Climate Change Vulnerability Index Report

Kalmia procumbens (*Loiseluria procumbens*; Alpine azalea)

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Assessor: Walter Fertig, WA Natural Heritage Program

Geographic Area: Washington Heritage Rank: G5/SH (formerly S1)

Index Result: Extremely 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	100
	-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		Somewhat Increase
2ai Change in historical thermal niche		Increase
2aii. Change in physiological thermal niche		Increase
2bi. Changes in historical hydrological niche		Neutral
2bii. Changes in physiological hydrological niche		Neutral
2c. Dependence on specific disturbance regime		Neutral
2d. Dependence on ice or snow-covered habitats		Greatly 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		Somewhat Increase
4g. Forms part of an interspecific interaction not covered above		Neutral
5a. Measured genetic diversity		Somewhat Increase
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	Unknown
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: Both of the known occurrences of *Kalmia procumbens* in Washington (100%) occur in areas with a projected temperature increase of 3.9-4.4˚ F (Figure 1).

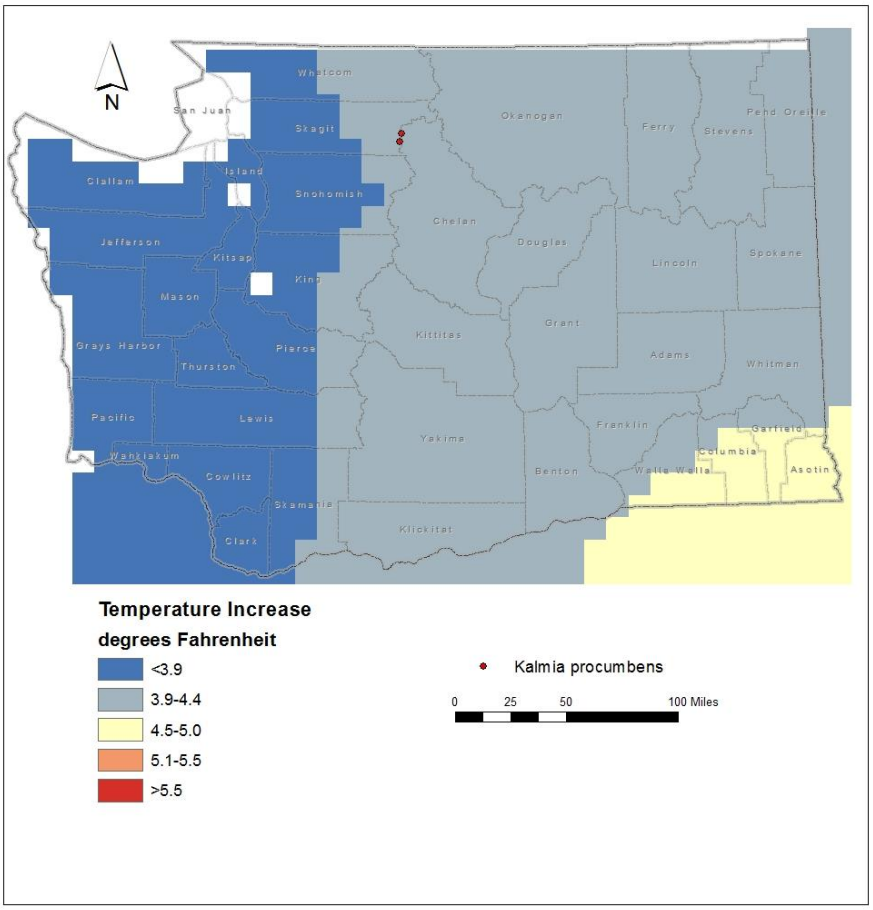

Figure 1. Exposure of *Kalmia procumbens* occurrences in Washington to projected local temperature change. Base map layers from www.natureserve.org/ccvi

A2. Hamon AET:PET Moisture Metric: The two occurrences of *Kalmia procumbens* (100%) 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 -0.074 to -0.096 (Figure 2).

