Climate Change Vulnerability Index Report

Saxifraga cernua (Nodding saxifrage)

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Assessor: Walter Fertig, WA Natural Heritage Program

Geographic Area: Washington Heritage Rank: G5/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	66.7
	-0.074 to - 0.096	33.3
	-0.051 to - 0.073	0
	-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		Somewhat Increase
2b. Distribution relative to anthropogenic barriers		Neutral
3. Impacts from climate change mitigation		Neutral
Section C		
1. Dispersal and movements		Increase
2ai Change in historical thermal niche		Increase
2aii. Change in physiological thermal niche		Greatly Increase
2bi. Changes in historical hydrological niche		Neutral
2bii. Changes in physiological hydrological niche		Somewhat 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		Neutral
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		Neutral
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	Somewhat Increase
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 six of the occurrences of *Saxifraga cernua* in Washington (100%) occur in areas with a projected temperature increase of 3.9-4.4˚ F (Figure 1).

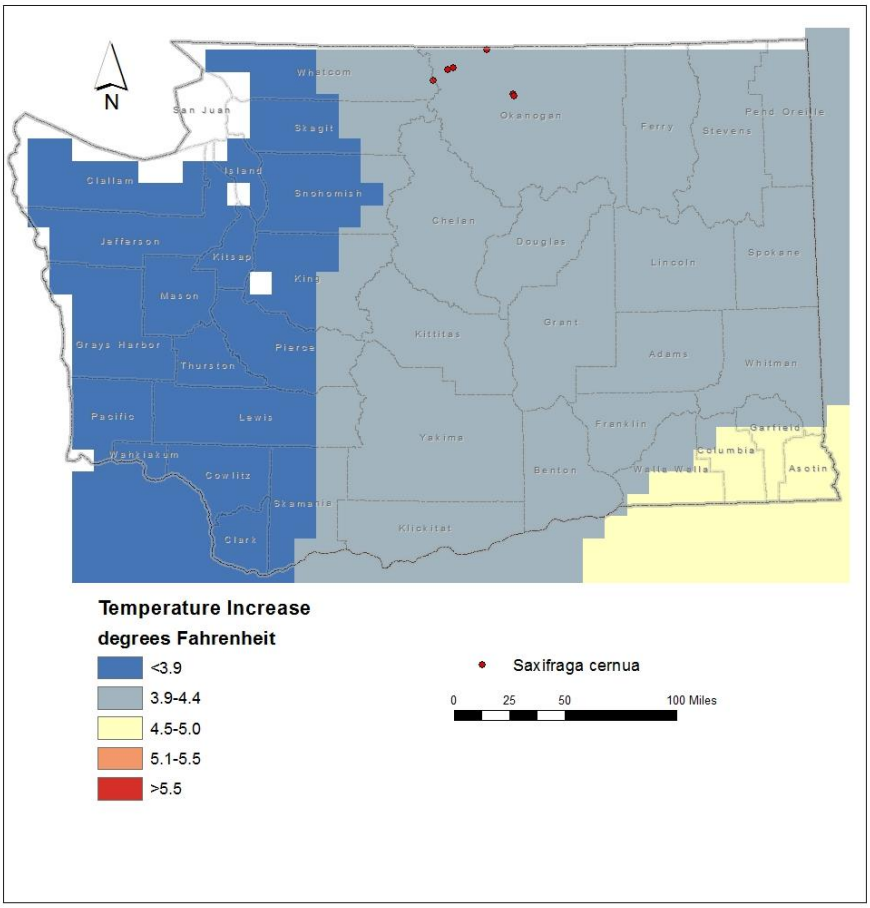

Figure 1. Exposure of *Saxifraga cernua* occurrences in Washington to projected local temperature change. Base map layers from www.natureserve.org/ccvi

A2. Hamon AET:PET Moisture Metric: Four of the six extant and historical occurrences of *Saxifraga cernua* (66.7%) 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). Two other occurrences (33.3%) are from sites with a projected decrease of -0.074 to - 0.096.

