Climate Change Vulnerability Index Report

Astragalus microcystis (Least bladdery milkvetch)

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Assessor: Walter Fertig, WA Natural Heritage Program

Geographic Area: Washington Heritage Rank: G5/S2

Index Result: Moderately Vulnerable Confidence: Moderate

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	88.9
	<3.9° F (2.2°C) warmer	11.1
2. Hamon AET:PET moisture	< -0.119	0
	-0.097 to -0.119	74.1
	-0.074 to -0.096	14.8
	-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		Somewhat Increase
2b. Distribution relative to anthropogenic barriers		Neutral
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/Somewhat Increase
2aii. Change in physiological thermal niche		Somewhat Increase/Increase
2bi. Changes in historical hydrological niche		Neutral
2bii. Changes in physiological hydrological niche		Somewhat Increase/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/Somewhat Increase
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: 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: Twenty-four occurrences of *Astragalus microcystis* in northeastern Washington (88.9%) are found in areas with a projected temperature increase of 3.9-4.4˚ F

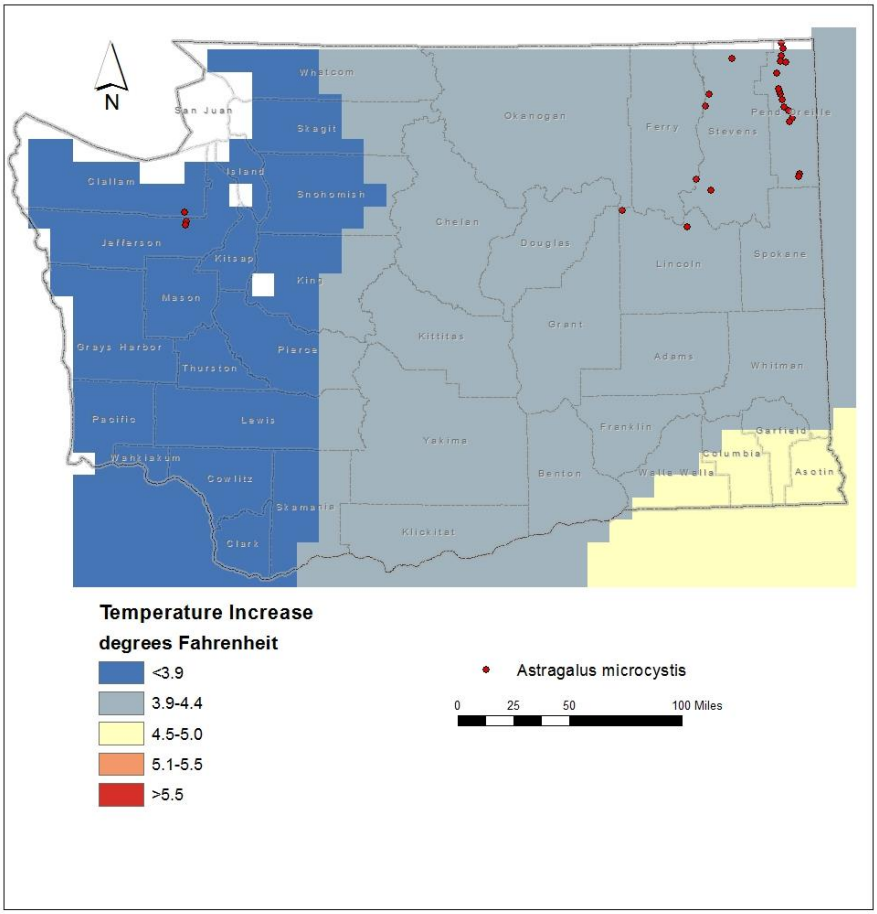

Figure 1. Exposure of *Astragalus microcystis* occurrences in Washington to projected local temperature change. Base map layers from www.natureserve.org/ccvi

(Figure 1). Three other occurrences from the Olympic Mountains (10.1%) are from areas with a projected temperature increase of < 3.9 ° F.