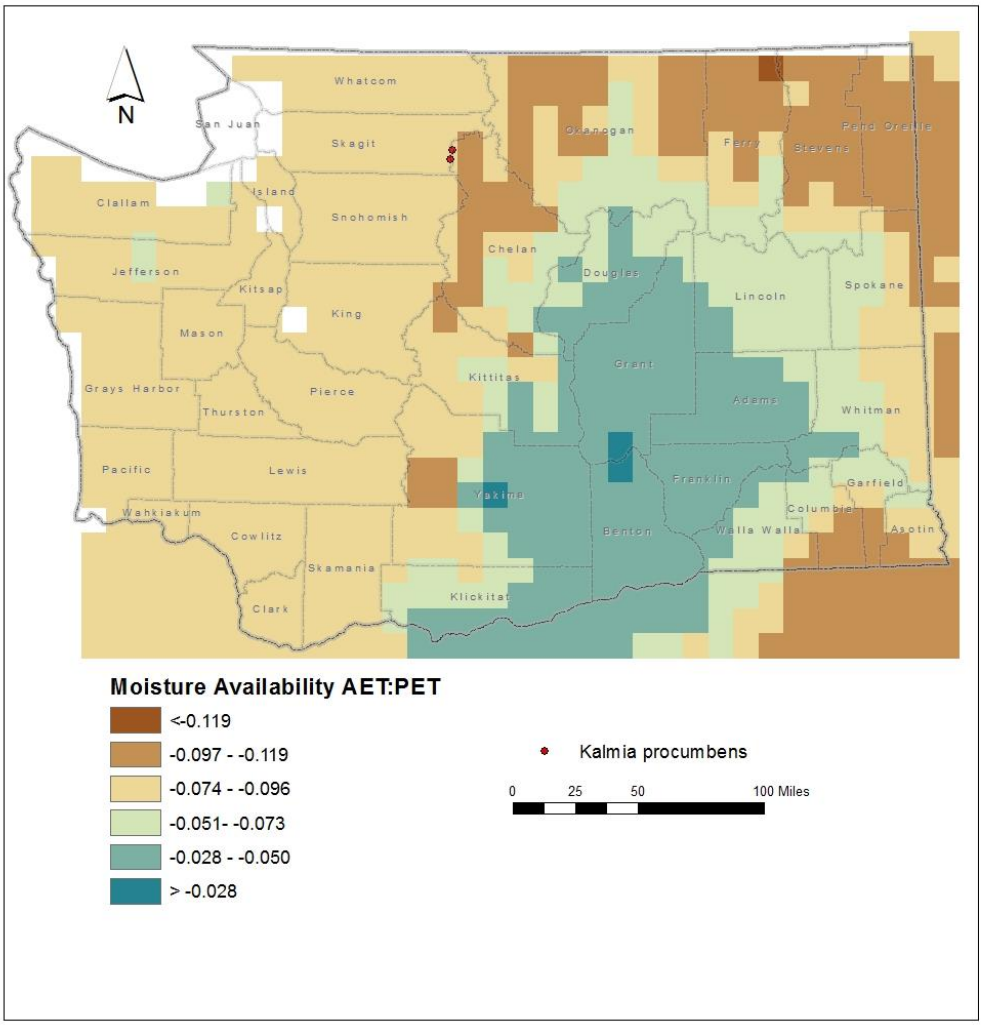

Figure 2. Exposure of *Kalmia procumbens* occurrences in Washington to projected moisture availability (based on ratio of actual to predicted evapotranspiration). Base map layers from www.natureserve.org/ccvi

Section B. Indirect Exposure to Climate Change

B1. Exposure to sea level rise: Neutral.
Washington occurrences of *Kalmia procumbens* are found at 6100-6550 feet (1800-2000 m) and would not be inundated by projected sea level rise.

B2a. Natural barriers: Somewhat Increase.
In Washington, *Kalmia procumbens* is found in cold, subalpine or alpine heath tundra vegetation often near lakeshores (Camp and Gamon 2011, Hitchcock and Cronquist 2018, WNHP records). This habitat is intermediate between the Temperate Pacific Subalpine-Montane Wet Meadow and North Pacific Dry and Mesic Alpine Dwarf-Shrubland, Fell-field and Meadow ecological systems (Rocchio and Crawford 2015). Individual populations occupy small areas and are separated by 6 km (3.7 miles). Although relatively widespread in the Cascades, this habitat type is naturally discontinuous, with montane valleys and lowlands presenting a natural barrier to gene flow.

