Climate Change Vulnerability Index Report

Allium constrictum (Constricted onion)

Date: 19 January 2021

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: 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	0
	-0.074 to -0.096	0
	-0.051 to -0.073	82.4
	-0.028 to -0.050	17.6
	>-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		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
2aii. Change in physiological thermal niche		Neutral
2bi. Changes in historical hydrological niche		Somewhat Increase
2bii. Changes in physiological hydrological niche		Greatly Increase
2c. Dependence on specific disturbance regime		Neutral
2d. Dependence on ice or snow-covered habitats		Neutral
3. Restricted to uncommon landscape/geological features		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		Somewhat Increase

5b. Genetic bottlenecks	Somewhat Increase
5c. Reproductive system	Somewhat Increase/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 17 of the known occurrences of *Allium constrictum* in Washington (100%) are found in areas with a projected temperature increase of 3.9-4.4˚ F (Figure 1).

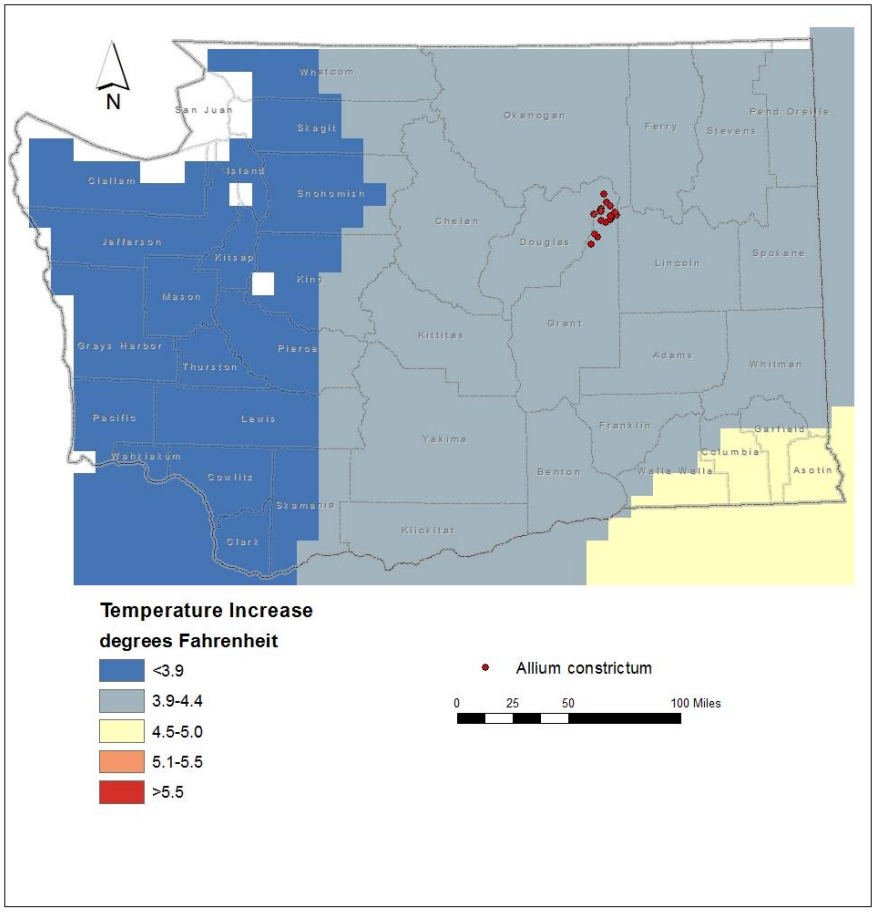

Figure 1. Exposure of *Allium constrictum* occurrences in Washington to projected local temperature change. Base map layers from www.natureserve.org/ccvi

A2. Hamon AET:PET Moisture Metric: Fourteen of the 17 Washington occurrences of *Allium constrictum* (82.4%) 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 – 0.051 to -0.073 (Figure 2). Three other occurrences (17.6%) are in areas with a projected decrease in the – 0.028 to – 0.050 range.

