Climate Change Vulnerability Index Report

Polyctenium fremontii (Fremont's combleaf)

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Assessor: Walter Fertig, WA Natural Heritage Program

Geographic Area: Washington Heritage Rank: G4/S1

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	100
	-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		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		Unknown
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/Somewhat Increase

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: The single occurrence of *Polyctenium fremontii* in Washington (100%) occurs in an area with a projected temperature increase of 3.9-4.4˚ F (Figure 1).

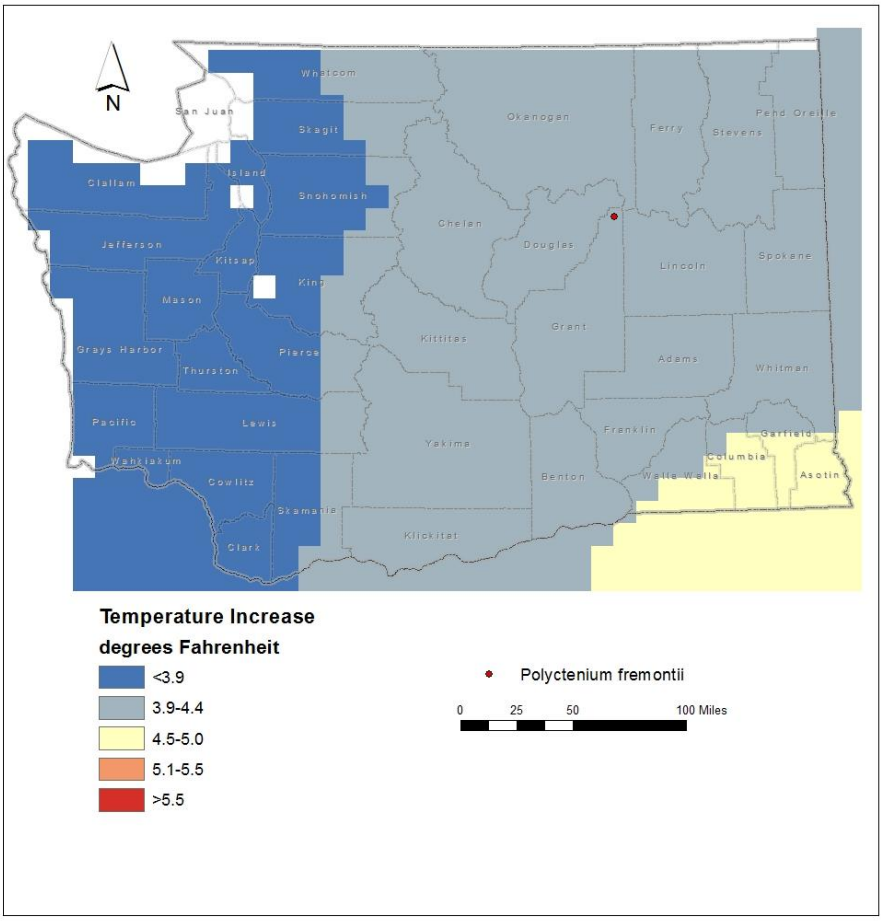

Figure 1. Exposure of *Polyctenium fremontii* occurrences in Washington to projected local temperature change. Base map layers from www.natureserve.org/ccvi

A2. Hamon AET:PET Moisture Metric: The single Washington occurrence of *Polyctenium fremontii* (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 -0.051 to -0.073 (Figure 2).