A2. Hamon AET:PET Moisture Metric: Twenty of the 27 occurrences (74.1%) of *Astragalus microcystis* 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 -0.097 to -0.119 (Figure 2). Four populations (14.8%), including all those from the Olympic Range, are from

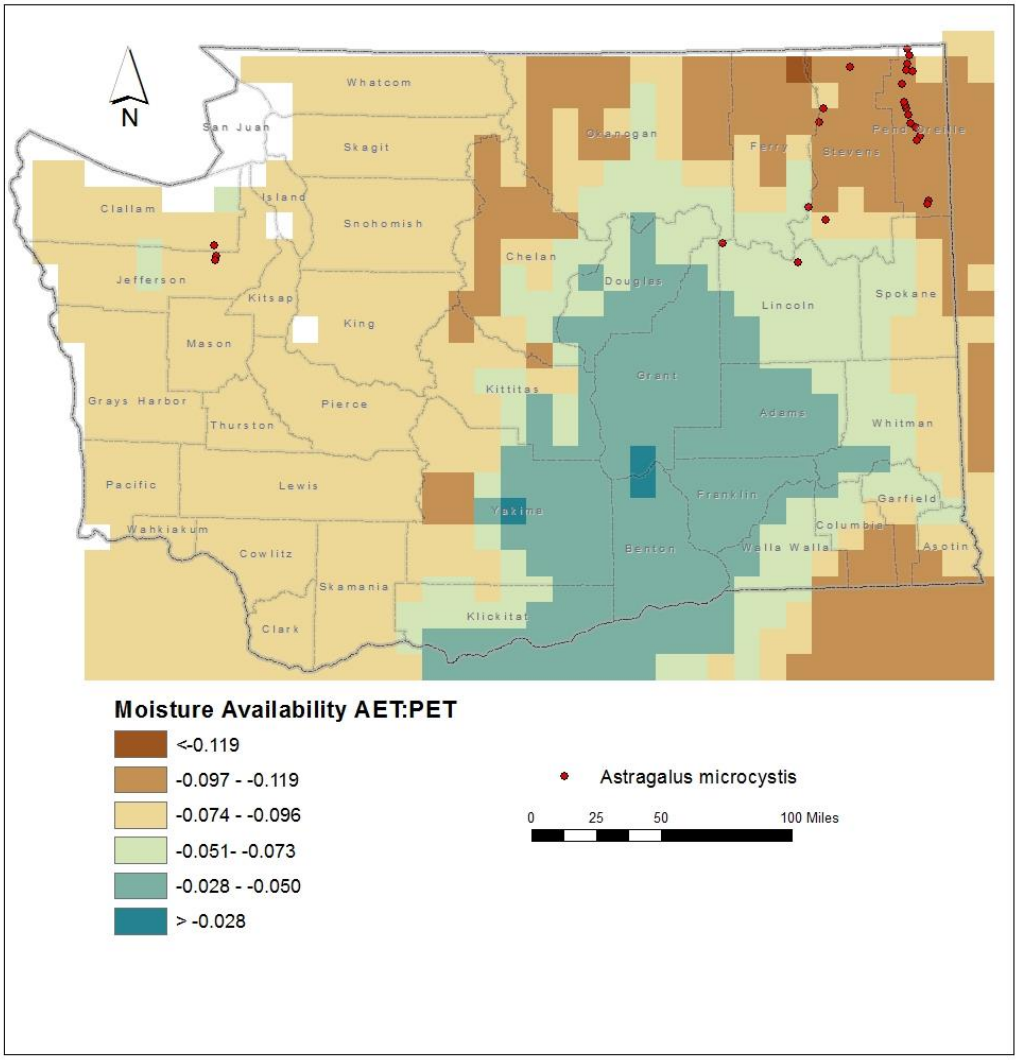

Figure 2. Exposure of *Astragalus microcystis* occurrences in Washington to projected moisture availability (based on ratio of actual to predicted evapotranspiration). Base map layers from www.natureserve.org/ccvi

areas with a projected decrease of -0.074 to -0.096 (14.8%). Three occurrences (11.1%) from the Columbia Plateau are from areas with a projected decrease of -0.051 to -0.073 (Figure 2).

Section B. Indirect Exposure to Climate Change

B1. Exposure to sea level rise: Neutral.
Washington occurrences of *Astragalus microcystis* are found at 1900-6300 feet (580-2000 m) and would not be inundated by projected sea level rise.