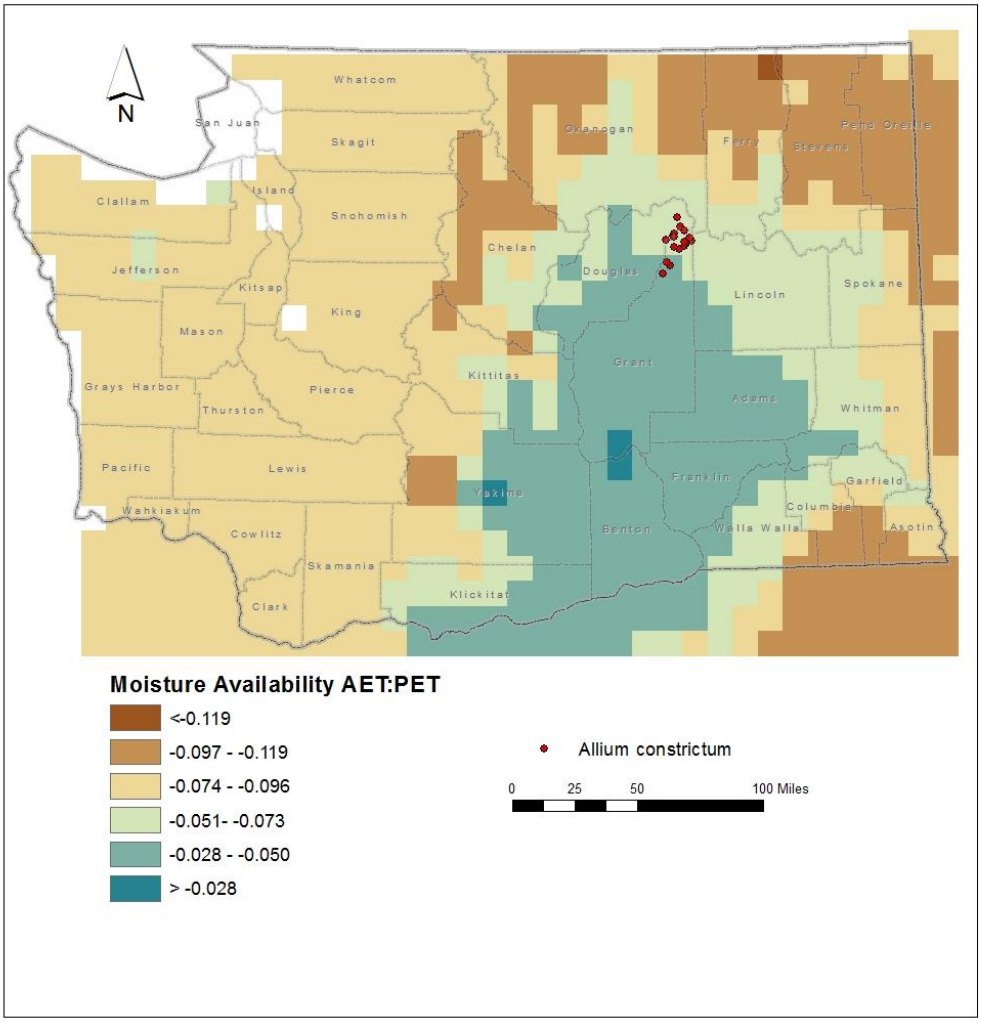

Figure 2. Exposure of *Allium constrictum* occurrences in Washington to projected moisture availability (based on ratio of actual to predicted evapotranspiration). Base map layers from www.natureserve.org/ccvi

Section B. Indirect Exposure to Climate Change

B1. Exposure to sea level rise: Neutral.
All occurrences of *Allium constrictum* in Washington are found at elevations from 2070-2550 ft (630-780 m) and would not be inundated by sea level rise.

B2a. Natural barriers: Neutral.
In Washington, *Allium constrictum* occurs on the margins of vernal pools and moist flats or gentle slopes over thin basalt lithosols (Camp and Gamon 2011, Fertig & Kleinknecht 2020). This vegetation type is part of the Columbia Plateau Vernal Pool ecological system (Rocchio and Crawford 2015). Washington populations are separated by 0,5-3 miles (0.6-4.7 km). The entire range of the species is limited to an area of approximately 23 x 11 miles (37 x 18 km) (Camp and Gamon 2011). Vernal depressions are widely scattered through this area within a matrix of big sagebrush (*Artemisia tridentata*) and stiff sagebrush (*A. rigida*) scabland vegetation. The surrounding vegetation does not impose a significant barrier to gene flow.

B2b. Anthropogenic barriers: Neutral.
Allium constrictum occurs primarily on rangelands managed for grazing with relatively few roads or other developments to impede gene flow.