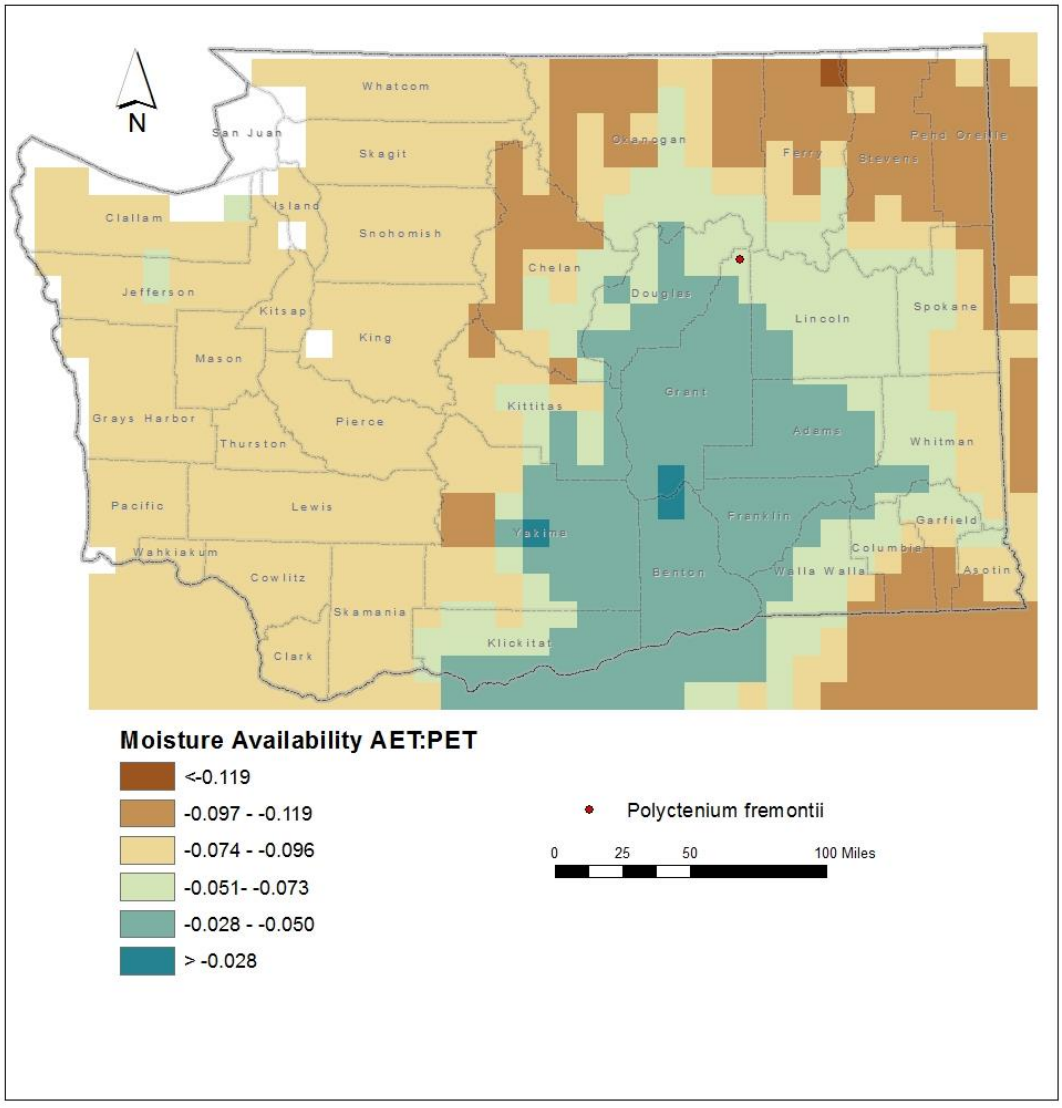

Figure 2. Exposure of *Polyctenium fremontii* occurrences in Washington to projected moisture availability (based on ratio of actual to predicted evapotranspiration). Base map layers from www.natureserve.org/ccvi

Section B. Indirect Exposure to Climate Change

B1. Exposure to sea level rise: Neutral.
Washington occurrences of *Polyctenium fremontii* are found at 2300 feet (700 m) and would not be inundated by projected sea level rise.

