Climate Change Vulnerability Index Report

Petrophytum cinerascens (Chelan rockmat)

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Assessor: Walter Fertig, WA Natural Heritage Program

Geographic Area: Washington Heritage Rank: G1G2/S1S2

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	60
	-0.028 to -0.050	40
	>-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		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		Increase
2c. Dependence on specific disturbance regime		Neutral
2d. Dependence on ice or snow-covered habitats		Neutral
3. Restricted to uncommon landscape/geological features		Increase
4a. Dependence on others species to generate required habitat		Neutral
4b. Dietary versatility		Not Applicable
4c. Pollinator versatility		Somewhat Increase
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		Neutral
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 five of the occurrences of *Petrophytum cinerascens* in Washington (100%) occur in areas with a projected temperature increase of 3.9-4.4˚ F (Figure 1).

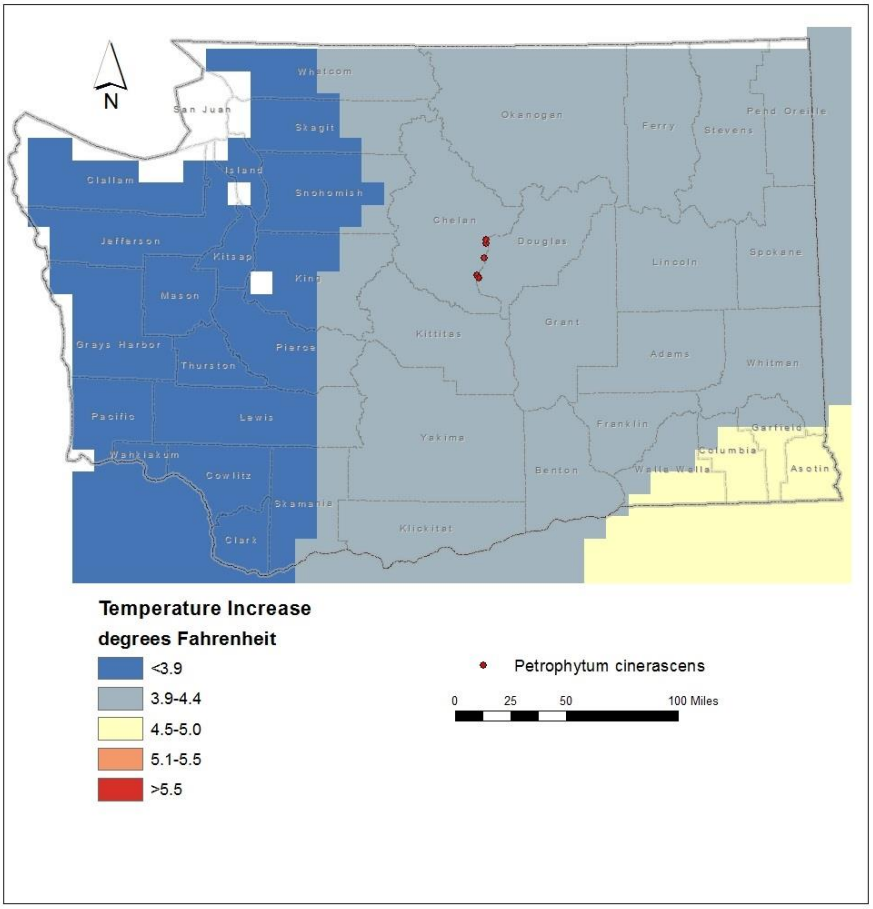

Figure 1. Exposure of *Petrophytum cinerascens* occurrences in Washington to projected local temperature change. Base map layers from www.natureserve.org/ccvi

A2. Hamon AET:PET Moisture Metric: Three of the five Washington occurrences of *Petrophytum cinerascens* (60%) 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). Two occurrences (40%) are found in areas with a projected decrease in moisture of -0.028 to -0.050.

