Climate Change Vulnerability Index Report

Petrophytum caespitosum ssp. *caespitosum* (Rocky Mountain rockmat)

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Assessor: Walter Fertig, WA Natural Heritage Program

Geographic Area: Washington Heritage Rank: G5T3T5/S1

Index Result: Highly 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	100
	3.9-4.4° F (2.2-2.4°C) warmer	0
	<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	100
	-0.051 to -0.073	0
	-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
2aii. Change in physiological thermal niche		Somewhat Increase
2bi. Changes in historical hydrological niche		Somewhat Increase
2bii. Changes in physiological hydrological niche		Somewhat 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		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		Somewhat Increase

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: The single occurrence of *Petrophytum caespitosum* ssp. *caespitosum* in Washington (100%) occurs in an area with a projected temperature increase of 4.5-5.0° F (Figure 1).

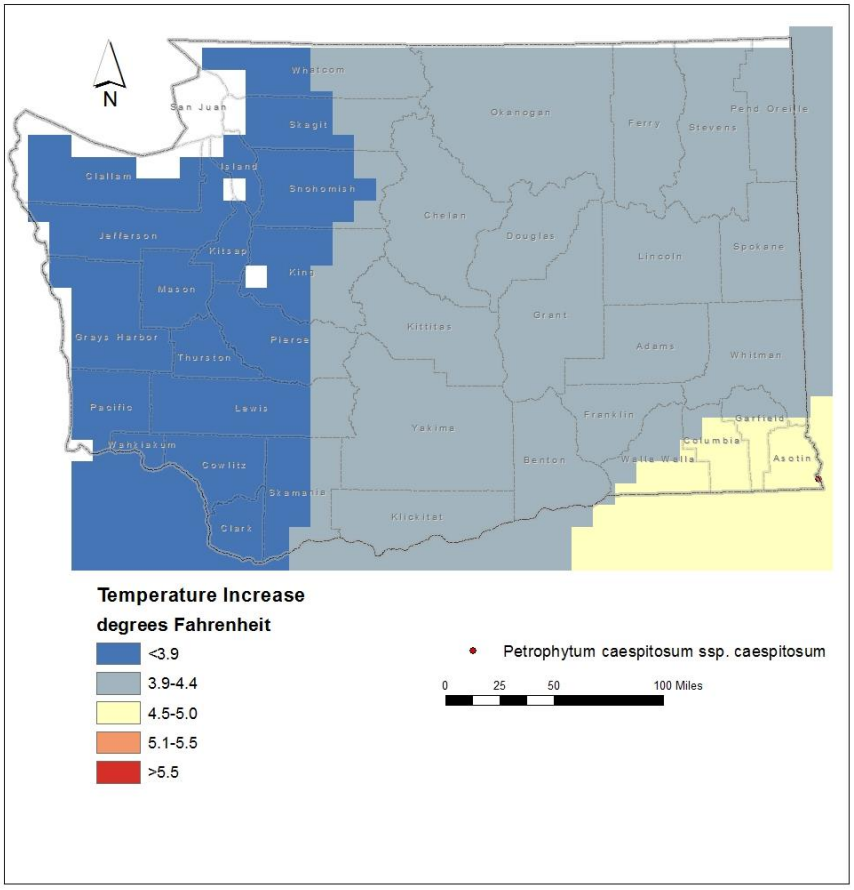

Figure 1. Exposure of *Petrophytum caespitosum* ssp. *caespitosum* occurrences in Washington to projected local temperature change. Base map layers from www.natureserve.org/ccvi

A2. Hamon AET:PET Moisture Metric: The one Washington occurrence of *Petrophytum caespitosum* ssp. *caespitosum* (100%) is found in an area with a projected decrease in available moisture (as measured by the ratio of actual to potential evapotranspiration) in the range of -0.074 to -0.096 (Figure 2).