B2a. Natural barriers: Somewhat Increase.
In Washington, *Polyctenium fremontii* is found in shallow vernal depressions in basalt bedrock with 4-10 inches of cobbley to gravelly lithosol loam within sagebrush grassland (Camp and Gamon 2011, Fertig and Kleinknecht 2020). This habitat corresponds with the Columbia Plateau Vernal Pool ecological system (Rocchio and Crawford 2015). Elsewhere in its range, *P. fremontii* occurs in sagebrush desert and pinyon and Ponderosa pine woodlands (Hitchcock and Cronquist 2018). The single Washington occurrence occupies a small area embedded within a matrix of sagebrush, scabland, and agricultural vegetation and isolated from other areas of potential habitat.

B2b. Anthropogenic barriers: Neutral.
The range of *Polyctenium fremontii* in Washington is embedded within a matrix of native and human-influenced lands. The species is probably more isolated by natural barriers than anthropogenic 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.
Polyctenium fremontii produces many-seeded dry fruits that split along two sutures to release seeds passively by gravity or strong winds. Average dispersal distances are probably relatively short (100-1000 meters). The related species, *P. williamsiae* (a vernal wetland endemic of Nevada and California) is reported to have mucilaginous seeds, which would aid in its long-distance dispersal (Holland and Morefield 2003). Holmgren (2005) contends that the seeds of *Polyctenium* are not mucilaginous, which would suggest dispersal is limited to passive means.

C2ai. Historical thermal niche: Neutral.
Figure 3 depicts the distribution of *Polyctenium fremontii* in Washington relative to mean seasonal temperature variation for the period from 1951-2006 ("historical thermal niche"). The single known 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.

C2aii. Physiological thermal niche: Neutral.
The vernal pool/sagebrush/lithosol habitat of *Polyctenium fremontii* is not associated with cool environments in the growing season and would have neutral vulnerability to climate change.