B2a. Natural barriers: Somewhat Increase.
Populations of *Astragalus microcystis* in northeastern Washington occur primarily on steep to flat gravelly or sandy riverbanks, islands, roadcuts, or terrace openings (Camp and Gamon 2011). Most of these occurrences are associated with the Columbia or Pend Oreille rivers. These sites are part of the Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland ecological system (Rocchio and Crawford 2015). Disjunct populations from the Olympic Range are found in sparsely vegetated alpine or upper subalpine cushion plant communities on dry, gravelly soils (Camp and Gamon 2011). These populations are part of the North Pacific Dry and Mesic Alpine Dwarf-Shrubland, Fell-Field and Meadow ecological system (Rocchio and Crawford 2015). Individual populations are separated by 1-29 miles (2.6-47 km) in northeastern Washington and 1.6-4.4 miles (3-6.8 km) in the Olympic Range. Natural barriers are relatively unimportant along river corridors in northeastern Washington or along ridgelines in the Olympic Mountains, but are more significant between watersheds or across mountain valleys. The populations in the Olympics are separated by 194 miles (310 km) of unsuitable habitat from those along the Columbia River and tributaries in eastern Washington.

B2b. Anthropogenic barriers: Neutral.
The alpine habitat of *Astragalus microcystis* in the Olympic Range is relatively unimpacted by human activities, other than summer recreation. Populations in northeastern Washington are found in naturally disturbed sites along rivers and occasionally in human-impacted sites (roadsides and a quarry) that have conditions comparable to its native habitat.

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

Section C: Sensitive and Adaptive Capacity

C1. Dispersal and movements: Somewhat Increase.
Astragalus microcystis produces 6-8 seeds per fruit. The fruits are papery and inflated at maturity, which may aid in dispersal. Barneby (1964) postulated that populations along the Pend Oreille and other tributaries of the Columbia River may have been transported by water from the core range of the species along the Continental Divide. Disjunct occurrences in the Olympic Mountains are likely due to chance, long distance dispersal events. Average dispersal distances are probably between 100-1,000 meters.

C2ai. Historical thermal niche: Neutral/Somewhat Increase.
Figure 3 depicts the distribution of *Astragalus microcystis* in Washington relative to mean seasonal temperature variation for the period from 1951-2006 (“historical thermal niche”). All

24 occurrences from northeastern Washington (88.9% of the state total) are found in areas that have experienced average temperature variation (57.1-77˚F/31.8-43.0˚C) during the past 50 years and are considered at neutral vulnerability to climate change (Young et al. 2016). Two occurrences from the Olympic Range are from areas with very small temperature variation (<37 ˚F/20.8˚C) during the same period and are at greatly increased vulnerability. One other population from the Olympic Range has experienced small temperature variation (37-47˚F/20.8-26.3˚C) and is at increased vulnerability to climate change. This variable is scored as Neutral/Somewhat Increase to capture the variation in vulnerability across the species' range in Washington.