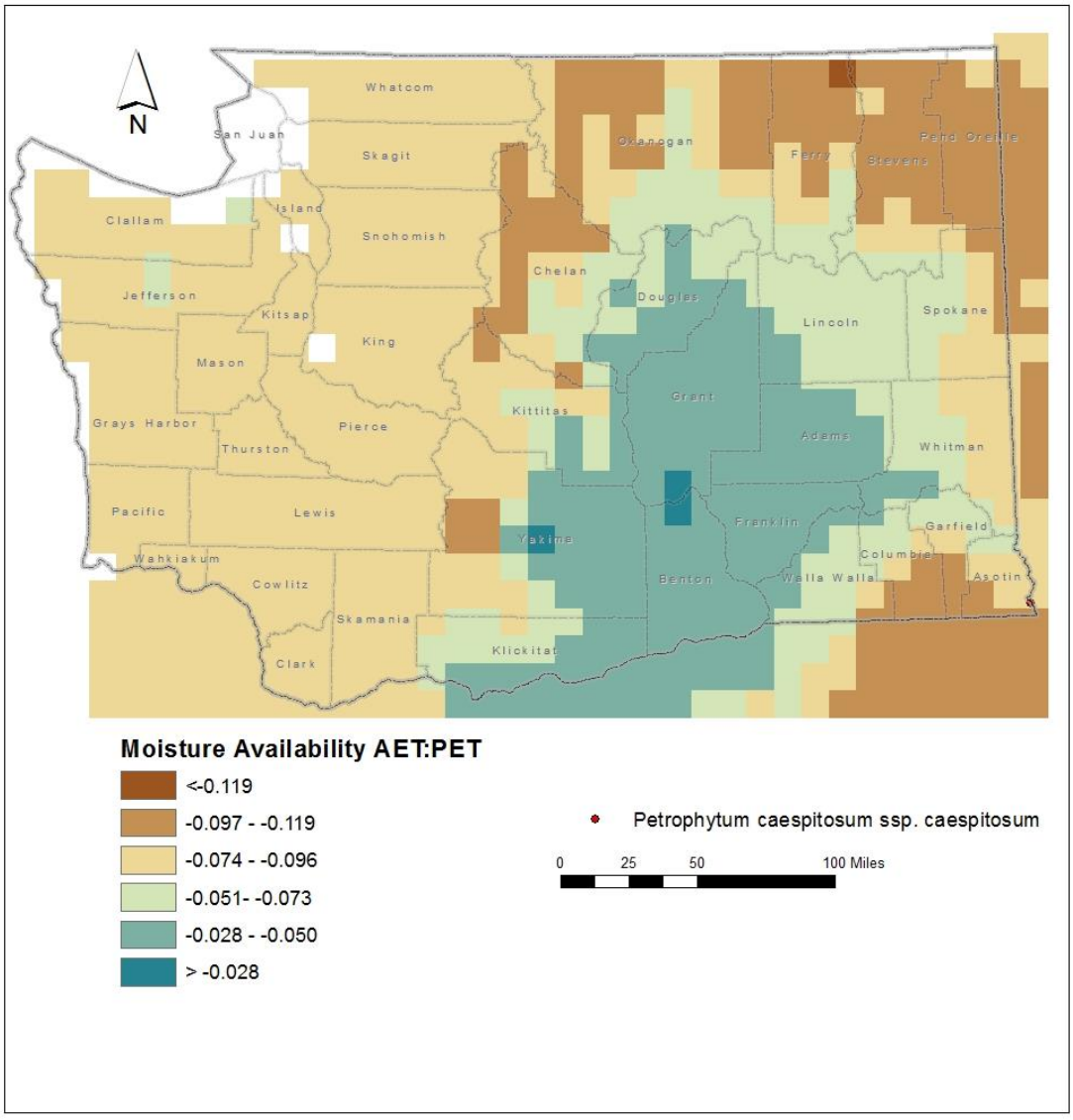

Figure 2. Exposure of *Petrophytum caespitosum* ssp. *caespitosum* occurrences in Washington to projected moisture availability (based on ratio of actual to predicted evapotranspiration). Base map layers from www.natureserve.org/ccvi

Section B. Indirect Exposure to Climate Change

B1. Exposure to sea level rise: Neutral.
In Washington, *Petrophytum caespitosum* ssp. *caespitosum* occurs at 2200 feet (670 m) and would not be inundated by projected sea level rise.