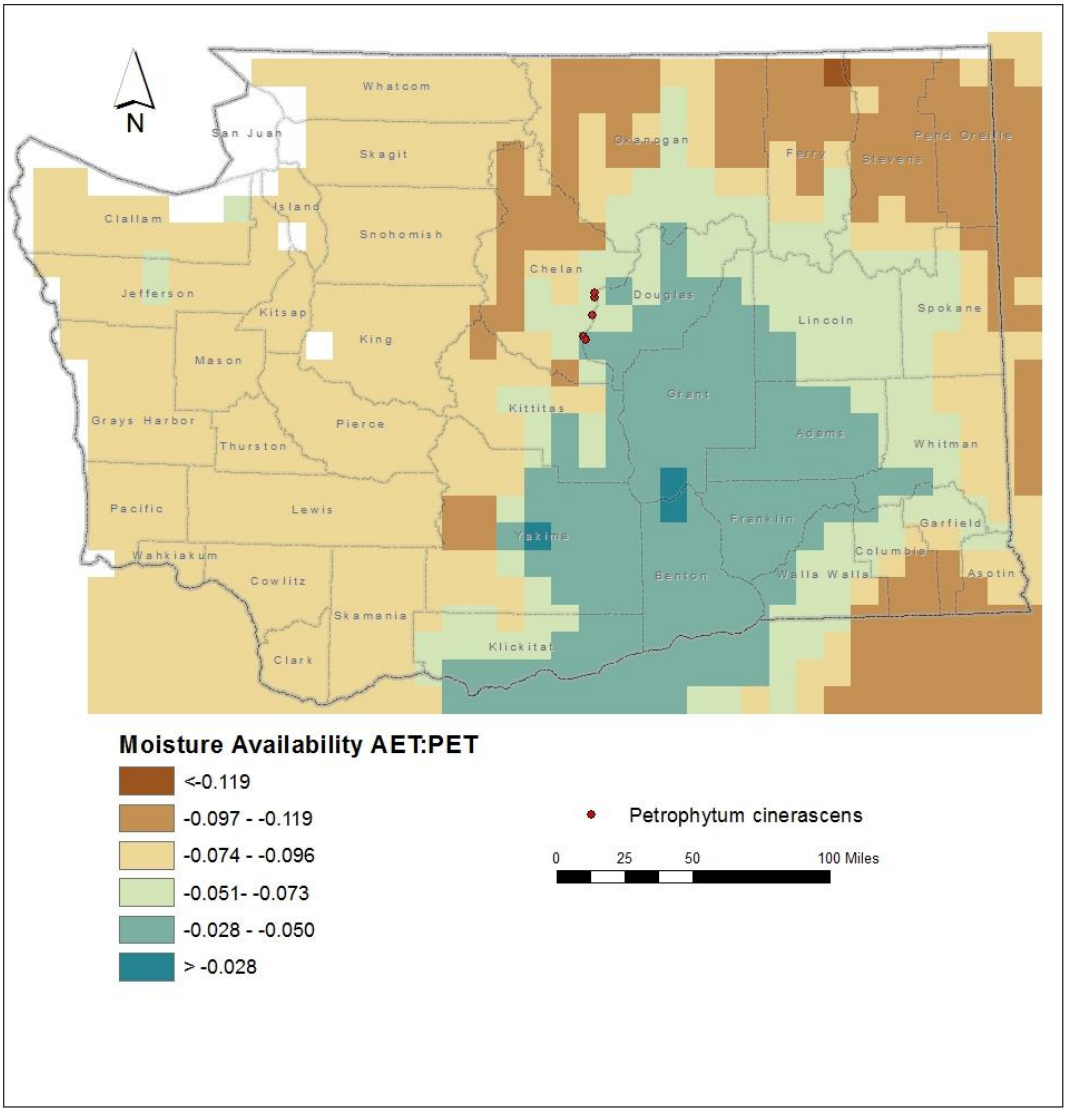

Figure 2. Exposure of *Petrophytum cinerascens* occurrences in Washington to projected moisture availability (based on ratio of actual to predicted evapotranspiration). Base map layers from www.natureserve.org/ccvi

Section B. Indirect Exposure to Climate Change

B1. Exposure to sea level rise: Neutral.
Washington occurrences of *Petrophytum cinerascens* are found at 800-1800 feet (240-550 m) and would not be inundated by projected sea level rise.