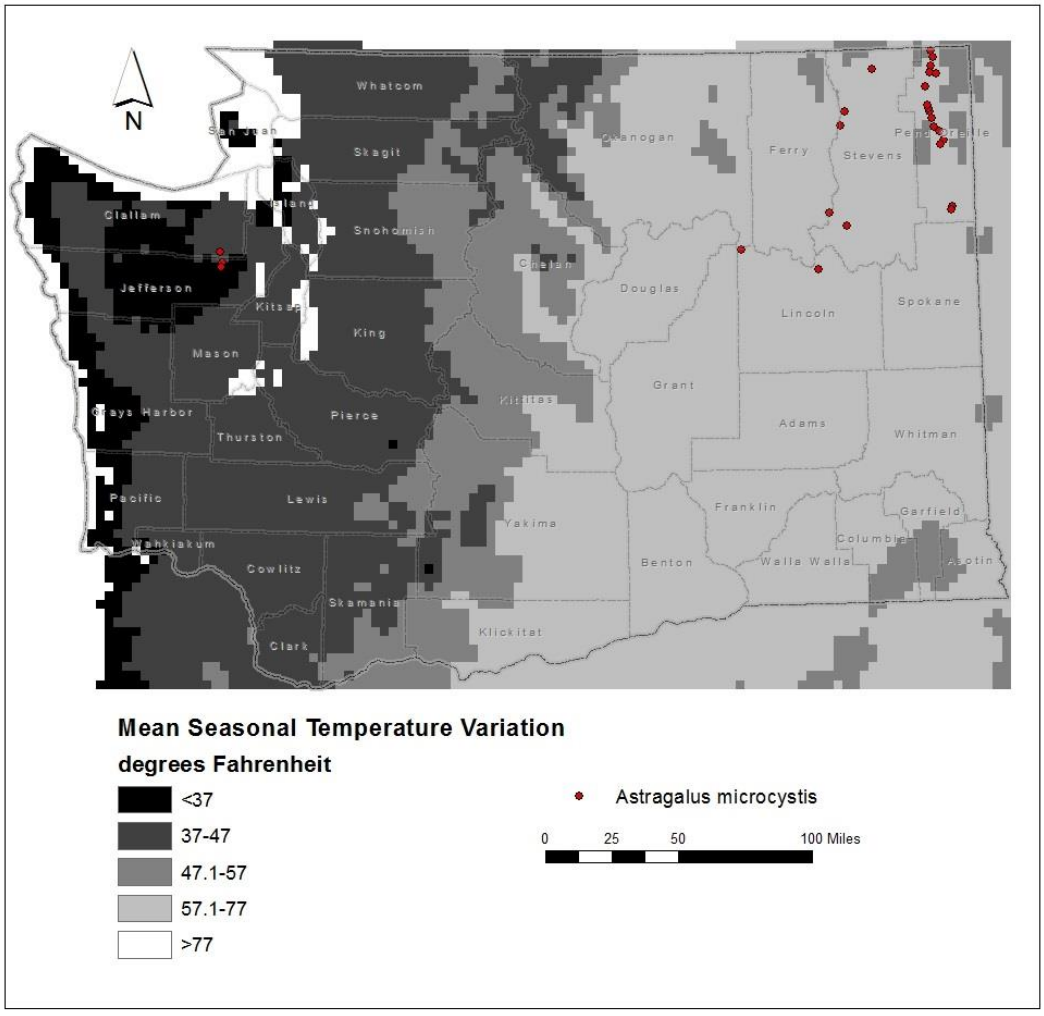

Figure 3. Historical thermal niche (exposure to past temperature variations) of *Astragalus microcystis* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2aii. Physiological thermal niche: Somewhat Increase/Increase.
Populations of *Astragalus microcystis* from alpine habitats in the Olympic Mountains are entirely within a cold climate zone during the flowering season and are highly vulnerable to temperature increase from climate change. Other populations from lower elevation sites in northeastern Washington are found in cold air drainages in river bottoms that are locally cooler microhabitats and somewhat vulnerable to temperature increases.

C2bi. Historical hydrological niche: Neutral.
Twenty-three populations of *Astragalus microcystis* in Washington (85.2%) are found in areas that have experienced average or greater than average precipitation variation in the past 50 years (>20 inches/508 mm) (Figure 4). According to Young et al. (2016), these occurrences are