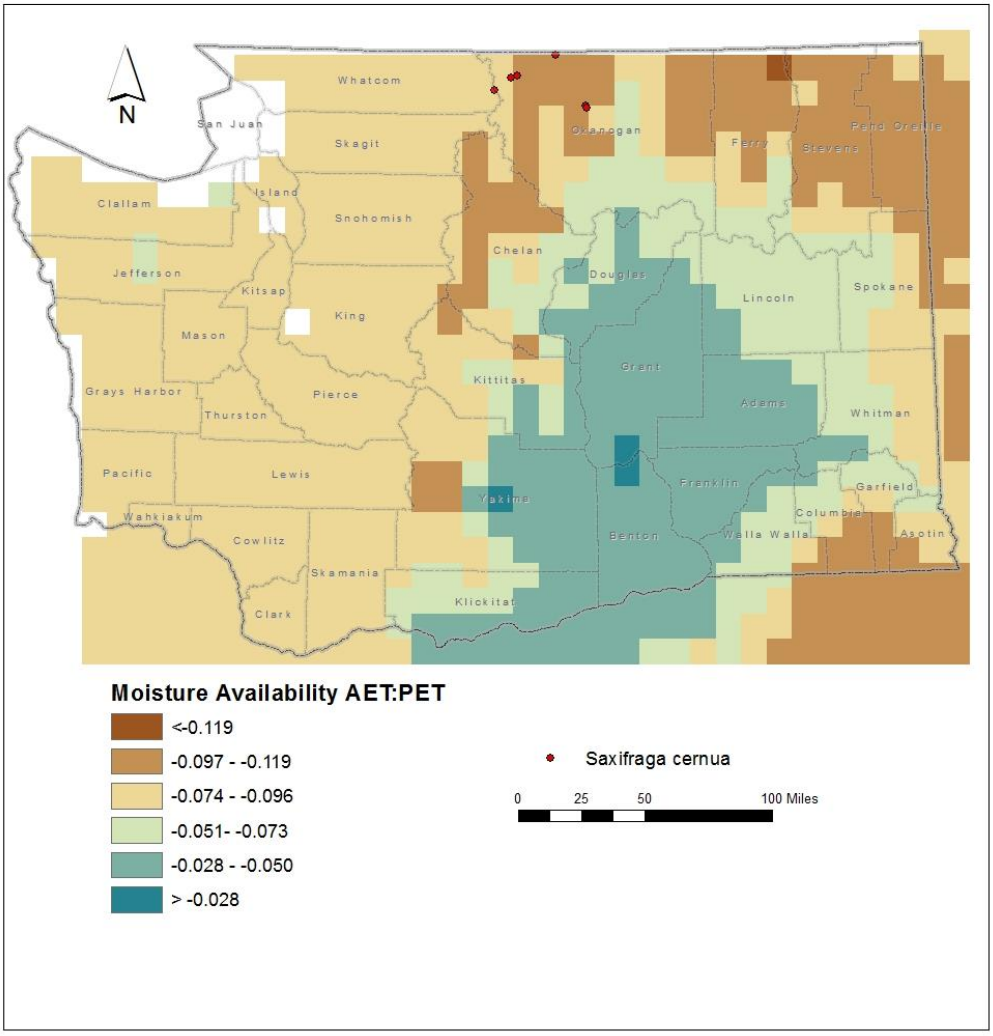

Figure 2. Exposure of *Saxifraga cernua* occurrences in Washington to projected moisture availability (based on ratio of actual to predicted evapotranspiration). Base map layers from www.natureserve.org/ccvi

Section B. Indirect Exposure to Climate Change

B1. Exposure to sea level rise: Neutral.
Washington occurrences of *Saxifraga cernua* are found at 5700-8120 feet (1740-2500 m) and would not be inundated by projected sea level rise.

B2a. Natural barriers: Somewhat Increase.
In Washington, *Saxifraga cernua* occurs in shady, moist alpine cliffs and talus slopes (Camp and Gamon 2011; WNHP records). This habitat is a component of the Rocky Mountain Alpine Dwarf Shrubland, Fell-Field, and Turf ecological system (Rocchio and Crawford 2015). Washington occurrences are restricted to small patches of suitable habitat separated by distances of 1-23 miles (1.5-38 km). The natural patchiness of the populations and large extents of unsuitable habitat between mountain peaks create a barrier for dispersal.

B2b. Anthropogenic barriers: Neutral.
The range of *Saxifraga cernua* is naturally somewhat fragmented. Human impacts on the landscape of northern Washington have little effect on this condition.