B2a. Natural barriers: Somewhat Increase.
The single Washington population of *Petrophytum caespitosum* ssp. *caespitosum* is found on ledges and faces of hard, dry, limestone cliffs near the mouth of the Grande Ronde and Snake rivers (Camp and Gamon 2011). This habitat is a component of the Inter-Mountain Basins Cliff and Canyon ecological system (Rocchio and Crawford 2015). The Washington occurrence is disjunct from the nearest population in Idaho by 46 miles (75 km) of unoccupied and unsuitable habitat. Deep canyons in the Blue Mountains area provide an effective barrier to dispersal.

B2b. Anthropogenic barriers: Neutral.
Human impacts are relatively minor within the occupied range of *Petrophytum caespitosum* ssp. *caespitosum* in southeastern Washington and present less of an obstacle to dispersal than natural barriers, such as the Snake River and its many tributary canyons.

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 caespitosum ssp. *caespitosum* produces 1-2 seeded dry follicle 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 caespitosum* ssp. *caespitosum* in Washington relative to mean seasonal temperature variation for the period from 1951-2006 ("historical thermal niche"). The single Washington occurrence (100%) is found in an area that has experienced average (57.1-77˚F/31.8-43.0˚C) temperature variation during the past 50 years and is considered at neutral risk from climate change (Young et al. 2016).

C2aii. Physiological thermal niche: Somewhat Increase.
The microsites within the limestone cliffs occupied by *Petrophytum caespitosum* ssp. *caespitosum* may be associated with cool, shaded conditions during the growing season and would have somewhat increased vulnerability to climate change.