B2a. Natural barriers: Somewhat Increase.
In Washington, *Petrophytum cinerascens* is found in ledges and exposed rock faces of east or west-facing cliffs of metamorphosed granitic or gneiss plutons (intrusions within the basalt matrix) along a 27 km (17 mile) stretch of the Columbia River near the Rocky Reach dam, north of Wenatchee (Camp and Gamon 2011, Fertig 2020, Gamon 1989). This habitat is a component of the Inter-Mountain Basins Cliff and Canyon ecological system (Rocchio and Crawford 2015). Individual populations are separated by 1.6-11 km (1-7 miles). Adjacent habitat (including south-facing gneiss cliffs) is unsuitable for this species and creates a barrier for dispersal.

B2b. Anthropogenic barriers: Neutral.
The range of *Petrophytum cinerascens* in Washington is constrained by the distribution of appropriate granite and genies plutons along the Columbia River. The east side of these cliffs has a highway. Dispersal is probably more constrained by natural conditions, however, than human ones.

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

Section C: Sensitive and Adaptive Capacity

C1. Dispersal and movements: Somewhat Increase.
Petrophytum cinerascens produces 1-2 seeded dry capsule fruits that split open at maturity to release the seeds passively by gravity or wind. Average dispersal distances are probably relatively short (100-1000 meters).

C2ai. Historical thermal niche: Neutral.
Figure 3 depicts the distribution of *Petrophytum cinerascens* in Washington relative to mean seasonal temperature variation for the period from 1951-2006 ("historical thermal niche"). All five of the known 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 risk from climate change.