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

Section C: Sensitive and Adaptive Capacity

C1. Dispersal and movements: Somewhat Increase.
Allium constrictum reproduces by seed formed in dry capsules. The smooth seeds lack any structures such as barbs, hooks, parachutes, or wings to facilitate transportation by animals. Seeds are relatively small and could be carried short distances by strong winds, but are more likely to be passively dispersed within 1000 meters of the parent plant.

C2ai. Historical thermal niche: Neutral.
Figure 3 depicts the distribution of known *Allium constrictum* occurrences in Washington relative to mean seasonal temperature variation for the period from 1951-2006 ("historical thermal niche"). All 17 of the Washington occurrences (100%) are found in areas that have experienced average (57.1-77˚F) temperature variation in the past 50 years. According to Young et al. (2016) these populations are at neutral vulnerability to climate change.

C2aii. Physiological thermal niche: Neutral.
Allium constrictum occurrences in Washington are found in ephemeral wetlands and vernal pools that are not cold air drainages and would be neutral for climate change.

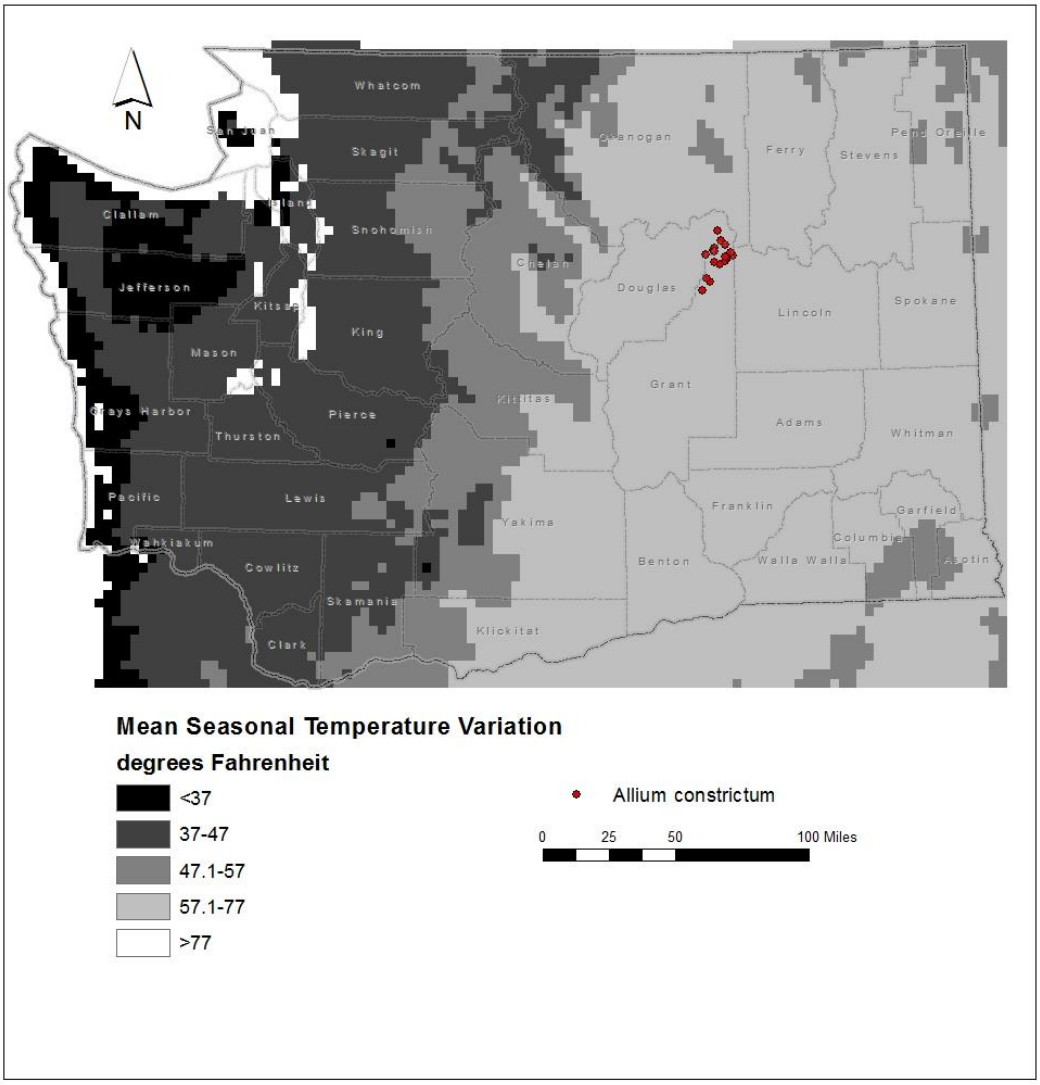