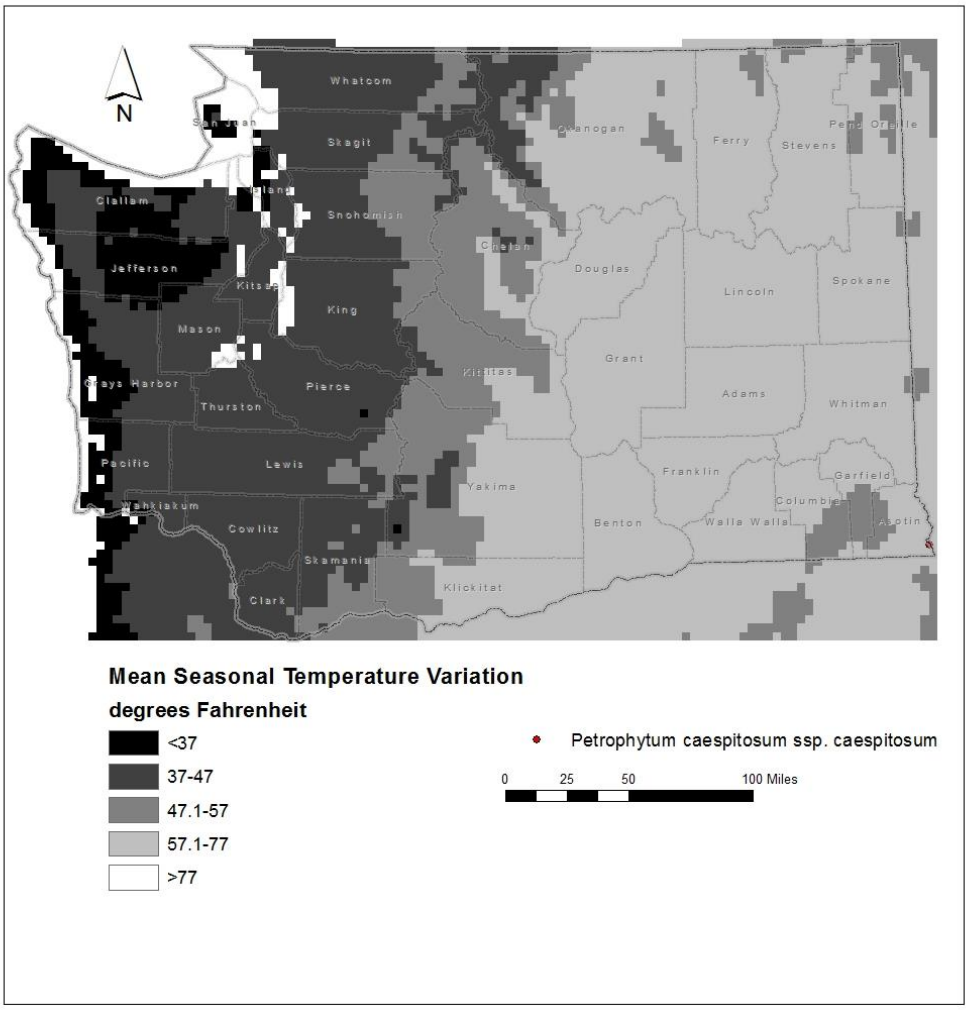

Figure 3. Historical thermal niche (exposure to past temperature variations) of *Petrophytum caespitosum* ssp. *caespitosum* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2bi. Historical hydrological niche: Somewhat Increase.
The single population of *Petrophytum caespitosum* ssp. *caespitosum* in Washington (100%) is found in an area that has 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 sites are at somewhat increased vulnerability from climate change.