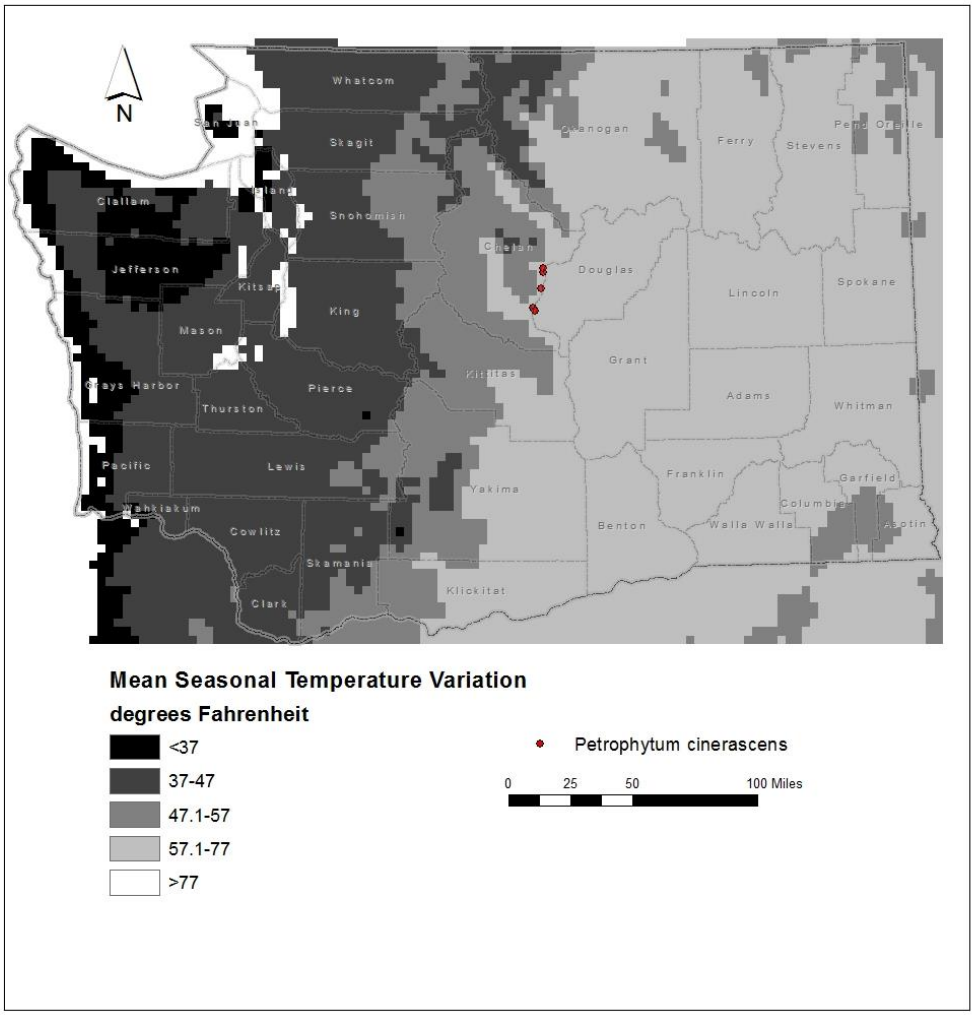

Figure 3. Historical thermal niche (exposure to past temperature variations) of *Petrophytum cinerascens* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2aii. Physiological thermal niche: Somewhat Increase.
The microsites within the intrusive gneiss cliffs occupied by *Petrophytum cinerascens* are often associated with cool, shaded conditions during the growing season and would have somewhat increased vulnerability to climate change. Under experimental conditions, Moore et al. (1998) found that *P. cinerascens* was not be able to acclimate to increased temperatures and thus would be a very sensitive indicator of climate change.

C2bi. Historical hydrological niche: Somewhat Increase.
All five of the populations of *Petrophytum cinerascens* in Washington (100%) are found in areas that have experienced slightly lower than average (11-20 inches/255-508 mm) precipitation variation in the past 50 years (Figure 4). According to Young et al. (2016), these occurrences are at somewhat increased vulnerability from climate change.