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

Section C: Sensitive and Adaptive Capacity

C1. Dispersal and movements: Increase.
Saxifraga cernua reproduces primarily by asexual bulbils produced in the axils of inflorescence bracts in place of ordinary flowers. These propagules are genetically identical to their parent and capable of short-distance dispersal by strong winds, water, or passive means. Plants may also produce terminal flowers, but fruit and seed production is rare. Fruits are many-seeded capsules and individual seeds are small and can be dispersed passively or by wind. Overall dispersal distances for bulbils or seeds is probably small (less than 100 m), although genetic data suggest that long-distance dispersal occurs often enough to maintain relatively high levels of genetic diversity, at least in the core areas of its circumboreal range (Gabrielsen and Brochmann 2002, Bauert et al. 2007).

C2ai. Historical thermal niche: Increase.
Figure 3 depicts the distribution of *Saxifraga cernua* in Washington relative to mean seasonal temperature variation for the period from 1951-2006 ("historical thermal niche"). Four of the six occurrences in the state (66.7%) are found in areas that have experienced small (37-47˚F/20.8-26.3˚C) temperature variation during the past 50 years and are considered at increased vulnerability to climate change. The two other populations (33.3%) are from areas with slightly lower than average (47.1-57˚F/26.3-31.8˚ C) temperature variation during the same period and would be at somewhat increased risk from climate change (Young et al. 2006).