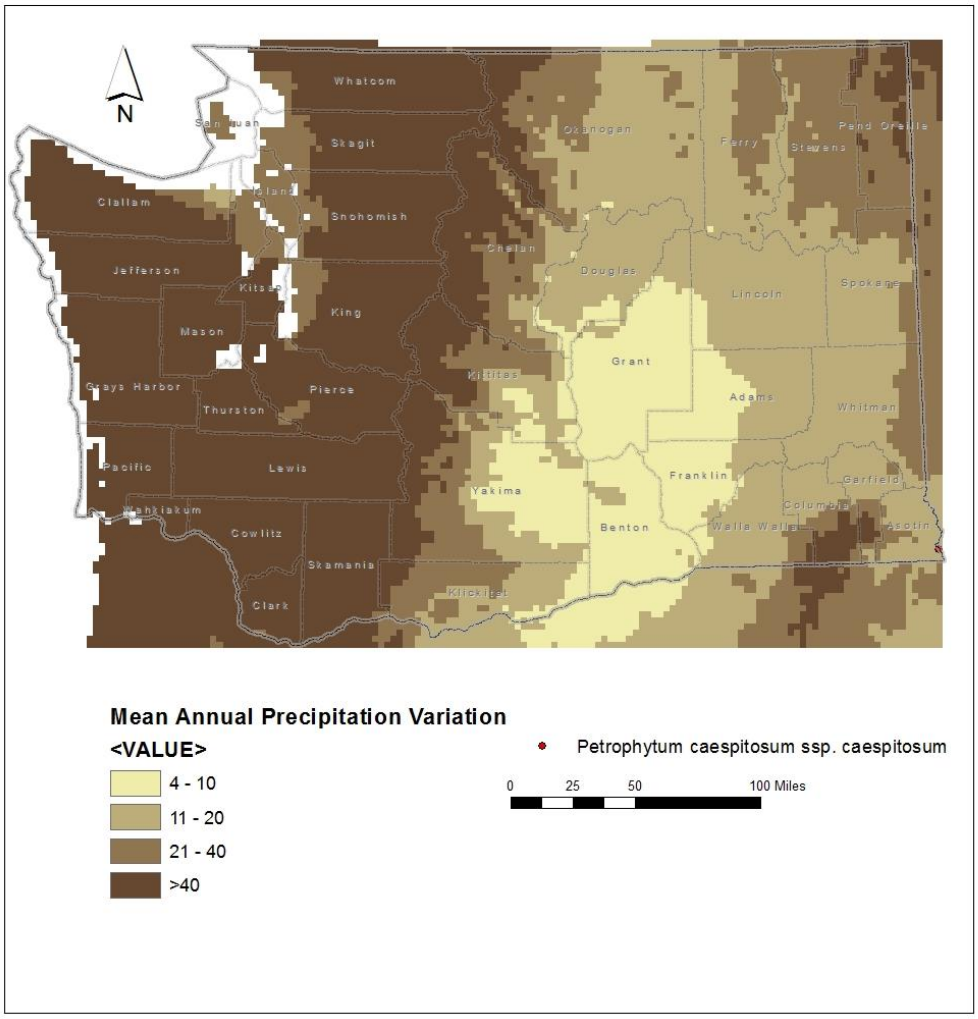

Figure 4. Historical hydrological niche (exposure to past variations in precipitation) of *Petrophytum caespitosum ssp. caespitosum* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2bii. Physiological hydrological niche: Somewhat 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 that could favor the replacement of perennial cushion plants in rock ledges with lichens or annual grasses (Rocchio and Ramm-Granberg 2017).

C2c. Dependence on a specific disturbance regime: Neutral.
Petrophytum caespitosum ssp. *caespitosum* is not dependent on periodic disturbances to maintain its montane cliff 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.
In Washington, *Petrophytum caespitosum* ssp. *caespitosum* occurs in an area of moderate accumulation of snow. It is probably more adversely affected by reduction in changes in the timing and volume of rainfall due to projected climate change (Rocchio and Ramm-Granberg 2017).

C3. Restricted to uncommon landscape/geological features: Increase.
The population of *Petrophytum caespitosum* ssp. *caespitosum* in Washington is found primarily on the Martin Bridge Limestone, a Triassic age metasedimentary formation, and the Doyle Creek Formation, a Triassic metasedimentary and metavolcanic layer (Washington Division of Geology and Earth Resources 2016). The species occurs mostly on hard cliffs rather than more erodible, softer limestones in the Lime Hill area (Curtis Björk, specimen label data, Consortium of Pacific Northwest Herbaria [https://www.pnwherbaria.org/index.php]). Limestone outcrops are uncommon in Washington, having mostly been buried by volcanic material.

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

C4b. Dietary versatility: Not applicable for plants

C4c. Pollinator versatility: Neutral.
Petrophytum caespitosum ssp. *caespitosum* has relatively unspecialized flowers. Based on its sticky pollen, this and related taxa in the tribe Spiraeeae (Rosaceae) are mostly pollinated by several families of bees (Song et al. 2017).

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. Animals may secondarily translocate fallen seed, but are not the primary dispersal agent.

C4e. Sensitivity to pathogens or natural enemies: Neutral.
Impacts from pathogens are not known. Due to its cliff habitat, *Petrophytum caespitosum* ssp. *caespitosum* receives minimal impacts from livestock or ungulate grazing.

C4f. Sensitivity to competition from native or non-native species: Neutral.
Rocky microsites occupied by *Petrophytum caespitosum* ssp. *caespitosum* are not especially vulnerable to competition from other native plant species. Rock ledges could become more susceptible to colonization by annual weedy plants under projected drier conditions in the future (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.
Genetic data are not available for the Washington population. Drysdale (1968) and McArthur and Sanderson (1985) documented a chromosome count of $n = 18$ for *Petrophytum caespitosum*. Genetic data are not available rangewide. Drysdale (1968) conducted a detailed morphologic analysis of specimens across the west (not including Washington) that suggests there is high genetic variability for the entire species. The Washington population likely contains a subset of the overall genetic diversity of the species due to inbreeding or founder effects.

C5b. Genetic bottlenecks: Unknown.
No data are available for the Washington population.

C5c. Reproductive System: Somewhat Increase.
Petrophytum caespitosum ssp. *caespitosum* produces perfect flowers that are pollinated by bees. The Washington population is disjunct from the nearest occurrences in central Idaho and likely has a fraction of the genetic variability of the species rangewide due to founder effects or inbreeding.

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 caespitosum* ssp. *caespitosum* has not changed notably since it was discovered in Washington in 1999.

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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