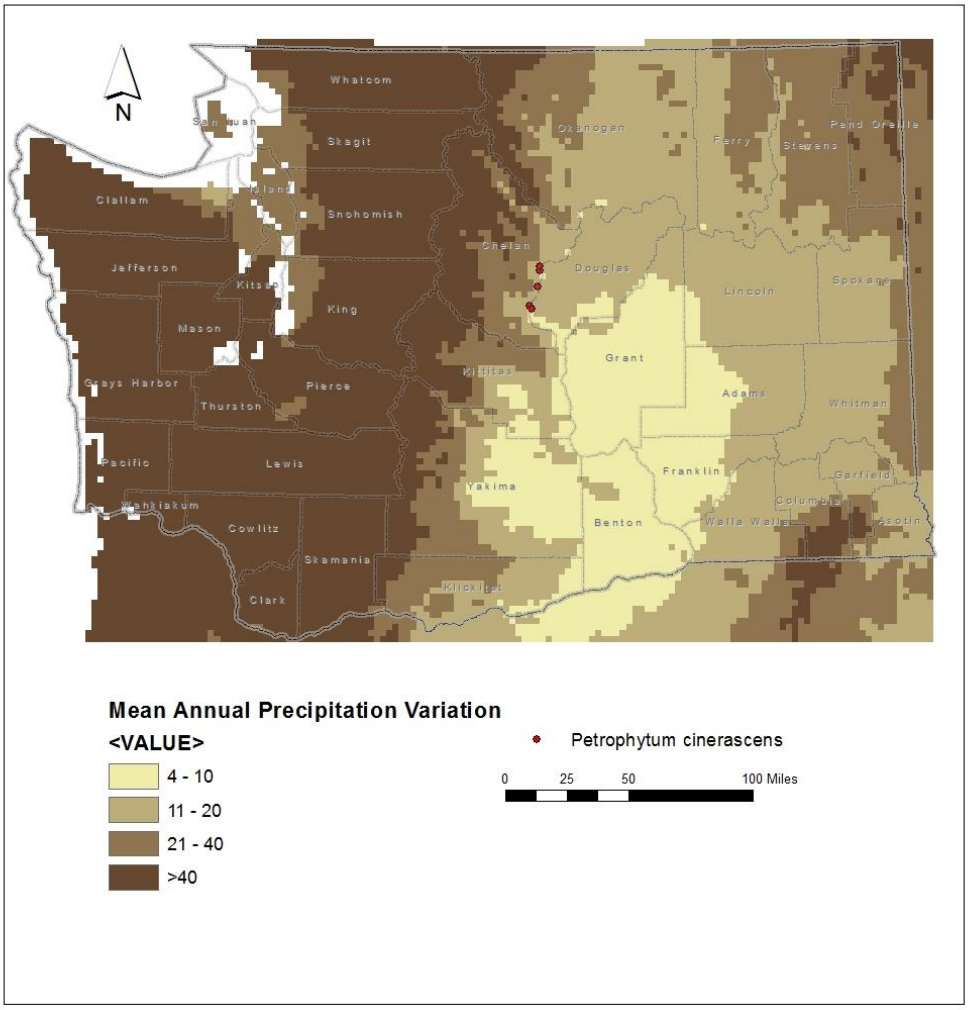

Figure 4. Historical hydrological niche (exposure to past variations in precipitation) of *Petrophytum cinerascens* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2bii. Physiological hydrological niche: Increase.
This species is dependent on precipitation and winter snow for its moisture requirements, because its habitat is not associated with springs, streams, or groundwater. The Inter-Mountain Basins Cliff and Canyon ecological system is vulnerable to changes in the timing or amount of precipitation and increases in temperature (Rocchio and Ramm-Granberg 2017).

C2c. Dependence on a specific disturbance regime: Neutral.
Petrophytum cinerascens is not dependent on periodic disturbances to maintain its montane rocky forest habitat. The species could, however, be detrimentally affected by increased summer temperatures, drought, or decreased precipitation that might favor conversion of this habitat to lichens or annual plants (Rocchio and Ramm-Granberg 2017).

C2d. Dependence on ice or snow-cover habitats: Neutral.
The five populations of *Petrophytum cinerascens* in Washington occur in an area of low to moderate accumulations of snow. These populations are probably more adversely affected by reduction in changes in the timing and volume of rainfall due to projected climate change (Rocchio and Ram-Granberg 2017).

C3. Restricted to uncommon landscape/geological features: Increase.
Petrophytum cinerascens is restricted to two geologic formations of limited extent in central Washington: Swakane Biotite and Entiat Pluton. These are intrusive granitic or gneiss formations within a matrix of basalt. These rock outcrops do not readily weather into soil, and *P. cinerascens* is mostly restricted to cracks or narrow ledges (Gamon 1989).

C4a. Dependence on other species to generate required habitat: Neutral
The habitat occupied by *Petrophytum cinerascens* is maintained primarily by natural abiotic processes rather than by interactions with other species.

C4b. Dietary versatility: Not applicable for plants

C4c. Pollinator versatility: Somewhat Increase.
Petrophytum cinerascens has relatively unspecialized flowers. It is probably pollinated by bumblebees (Gamon 1989). The diversity of bee species may be threatened by insecticide drift from nearby agricultural fields.

C4d. Dependence on other species for propagule dispersal: Neutral.
Seed dispersal in *Petrophytum* is passive, with small seeds spreading by gravity or high winds once the dry fruit capsule is ripe and splits open. The genus is not dependent on animals for dispersal.

C4e. Sensitivity to pathogens or natural enemies: Neutral.
Impacts from pathogens are not known. Due to its remote cliff habitat, *Petrophytum cinerascens* receives minimal impacts from livestock or ungulate grazing. Gamon (1989) noted that stems were sometimes nipped off by an unknown herbivore. Possible grazers could be rodents or insects. Overall impacts are probably low.

C4f. Sensitivity to competition from native or non-native species: Neutral.
Rocky microsites occupied by *Petrophytum cinerascens* are not especially vulnerable to competition from other native or introduced plant species.

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

C5a. Measured genetic variation: Neutral.
Michael Windham observed relatively high genetic variability in one population of *Petrophytum cinerascens* based on electrophoretic research (Gamon 1989)

C5b. Genetic bottlenecks: Unknown.

C5c. Reproductive System: Neutral
Petrophytum cinerascens produces perfect flowers that are pollinated by bees. Self-pollination could be possible.

C6. Phenological response to changing seasonal and precipitation dynamics: Neutral.
Based on flowering dates from specimens in the Consortium of Pacific Northwest herbaria website, no major 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 distribution of *Petrophytum cinerascens* has not changed notably in the last 50 years.

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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