Climate Change Vulnerability Index Report

Geum rossii var. *depressum* (Ross's avens)

Date: 11 March 2021

Assessor: Walter Fertig, WA Natural Heritage Program

Geographic Area: Washington Heritage Rank: G5T1/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	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	20
	-0.074 to -0.096	80
	-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		Increase
2ai Change in historical thermal niche		Somewhat 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		Increase
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		Unknown
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/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: Documented or Modeled Response	
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: The five extant and historical occurrences of *Geum rossii* var. *depressum* in Washington (100%) occur in areas with a projected temperature increase of 3.9-4.4˚ F (Figure 1).

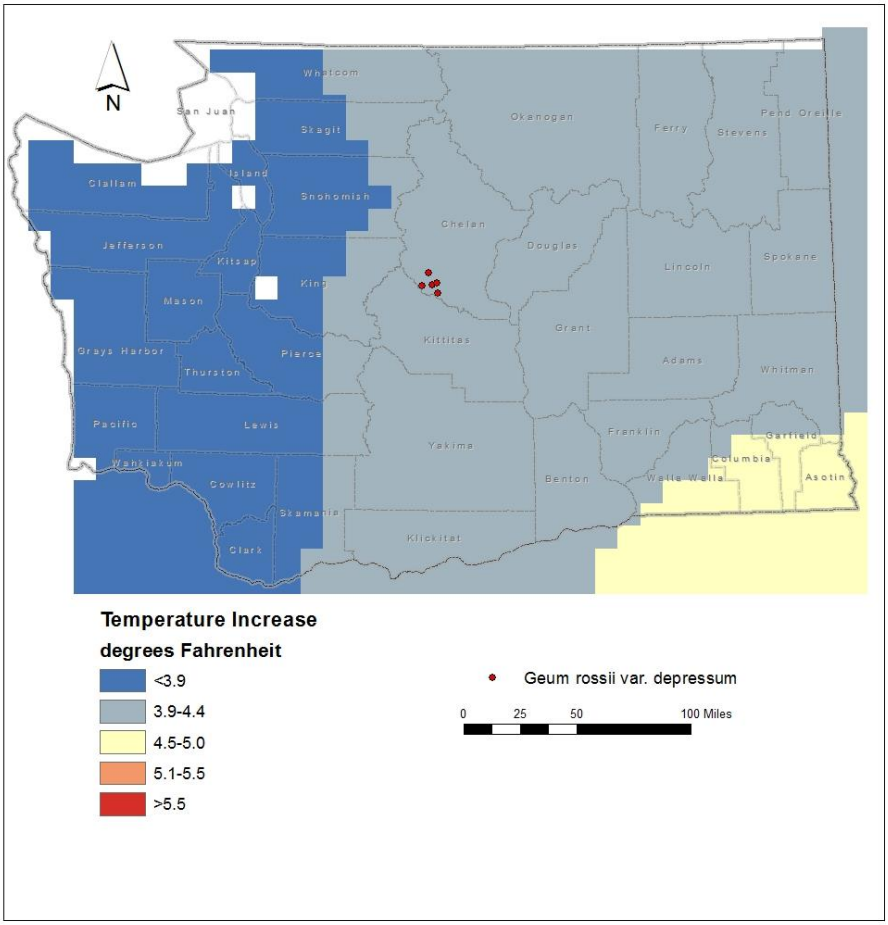

Figure 1. Exposure of *Geum rossii* var. *depressum* occurrences in Washington to projected local temperature change. Base map layers from www.natureserve.org/ccvi

A2. Hamon AET:PET Moisture Metric: Four of the five occurrences (80%) of *Geum rossii* var. *depressum* 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). One of the five populations (20%) is from an area with a projected decrease of -0.097 to -0.119.

