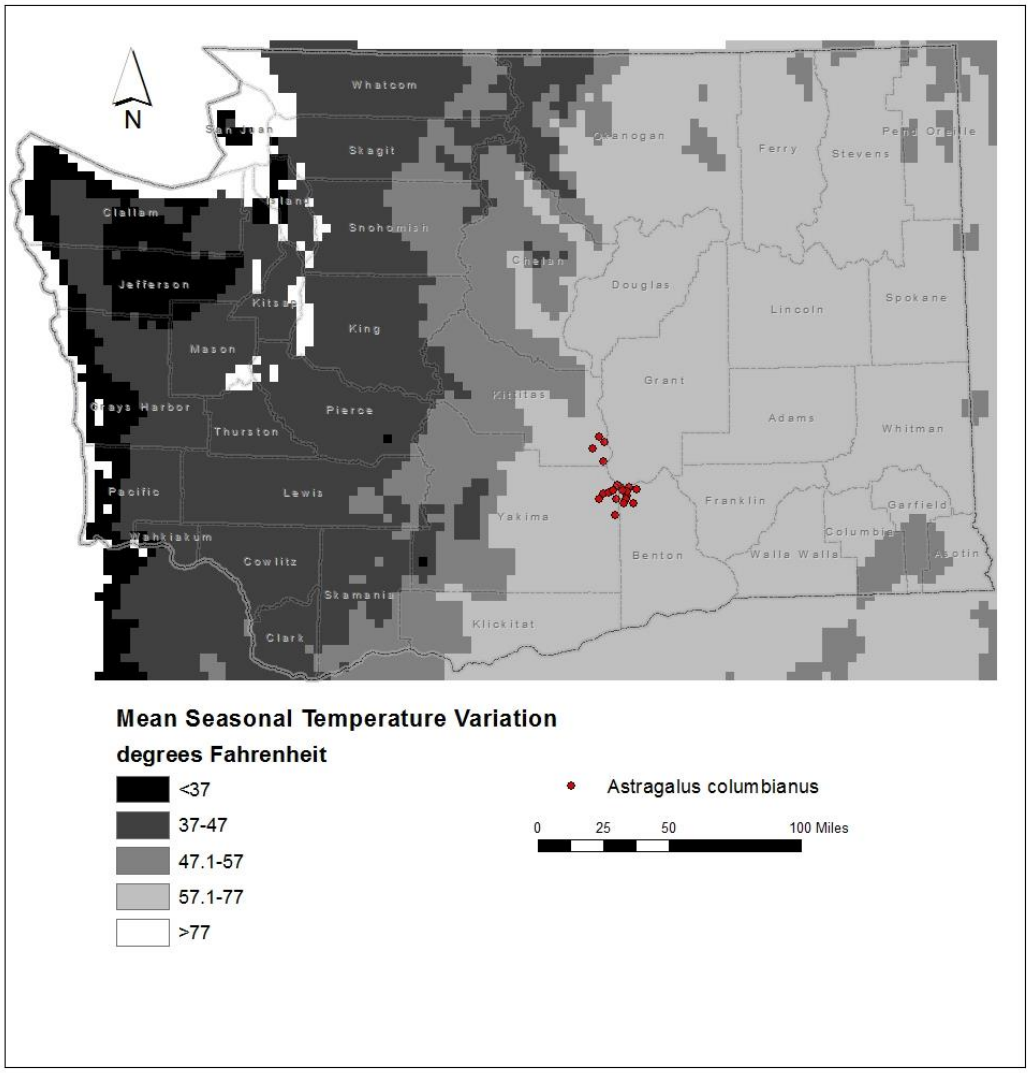

Figure 3. Historical thermal niche (exposure to past temperature variations) of *Astragalus columbianus* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2aii. Physiological thermal niche: Neutral.
The Inter-Mountain Basins Big Sagebrush Steppe habitat of *Astragalus columbianus* is not associated with cold air drainage during the growing season and would have neutral vulnerability to climate change.