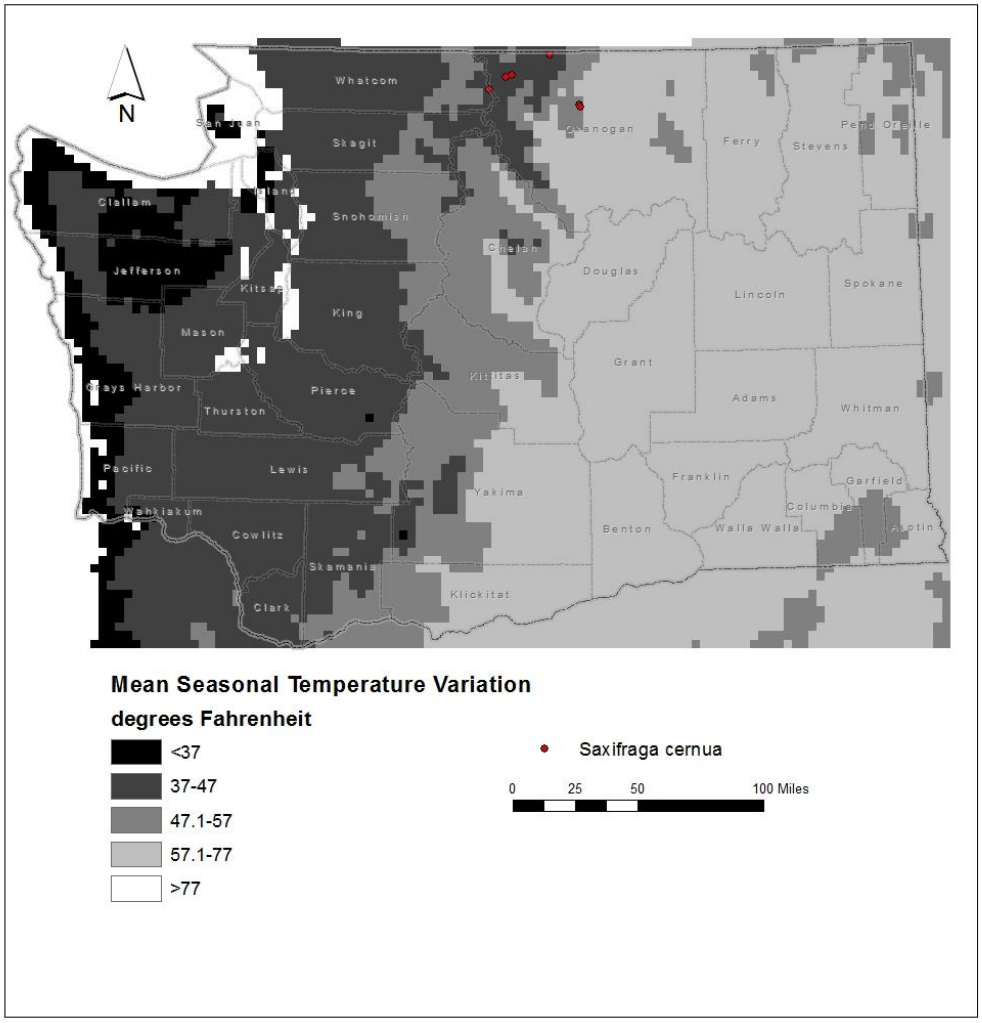

Figure 3. Historical thermal niche (exposure to past temperature variations) of *Saxifraga cernua* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2aii. Physiological thermal niche: Greatly Increase.
The alpine talus and cliff habitat of *Saxifraga cernua* is strongly correlated with cold air drainage during the growing season and would have greatly increased vulnerability to temperature changes associated with global warming.

C2bi. Historical hydrological niche: Neutral.
All six of the populations of *Saxifraga cernua* in Washington (100%) are found in areas that have experienced average or greater than average (>20 inches/508 mm) precipitation variation in the past 50 years (Figure 4). According to Young et al. (2016), these occurrences are at neutral vulnerability to climate change.