B2b. Anthropogenic barriers: Neutral.
The range of *Kalmia procumbens* in Washington is in the subalpine/alpine ecotone in the Northern Cascades along the Chelan/Skagit county line. This area receives little impact from human activities other than seasonal recreation.

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

Section C: Sensitive and Adaptive Capacity

C1. Dispersal and movements: Somewhat Increase.
Kalmia procumbens produces dry, capsule fruits containing 100-150 tiny, winged seeds. Seeds are released passively and are probably dispersed by wind. Average distances may be relatively short, but a small fraction of seed could disperse over hundreds of meters. Typical dispersal distance is probably less than 1 km, so this factor is scored as 'somewhat increase' following Young et al. (2016).

C2ai. Historical thermal niche: Increase.
Figure 3 depicts the distribution of *Kalmia procumbens* in Washington relative to mean seasonal temperature variation for the period from 1951-2006 ("historical thermal niche"). Both of the known historical occurrences (100%) 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.

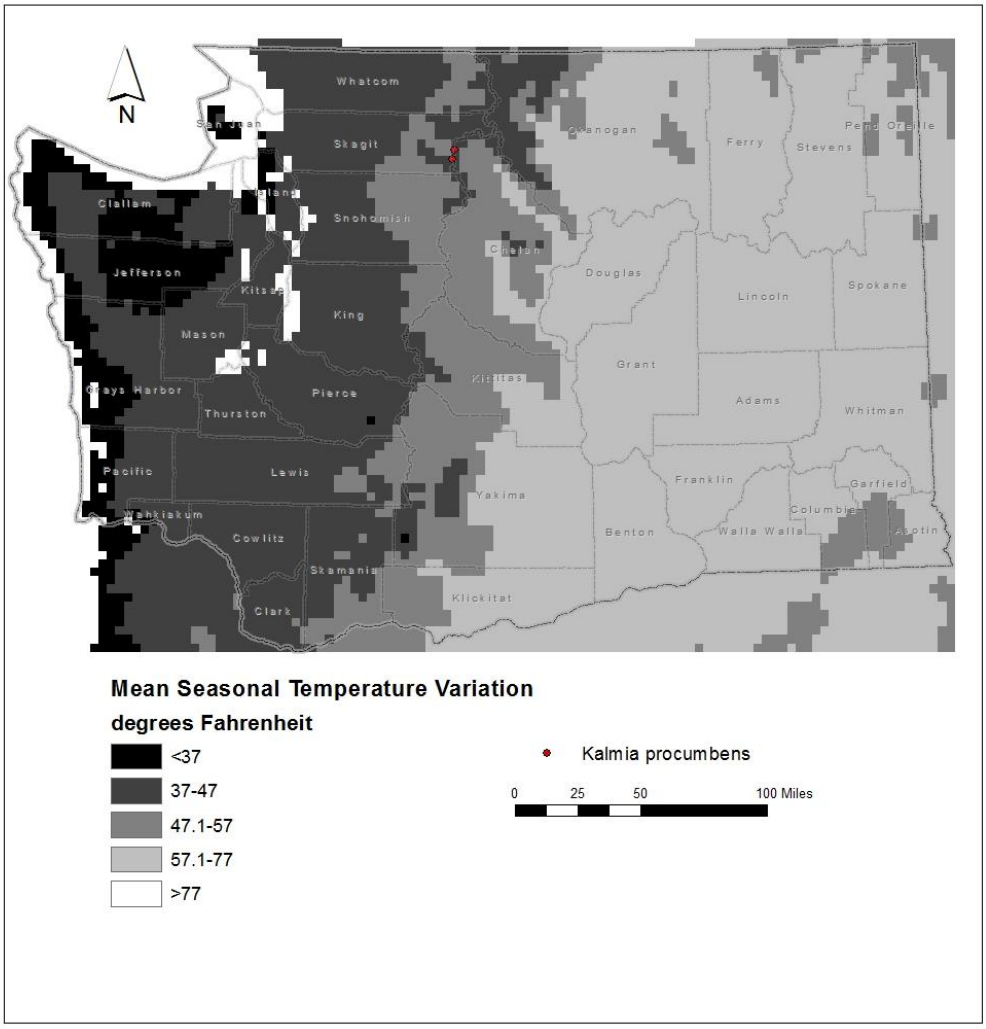

Figure 3. Historical thermal niche (exposure to past temperature variations) of *Kalmia procumbens* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2aii. Physiological thermal niche: Increase.
The subalpine/alpine heath habitat of *Kalmia procumbens* is associated with cold air drainage during the growing season and would have increased vulnerability to higher temperatures resulting from climate change.

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

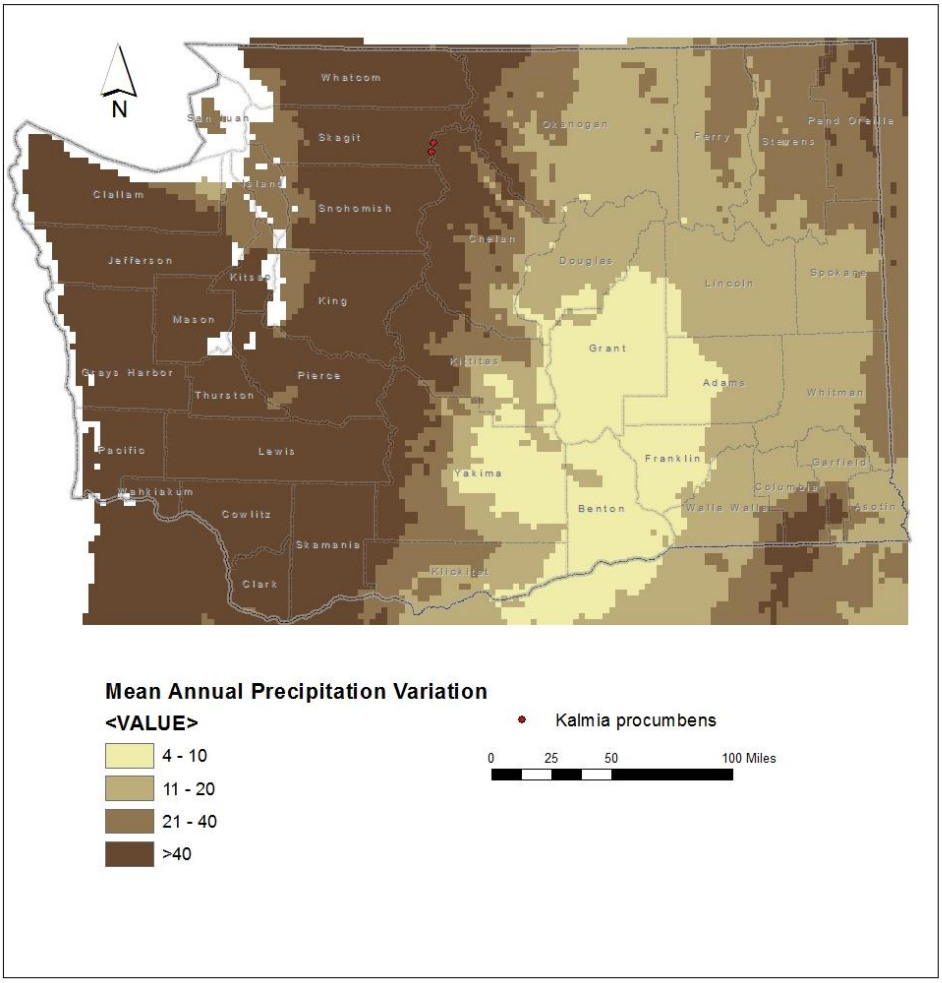

Figure 4. Historical hydrological niche (exposure to past variations in precipitation) of *Kalmia procumbens* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2bii. Physiological hydrological niche: Neutral.
This species is not dependent on a strongly seasonal hydrologic regime or specific wetland habitats (but see "Dependence on ice or snow-cover habitats" below).