C2bi. Historical hydrological niche: Increase.
Seventeen of the 20 occurrences of *Astragalus columbianus* in Washington (85%) are found in areas that have experienced small (4-10 inches/100-254 mm) precipitation variation in the past 50 years (Figure 4). According to Young et al. (2016), these occurrences are at increased vulnerability to climate change. The remaining three occurrences (15%) are from areas with a slightly lower than average (11-20 inches/255-508 mm) precipitation variation in the same period and are at somewhat increased vulnerability to climate change.

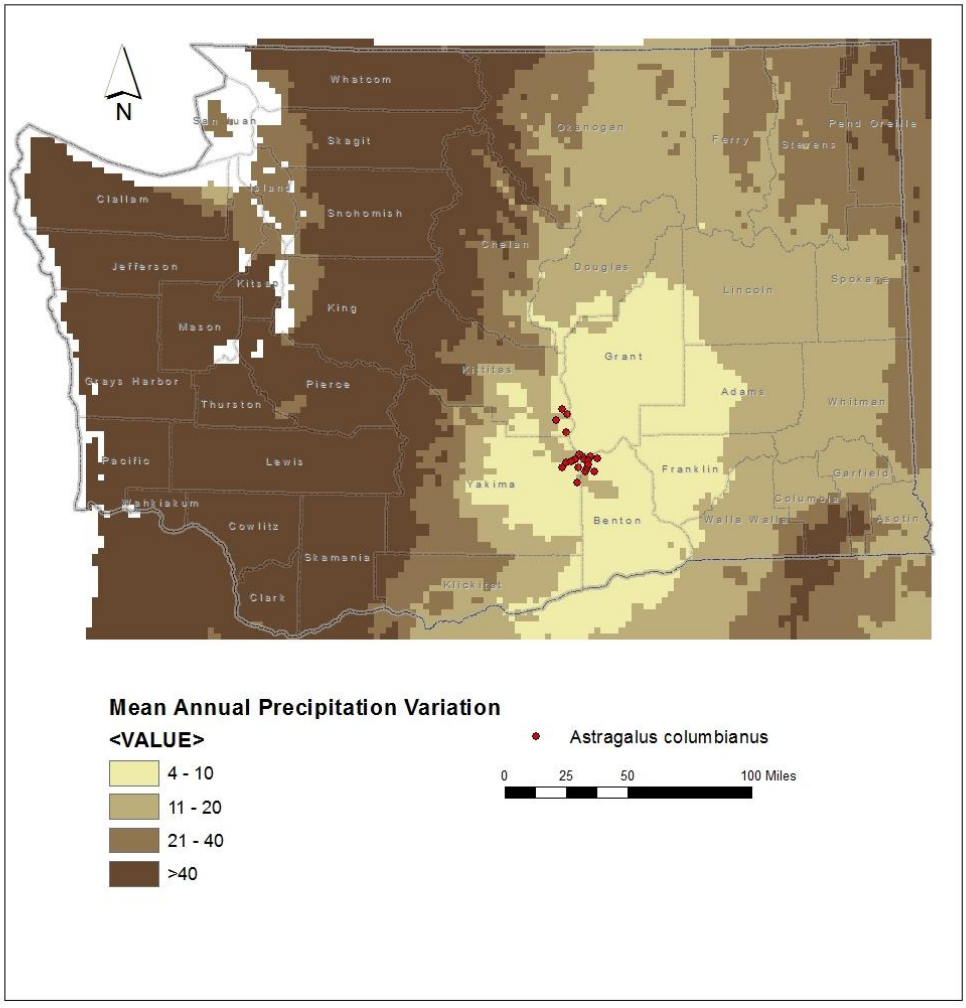

Figure 4. Historical hydrological niche (exposure to past variations in precipitation) of *Astragalus columbianus* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2bii. Physiological hydrological niche: Somewhat Increase.
This species is primarily dependent on adequate precipitation for its moisture requirements, because its habitat is typically not associated with springs, streams, or a high water table. The Inter-Mountain Basins Big Sagebrush Steppe ecological system is vulnerable to changes in the timing or amount of precipitation that coupled with increases in temperature would result in more frequent and severe drought and an increase in fire frequency (Rocchio and Ramm-Granberg 2017).