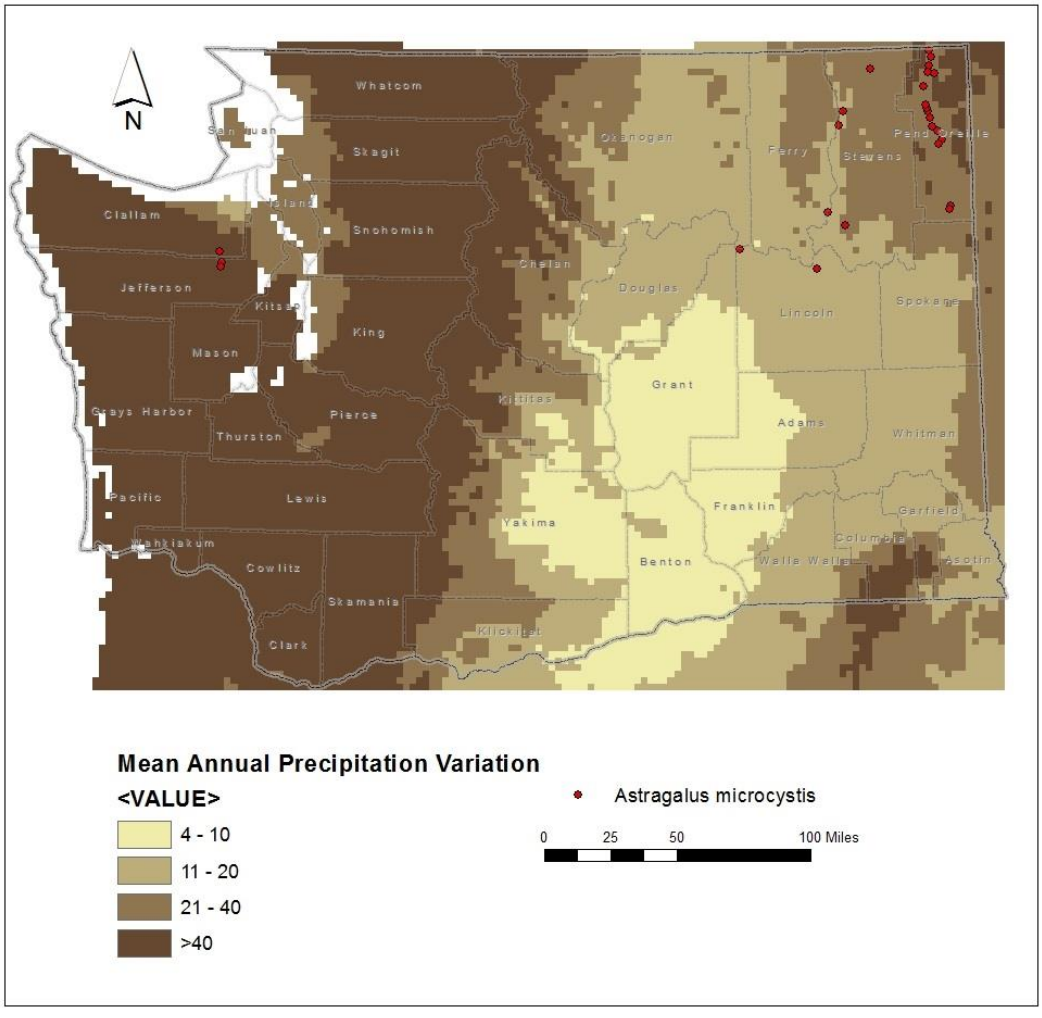

Figure 4. Historical hydrological niche (exposure to past variations in precipitation) of *Astragalus microcystis* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

Neutral for climate change. Four other occurrences from northeastern Washington (14.8%) are from areas with slightly lower average (11-20 inches/255-508 mm) precipitation variation and are at somewhat increased vulnerability to climate change.

C2bii. Physiological hydrological niche: Somewhat Increase/Increase.
Populations from the Olympic Mountains are found on drier slopes where snow drifts may not persist. Increased temperatures from climate change are likely to alter the timing of snowmelt, potentially making these sites even drier (Rocchio and Ramm-Granberg 2017). Low elevation occurrences along gravelly riverbanks in northeastern Washington could be impacted by shifts in seasonal flooding patterns related to changes in the amount of precipitation or timing of mountain snow runoff related to climate change. Lower summer stream flows due to lower precipitation or higher temperatures are also a potential impact of climate change (Rocchio and Ramm-Granberg 2017).

C2c. Dependence on a specific disturbance regime: Neutral.
In northeastern Washington, *Astragalus microcystis* occurs in naturally disturbed sandy and gravel terraces along rivers and in some human-altered sites, such as roadsides and quarries. Other populations from the Olympic Mountains are found in sparsely vegetated cushion plant communities with dry, rocky soil exposed to natural disturbances, such as high winds and erosion. Across its range, disturbance patterns are not likely to be altered by climate change.