Figure 3. Historical thermal niche (exposure to past temperature variations) of *Allium constrictum* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2bi. Historical hydrological niche: Somewhat Increase.
All 17 of the Washington occurrences (100%) of *Allium constrictum* (Figure 4) are found in areas that have averaged 11-20 inches (255-508 mm) of precipitation variation in the past 50 years and are considered at somewhat increased risk from climate change by Young et al. (2016).

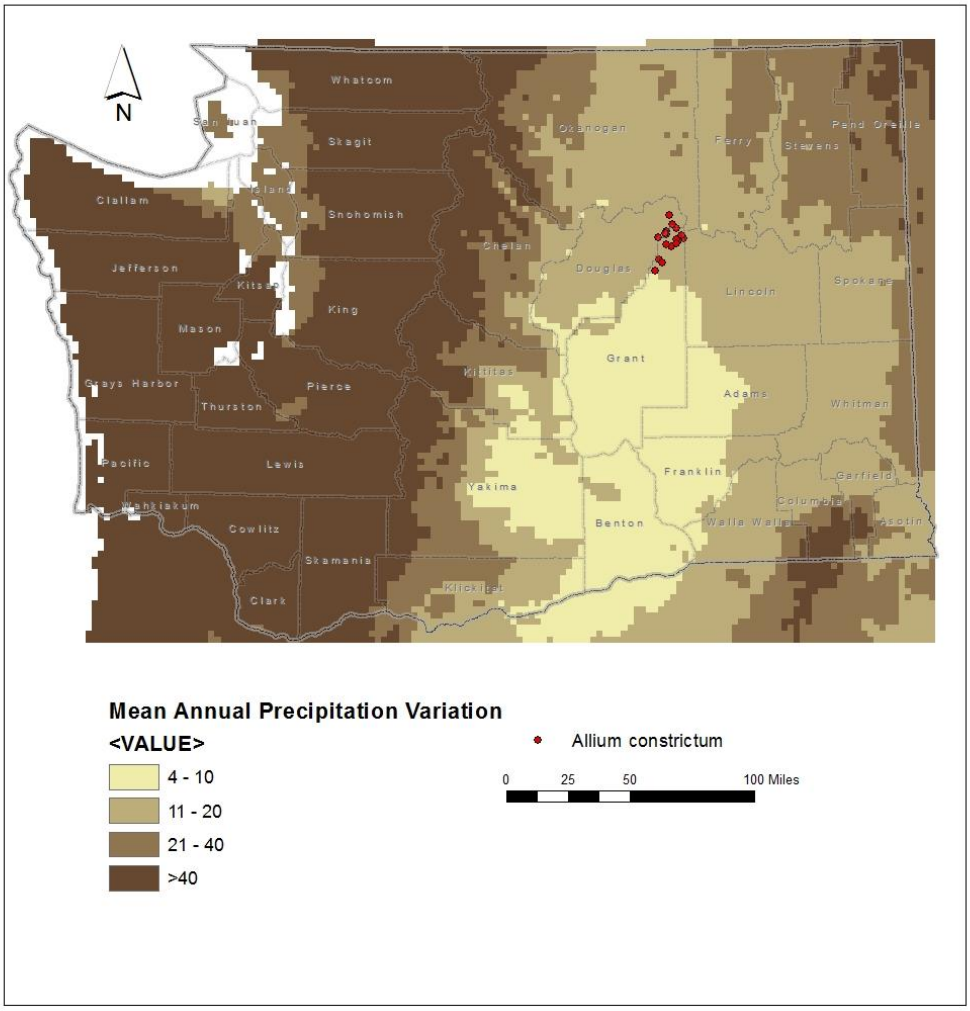

Figure 4. Historical hydrological niche (exposure to past variations in precipitation) of *Allium constrictum* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2bii. Physiological hydrological niche: Greatly Increase.
Allium constrictum is limited to vernal pools and thin lithosol habitats that are dependent on winter or spring snow or rain (and not groundwater) as a water source. These areas are impacted by drought in the summer. Changes in the timing or amount of precipitation in the growing season would likely alter the community structure of these ephemeral wetlands (Rocchio and Ramm-Granberg 2017). Increased drought in the growing season could lead to conversion of this ecological system to the sparsely vegetated Intermountain Basins Cliff and Canyon type.