C2c. Dependence on a specific disturbance regime: Neutral.
Kalmia procumbens is not dependent on periodic disturbances to maintain its subalpine/alpine heath habitat. The species could, however, be detrimentally affected by increased summer temperatures, drought, or decreased snowpack that might favor conversion of this habitat to forest or meadows (Rocchio and Ramm-Granberg 2017).

C2d. Dependence on ice or snow-cover habitats: Greatly Increase.
The populations of *Kalmia procumbens* in Washington occur at the subalpine/alpine ecotone in heath-dominated habitats near small lakes. These sites are highly dependent on moisture from late-lying snowbanks (Rocchio and Ramm-Granberg 2017). Changes in the amount of snow or timing of snowmelt could lead to shifts in the dominance of herbaceous species or invasion of trees or shrubs.

C3. Restricted to uncommon landscape/geological features: Neutral.
Kalmia procumbens is found on outcrops of Triassic-age gneiss, which is relatively widespread in the North Cascades Range.

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

C4b. Dietary versatility: Not applicable for plants

C4c. Pollinator versatility: Neutral.
Gracie (2020) notes that the primary pollinators of *Kalmia procumbens* are bees. In Europe, pollination has also been recorded by flies and butterflies. *Kalmia procumbens* is atypical in the genus in not having the ripe anthers held under tension in small pockets in the corolla tube and triggered to release pollen explosively when an insect steps on the spring-loaded filaments. The diversity of available pollinators is poorly known in Washington, but is assumed to be broad enough to warrant "neutral" designation.

C4d. Dependence on other species for propagule dispersal: Neutral.
Seeds are released passively by wind when the dry capsule fruits are mature and split open.

C4e. Sensitivity to pathogens or natural enemies: Neutral.
Impacts from pathogens are not known. This species is low-growing and not readily grazed by livestock.

C4f. Sensitivity to competition from native or non-native species: Somewhat Increase.
Kalmia procumbens can be sensitive to competition from other vegetation. Washington populations are sparse and difficult to observe amid dense patches of *Vaccinium deliciosum* and other heath species (Mary Fries, 1982 letter in WNHP files). Climate change is likely to increase competition from meadow species or invasive trees and shrubs if subalpine/alpine heath sites become drier or have reduced snowpack (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: Somewhat Increase.
Ikeda et al. (2017) examined the range-wide genetic diversity of *Kalmia procumbens* from northern Europe, NE Asia, Alaska, northern Canada, and the northeastern US to test hypotheses on the post-Pleistocene spread of this circumboreal arctic-alpine species. They found genetic differentiation between these population centers and evidence for secondary diversification between core arctic populations and outlying alpine ones. It is likely that the Washington occurrences, being at the southern periphery of the species range in western North America, have a reduced genome due to founder effects or limited gene flow with neighboring occurrences in southern British Columbia. Data are not available on the actual genetic diversity of Washington populations however, as neither has been relocated since 1963.

C5b. Genetic bottlenecks: Unknown.

C5c. Reproductive System: Neutral
Kalmia procumbens produces showy, insect-pollinated flowers and is a functional out-crosser due to the maturation of the stigmas before the anthers (Gracie 2020).

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: Unknown.
Kalmia procumbens has not been relocated in Washington (despite at least three attempts) since first being discovered in the state in 1963. It is possible that the species may be extirpated, or has avoided detection at other sites. Whether its present status is the result of ongoing climate change 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

Camp, P. and J.G. Gamon, eds. 2011. Field Guide to the Rare Plants of Washington. University of Washington Press, Seattle. 392 pp.

Gracie, C. 2020. Summer Wildflowers of the Northeast: A Natural History. Princeton University Press. 371 pp.

Ikeda, H., P. Bronken Eidesen, V. Yakubov, V. Barkalov, C. Brochmann, and H. Setoguchi. 2017. Late Pleistocene origin of the entire circumarctic range of the arctic-alpine plant *Kalmia procumbens*. Molecular Ecology 26(20): 5773-5783.

Rocchio, F.J. and R.C. Crawford. 2015. Ecological systems of Washington State. A guide to identification. Natural Heritage Report 2015-04. Washington Natural Heritage Program, WA Department of Natural Resources, Olympia, WA. 384 pp.

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