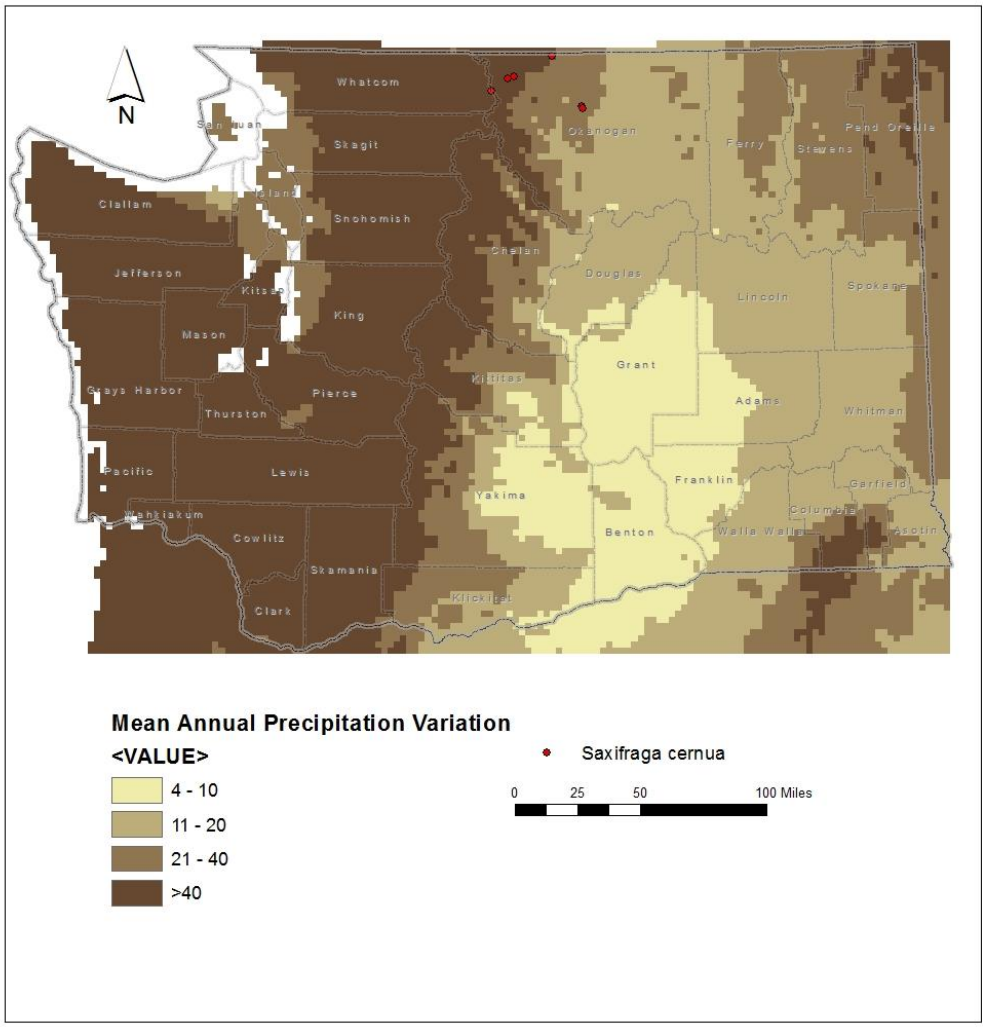

Figure 4. Historical hydrological niche (exposure to past variations in precipitation) of *Saxifraga cernua* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2bii. Physiological hydrological niche: Somewhat Increase.
This species is often associated with small seeps that keep the habitat moist year round. The ultimate source of this moisture is precipitation and slow-melting snow. Changes in the amount and timing of precipitation could be detrimental to the habitat of *Saxifraga cernua*, allowing

shrubs or dry meadow species to displace alpine talus and rock field taxa (Rocchio and Ramm-Granberg 2017). See "Dependence on ice or snow-cover habitats" below.

C2c. Dependence on a specific disturbance regime: Neutral.
Saxifraga cernua occurs in alpine rock ledge and scree habitats. Other than occasional rock fall, these are largely undisturbed sites at present. Under future climate change scenarios, these areas could become invaded by tree or shrub species or lower elevation forbs and grasses, resulting in increased soil accumulation, more litter, and enhanced probability of fire (Rocchio and Ramm-Granberg 2017).

C2d. Dependence on ice or snow-cover habitats: Somewhat Increase.
The populations of *Saxifraga cernua* in Washington are found in moist and shady alpine talus and cliff sites. The primary source of growing-season moisture is meltwater from late-lying and slow-melting snow or spring and summer precipitation. Reduced snowpack due to climate change would lessen the amount of moisture available through runoff (Rocchio and Ramm-Granberg 2017).

C3. Restricted to uncommon landscape/geological features: Neutral.
Populations of *Saxifraga cernua* in Washington occur on a variety of substrates, including quartz monzonite, metamorphic/igneous gneiss of the Tiffany Formation, and Winthrop Sandstone (WNHP records). These outcrops are relatively widespread in the Okanogan and North Cascades ranges.

C4a. Dependence on other species to generate required habitat: Neutral.
The alpine talus and cliff habitat occupied by *Saxifraga cernua* is maintained primarily by natural abiotic processes.

C4b. Dietary versatility: Not applicable for plants

C4c. Pollinator versatility: Neutral.
Saxifraga cernua flowers are insect pollinated, but the species rarely produces fruit or seed (Bauert et al. 2007), reproducing instead by asexual bulbils formed in place of flowers in the inflorescence.

C4d. Dependence on other species for propagule dispersal: Neutral.
The bulbils and seeds of *Saxifraga cernua* are primarily dispersed short distances by passive means, such as wind or gravity (rather than by animals).

C4e. Sensitivity to pathogens or natural enemies: Neutral.
Impacts from pathogens are not known. This species is not vulnerable to browsing because of protection provided by its rocky habitat.

C4f. Sensitivity to competition from native or non-native species: Neutral.
Under present conditions, competition from non-native species is minimal, as few introduced plants are adapted to the harsh environmental conditions of subalpine talus slopes and cliffs. Under projected climate change, competition could increase if lower elevation plant species are able to expand their range into formerly uninhabitable habitat (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.
Data are not available on the genetic diversity of this species in Washington.

C5b. Genetic bottlenecks: Unknown.

C5c. Reproductive System: Neutral
Saxifraga cernua reproduces primarily by asexual bulbils, and so might be expected to have low genetic diversity among populations and higher diversity between isolated occurrences. Kjølner et al. (2006) found high levels of genetic variation, suggesting some sexual reproduction is occurring as well as long distance transport of seed or bulbils. Isolated populations in the Alps, however, had little genetic diversity, suggesting impacts from inbreeding depression or founder effects (Bauert et al. 2007). Washington occurrences are at the southern edge of the species range in the Pacific Northwest and isolated from other occurrences in the Rocky Mountains, and might be expected to have lower diversity.

C6. Phenological response to changing seasonal and precipitation dynamics: Neutral.
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: Somewhat Increase?
Three occurrences of *Saxifraga cernua* have not been relocated from 1916 to 1980 and are considered historical or possibly extripated. Whether these occurrences have been overlooked and are still present or lost due to climate change or other factors 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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