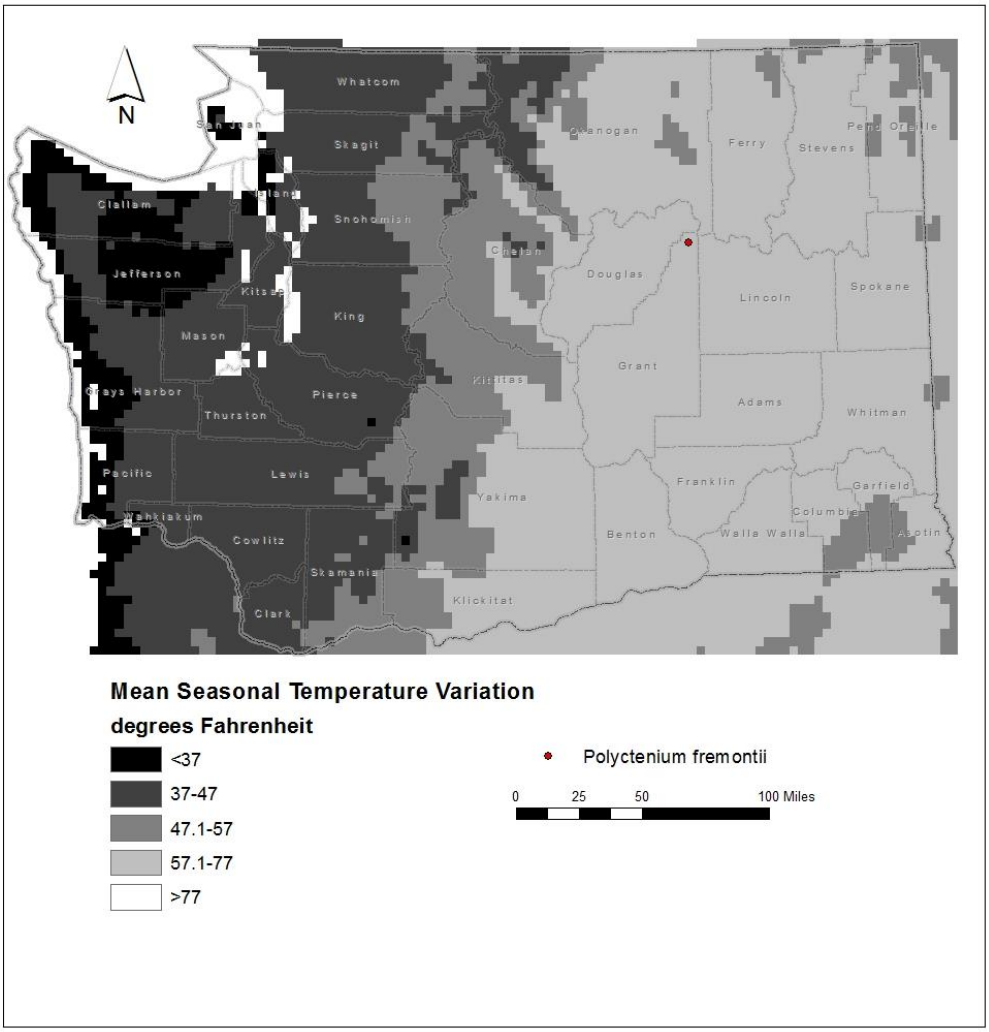

Figure 3. Historical thermal niche (exposure to past temperature variations) of *Polyctenium fremontii* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2bi. Historical hydrological niche: Somewhat Increase.
The single population of *Polyctenium fremontii* 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 areas are at somewhat increased vulnerability from climate change.