C2c. Dependence on a specific disturbance regime: Somewhat Increase.
Astragalus columbianus is dependent on periodic, low-intensity wildfires to reduce encroachment from less fire-adapted shrub species and to maintain open grassland habitat. Long-term monitoring suggests that populations may be ephemeral and the species depends on freshly disturbed sites for population expansion (Camp and Gamon 2011). Increased drought and reduced summer precipitation, however, could make wildfires too frequent and result in replacement of native perennial bunchgrass with annual introduced grasses, such as cheatgrass (Rocchio and Ramm-Granberg 2017).

C2d. Dependence on ice or snow-cover habitats: Neutral.
Snowpack is relatively low over the range of *Astragalus columbianus* in the Columbia Plateau of eastern Washington area and a minor component of its annual water budget.

C3. Restricted to uncommon landscape/geological features: Neutral.
Astragalus columbianus is found primarily on the Grande Ronde Basalt, which is a widespread Miocene-age deposit in central and eastern Washington.

C4a. Dependence on other species to generate required habitat: Neutral
Browsing by ungulates, rodents, and insects could help maintain open areas within big sagebrush steppe vegetation occupied by *Astragalus columbianus,* although drought and periodic low-intensity fire are probably more significant.

C4b. Dietary versatility: Not applicable for plants

C4c. Pollinator versatility: Unknown.
The specific pollinators of *Astragalus columbianus* are not known, but other *Astragalus* species are usually pollinated by bees or other insects.

C4d. Dependence on other species for propagule dispersal: Neutral.
The fruits of *Astragalus columbianus* dehisce when dry to release seeds passively. These seeds lack wings, barbs, or hooks for dispersal by wind or animals. Dispersal distances are probably relatively short.

C4e. Sensitivity to pathogens or natural enemies: Neutral.
Impacts from pathogens are not known. Herbivory has not been identified as a significant threat (Camp and Gamon 2011).

C4f. Sensitivity to competition from native or non-native species: Somewhat Increase.
Astragalus columbianus occurs in grassland slopes that burn infrequently. Under projected future climate change, these areas will be more prone to drought and increased frequency of wildfires, which in turn could lead to increased competition with non-native annual weeds (Rocchio and Ramm-Granberg 2017).

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

C5a. Measured genetic variation: Unknown.
No genetic data are available for *Astragalus columbianus* in Washington.

C5b. Genetic bottlenecks: Unknown.

C5c. Reproductive System: Neutral
Astragalus columbianus is an outcrosser, rather than self-pollinated. Presumably, genetic variation is average, compared to other species, but no studies have been done for confirmation.

C6. Phenological response to changing seasonal and precipitation dynamics: Neutral.
Based on herbarium records from the Consortium of Pacific Northwest herbaria website, no significant changes in the phenology of *Astragalus columbianus* populations in Washington have been detected over the past 40 years since the species was rediscovered (Sauer et al. 1979).

Section D: Documented or Modeled Response to Climate Change

D1. Documented response to recent climate change: Neutral.
This species had been thought to be extirpated, until it was rediscovered in the late 1970s. Its known range has increased in recent years due to more thorough survey effort. Long-term population trends are poorly known, as some of its former habitat was probably lost to development of fruit orchards (Camp and Gamon 2011).

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

Camp, P. and J.G. Gamon, eds. 2011. Field Guide to the Rare Plants of Washington. University of Washington Press, Seattle. 392 pp.

Rocchio, F.J. and R.C. Crawford. 2015. Ecological systems of Washington State. A guide to identification. Natural Heritage Report 2015-04. Washington Natural Heritage Program, WA Department of Natural Resources, Olympia, WA. 384 pp.

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Sauer, R.H., J.D. Mastrogiuseppe, and R.H. Smookler. 1979. *Astragalus columbianus* (Leguminosae) – rediscovery of an "extinct" species. Brittonia 31(2): 261-264.

Young, B.E., E. Byers, G. Hammerson, A. Frances, L. Oliver, and A. Treher. 2016. Guidelines for using the NatureServe Climate Change Vulnerability Index. Release 3.02. NatureServe, Arlington, VA. 48 pp. + app.