C2c. Dependence on a specific disturbance regime: Neutral.
This species is not dependent on periodic and unpredictable disturbances to maintain its vernal pool habitat on basalt outcrops (although regular summer drought does prevent these areas from converting to other wetland ecological systems associated with perennial water sources). Increased disturbances from drought and more frequent wildfire would likely affect the sagebrush scabland matrix in which its vernal pool habitat is embedded (Rocchio and Ramm-Granberg 2017).

C2d. Dependence on ice or snow-cover habitats: Neutral
In Washington, *Allium constrictum* is found in basin areas that receive relatively little snowfall (though vernal depressions would likely accumulate any blowing snow).

C3. Restricted to uncommon landscape/geological features: Somewhat Increase.
All of the Washington occurrences of *Allium constrictum* are found in shallow depressions or flats on outcrops of Miocene-age basalts of the Priest Rapids Member of the Wanapum basalt (Washington Division of Geology and Earth Resources 2016). While this geologic formation is widespread in the Columbia Plateau of central Washington, the vernal pool depressions are far less common and often widely scattered. The distribution of these geologic features is probably an important factor limiting the range of this species.

C4a. Dependence on other species to generate required habitat: Neutral.
The vernal pool and rock outcrop habitat occupied by this species is maintained primarily by natural abiotic processes.

C4b. Dietary versatility: Not applicable for plants

C4c. Pollinator versatility: Unknown.
McNeal (1994) reports that the pollinators of *Allium constrictum* are not known, but are probably solitary and social bees (including *Apis mellifera*) and other insects. If multiple insect species are capable of pollination, this factor could be scored as Neutral.

C4d. Dependence on other species for propagule dispersal: Neutral.
Dispersal of *Allium* seed is primarily passive and the small seeds can be spread by wind or gravity (McNeal 1994). Dispersal distances are probably short.

C4e. Sensitivity to pathogens or natural enemies: Neutral.
Current rates of livestock grazing is not considered a significant threat to *Allium constrictum* (Barrett and Sprague 1985; Camp and Gamon 2011). *Allium* flowers and leaves are palatable, and underground bulbs are also consumed by fossorial mammals, but whether natural herbivory is a limiting factor for *A. constrictum* is not known.

C4f. Sensitivity to competition from native or non-native species: Somewhat Increase.
The vernal pool habitat of *Allium constrictum* is vulnerable to invasion by native or introduced plant species adapted to drier conditions if changes in the amount or timing of winter/spring precipitation are altered due to climate change (Rocchio and Ramm-Granberg 2015).

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

C5a. Measured genetic variation: Somewhat Increase.
Rieseberg et al. (1987) conducted a genetic analysis of *Allium douglasii* and related taxa (at the time considered varieties, but now recognized as separate species), including *A. constrictum* (*A. douglasii* var. *constrictum*). Isozyme data suggest that *A. constrictum* is probably recently derived from *A. columbianum*, an endemic of vernal wetlands in Spokane County, western Idaho, and western Montana. *Allium constrictum* possesses a less diverse genome than *A. columbianum*, suggesting it evolved from a peripheral population that became reproductively isolated, possibly related to Pleistocene flooding events. The relatively low genetic diversity within *A. constrictum* makes it somewhat more vulnerable to impacts of climate change.

C5b. Genetic bottlenecks: Somewhat Increase.
Genetic data from Rieseberg et al. (1987) suggest that *Allium constrictum* evolved from a peripheral occurrence of *A. columbianum* and has since diverged somewhat due to reproductive isolation. The founder population, thus, may have been relatively small, suggesting an initial genetic bottleneck.

C5c. Reproductive System: Somewhat Increase/Neutral.
Allium species generally are outcrossers and have non-specialized pollinators. Due to its recent origin, *A. constrictum* may have lower than average levels of genetic diversity and at least two unique allozymes distinct from related onion species (Rieseberg et al. 1987).

C6. Phenological response to changing seasonal and precipitation dynamics: Neutral.
Based on WNHP and Consortium of Pacific Northwest Herbaria records, no changes have been detected in phenology in recent years.

Section D: Documented or Modeled Response to Climate Change

D1. Documented response to recent climate change: Neutral.
The range of *Allium constrictum* has not been altered in recent years due to impacts from climate change.

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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