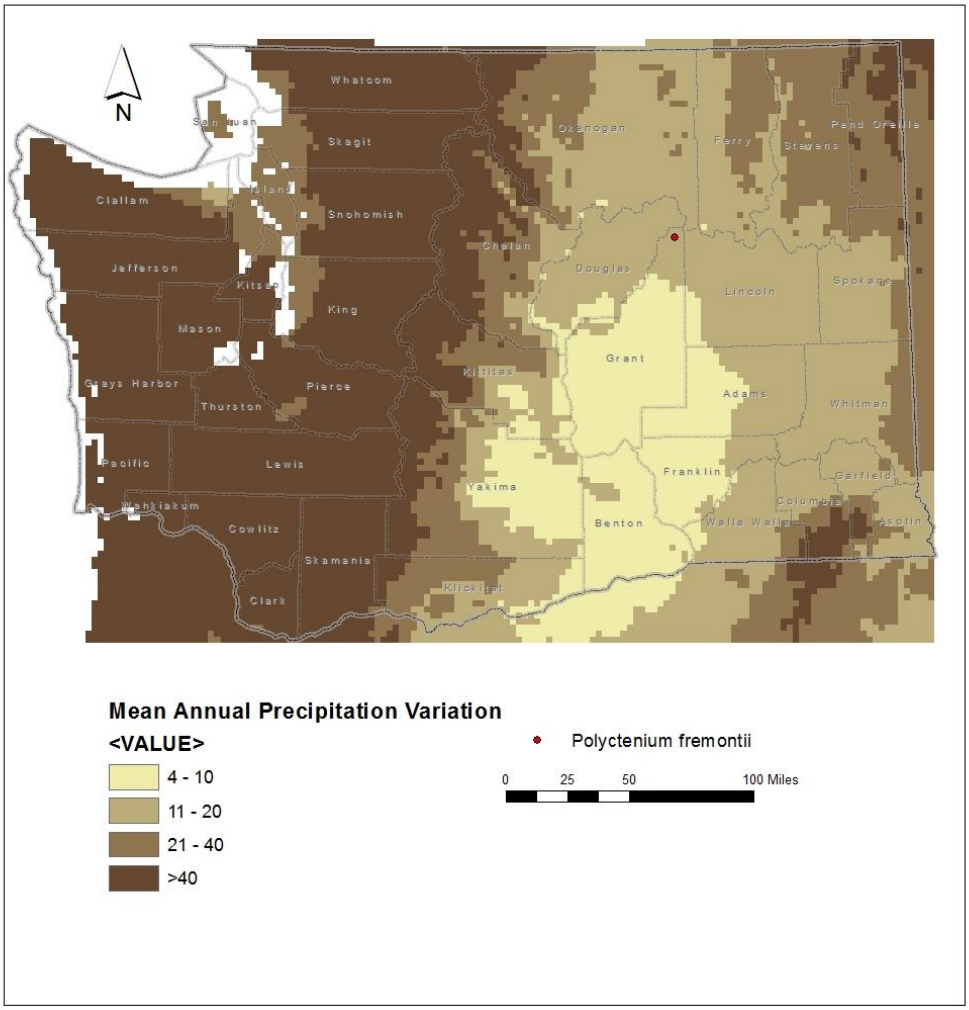

Figure 4. Historical hydrological niche (exposure to past variations in precipitation) of *Polyctenium fremontii* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2bii. Physiological hydrological niche: Greatly Increase.
In Washington, *Polyctenium fremontii* is a vernal pool obligate associated with basalt bedrock and thus dependent on winter or spring snow or rain (and not groundwater), followed 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 the ecological system to the sparsely vegetated Intermountain Basins Cliff and Canyon type.

C2c. Dependence on a specific disturbance regime: Neutral.
Polyctenium fremontii is not dependent on periodic and unpredictable disturbances to maintain its vernal pool/basalt outcrop habitat (although it does require predictable summer drought to prevent the sites from converting to another wetland ecological system) (Rocchio and Ramm-Granberg 2017). Increased disturbances related to prolonged drought (such as increase in fire frequency) would affect the sagebrush-grassland matrix in which the vernal pool systems are embedded.

C2d. Dependence on ice or snow-cover habitats: Neutral.
The range of *Polyctenium fremontii* in Washington in the northern Columbia Plateau is an area of relatively low snowfall (though vernal pool depressions would likely accumulate blowing snow). Also, the basalt bedrock underlying vernal pools in this area is not recharged by snow-melt.

C3. Restricted to uncommon landscape/geological features: Somewhat Increase.
In Washington, *Polyctenium fremontii* is strongly associated with shallow depressions in basalt scabland outcrops with thin lithosols and standing water in spring. While basalt outcrops are common in the Columbia Plateau, eroded depressions of appropriate depth to support vernal pool vegetation is less common, and probably an important limiting factor in the distribution and abundance of this species.

C4a. Dependence on other species to generate required habitat: Neutral
The habitat occupied by *Polyctenium fremontii* is maintained primarily by natural abiotic processes.

C4b. Dietary versatility: Not applicable for plants

C4c. Pollinator versatility: Unknown.
Pollinators are not known, but related species are visited by a variety of small insects (Holland and Morefield 2003).

C4d. Dependence on other species for propagule dispersal: Unknown.
Seed dispersal in *Polyctenium fremontii* is probably passive, with small seeds spreading by gravity or high winds once the dry fruit capsule is ripe and splits open. There is disagreement in the literature whether the seeds are mucilaginous when wet, and thus could be transported long distances by waterfowl (Holland and Morefield 2003, Holmgren 2005).

C4e. Sensitivity to pathogens or natural enemies: Neutral.
The related *Polyctenium williamsiae* is occasionally infected by rust fungi (Holland and Morefield 2003). *Polyctenium fremontii* is probably grazed by rabbits and insects. Impacts from livestock are poorly known.

C4f. Sensitivity to competition from native or non-native species: Somewhat Increase.
Polyctenium fremontii could be vulnerable to competition from other native or introduced plant species if its specialized vernal pool habitat became completely dried out due to climate change (Rocchio and Ramm-Granberg 2015).

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

C5a. Measured genetic variation: Unknown.
No studies of genetic variability for this species are known.

C5b. Genetic bottlenecks: Unknown.

C5c. Reproductive System: Neutral /Somewhat Increase
Polyctenium fremontii is pollinated by a variety of insects and is likely an outcrosser. The Washington occurrence is disjunct from others and probably has less genetic diversity due to founder effects or genetic drift.

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 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.
No changes in the distribution of this species in Washington has been observed in recent 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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