C2d. Dependence on ice or snow-cover habitats: Somewhat Increase.
The populations of *Astragalus microcystis* from the Olympic Mountains of Washington are found on alpine ridgecrests in cushion plant communities where snow accumulation may be low due to blowing wind. Reduced snowpack due to climate change, however, would further decrease the amount of moisture available through runoff (Rocchio and Ramm-Granberg 2017). Other populations from eastern Washington at lower elevations along the Columbia and Pend Oreille rivers may be impacted from reduced stream flows resulting from decreased snowpack in the Okanogan Plateau or Canadian Rockies.

C3. Restricted to uncommon landscape/geological features: Neutral/Somewhat Increase.
Most occurrences of *Astragalus microcystis* along the Columbia and Pend Oreille rivers are found on alluvial deposits of gravel or sand (Washington Division of Geology and Earth Resources 2016). This geologic feature is widespread in northeastern Washington. Populations in the Olympic Mountains are strongly correlated with limestone (Camp and Gamon 2011) which is limited primarily to the northeastern part of the range.

C4a. Dependence on other species to generate required habitat: Neutral
The river terrace and alpine cushion plant communities occupied by *Astragalus microcystis* are maintained largely by natural abiotic processes. Feral mountain goats may contribute to habitat disturbance in the Olympic Mountains.

C4b. Dietary versatility: Not applicable for plants

C4c. Pollinator versatility: Unknown.
The specific pollinators of *Astragalus microcystis* are poorly documented. Documented pollinators of other *Astragalus* species in north-central Washington include bumblebees (*Bombus*) and mason bees (*Osmia*) (Wilson et al. 2010).

C4d. Dependence on other species for propagule dispersal: Neutral.
The fruits of *Astragalus microcystis* are papery and bladdery for dispersal by wind or potentially by water (Barneby 1964). The fruits dehisce when dry to release seeds passively by gravity or wind. These seeds lack wings, barbs, or hooks for secondary dispersal by wind or animals. Average dispersal distances are probably relatively short.

C4e. Sensitivity to pathogens or natural enemies: Neutral.
Impacts from herbivory or pathogens appear to be low in eastern Washington. Populations in the Olympic Mountains could be affected by trampling by introduced mountain goats (Camp and Gamon 2011).

C4f. Sensitivity to competition from native or non-native species: Somewhat Increase.
Disturbed river terrace and bank habitats in eastern Washington could be impacted by invasion of non-native weed species competing for available space and nutrients. Trampling by introduced mountain goats and associated erosion is a potential threat in the Olympic Mountains (Camp and Gamon 2011).

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

C5a. Measured genetic variation: Unknown.
Not known.

C5b. Genetic bottlenecks: Unknown.
Not known. The disjunct populations from the Olympic Range might be expected to have lower genetic diversity than those from eastern Washington due to founder effects or inbreeding.

C5c. Reproductive System: Neutral.
Many *Astragalus* species are capable of self-pollination, but most reproduce by outcrossing. The reproductive biology of *A. microcystis* is poorly known, but is assumed to have neutral impacts from climate change.

C6. Phenological response to changing seasonal and precipitation dynamics: Neutral.
Based on herbarium records in the Consortium of Pacific Northwest Herbaria website (pnwherbaria.org), *Astragalus microcystis* has not significantly altered its typical blooming time since the 1890s.

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 *Astragalus microcystis* in Washington since it was first discovered in the state in 1860.

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

Barneby, R.C. 1964. Atlas of North American *Astragalus*. Memoirs of the New York Botanical Garden 13:1-1188.

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.

Rocchio F.J. and T. Ramm-Granberg. 2017. Ecological System Climate Change Vulnerability Assessment. Unpublished Report to the Washington Department of Fish and Wildlife. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.

Washington Division of Geology and Earth Resources. 2016. Surface geology, 1:100,000--GIS data, November 2016: Washington Division of Geology and Earth Resources Digital Data Series DS-18, version 3.1, previously released June 2010.
http://www.dnr.wa.gov/publications/ger_portal_surface_geology_100k.zip

Wilson, J.S., L.E. Wilson, L.D. Loftis, and T. Griswold. 2010. The montane bee fauna of north central Washington, USA, with floral associations. Western North American Naturalist 70(2): 198-207.

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.