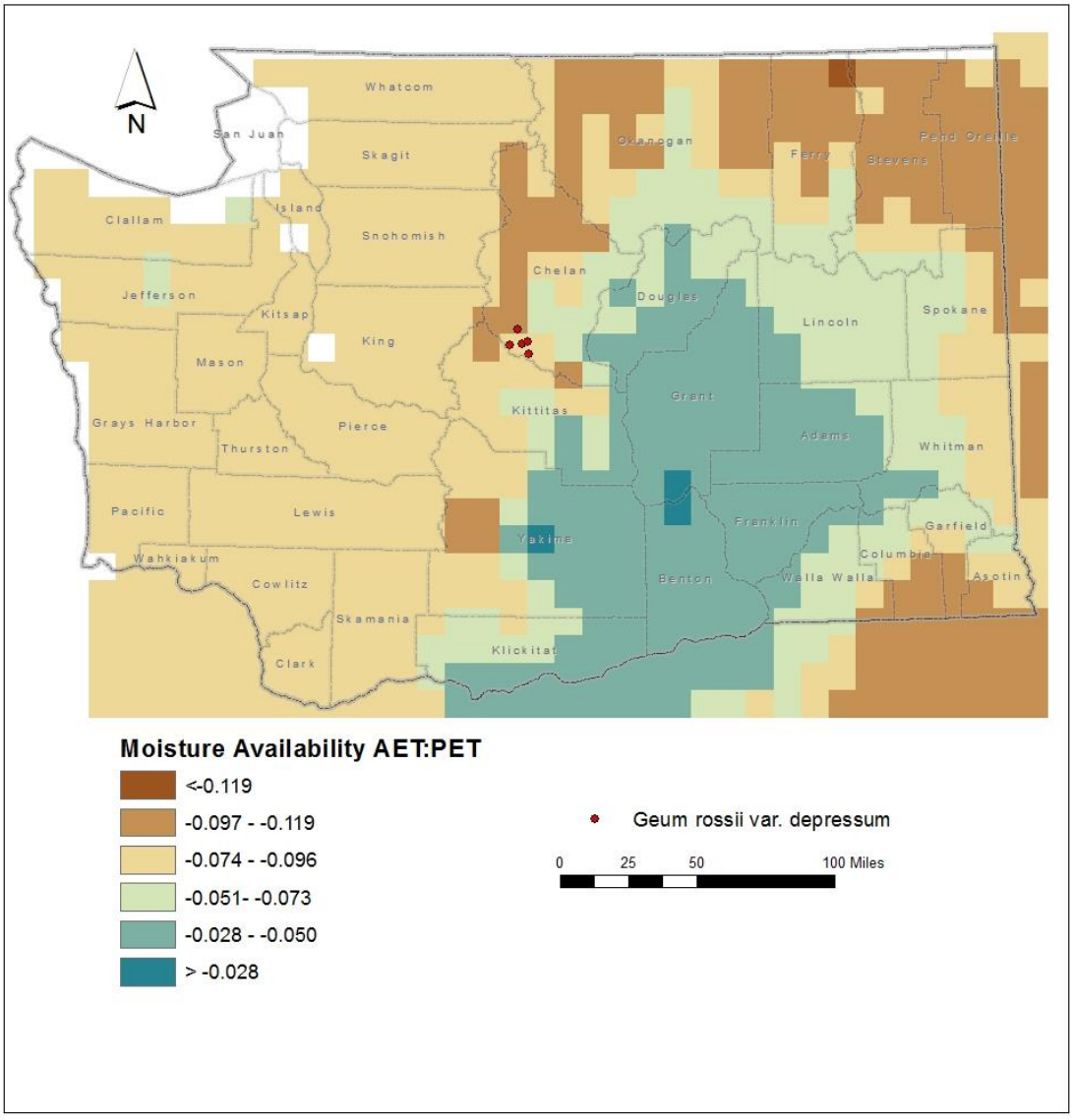

Figure 2. Exposure of *Geum rossii* var. *depressum* occurrences in Washington to projected moisture availability (based on ratio of actual to predicted evapotranspiration). Base map layers from www.natureserve.org/ccvi

Section B. Indirect Exposure to Climate Change

B1. Exposure to sea level rise: Neutral.
Washington occurrences of *Geum rossii* var. *depressum* are found at 6700-8400 feet (2040-2560 m) and would not be inundated by projected sea level rise.

B2a. Natural barriers: Somewhat Increase.
Geum rossii var. *depressum* occurs in alpine talus slopes, rock ledges, and cliffs of granite, quartz, and occasionally serpentine (Camp and Gamon 2011; Fertig 2020). This habitat is part of the North Pacific Serpentine Barren and Rocky Mountain Alpine Dwarf-Shrubland, Fell-Field, and Turf ecological systems (Rocchio and Crawford 2015). Populations are found on separate ridges or peaks isolated by 1.3-6 miles (6-10 km) of unoccupied and unsuitable habitat. The natural heterogeneity of available habitat forms a barrier to propagule dispersal and future migration.

B2b. Anthropogenic barriers: Neutral.
Four of the populations of *Geum rossii* var. *depressum* in Washington are found in wilderness or special interest areas with a minimal human footprint. The alpine summits inhabited by the species are surrounded by anthropogenic infrastructure in surrounding valley bottoms, but these areas are already a natural barrier to dispersal.

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

Section C: Sensitive and Adaptive Capacity

C1. Dispersal and movements: Increase.
Geum rossii var. *depressum* produces hairy, spindle-shaped, one-seeded achenes that lack structures associated with wind dispersal. Spence and Shaw (1983) suggested that pikas (*Ochotona princeps*) may disperse whole fruiting stalks of *Geum rossii* in the Wyoming Tetons as they gather and dry leaf material in hay piles for later storage and consumption in winter. Dispersal by gravity and small animals (rodents, lagomorphs) may account for short distance dispersal of fruits or fruiting stems of less than 25 m (the maximum foraging distance for pikas; Huntly et al. 1986).

C2ai. Historical thermal niche: Somewhat Increase.
Figure 3 depicts the distribution of *Geum rossii* var. *depressum* in Washington relative to mean seasonal temperature variation for the period from 1951-2006 ("historical thermal niche"). All five of the known occurrences in the state (100%) are found in areas that have experienced slightly lower than average (47.1-57˚F/26.3-31.8˚C) temperature variation during the past 50 years and are considered at somewhat increased vulnerability to climate change (Young et al. 2016).

C2aii. Physiological thermal niche: Greatly Increase.
The alpine talus habitat of *Geum rossii* var. *depressum* is entirely within a cold climate zone during the flowering season and is highly vulnerable to temperature increases from climate change.

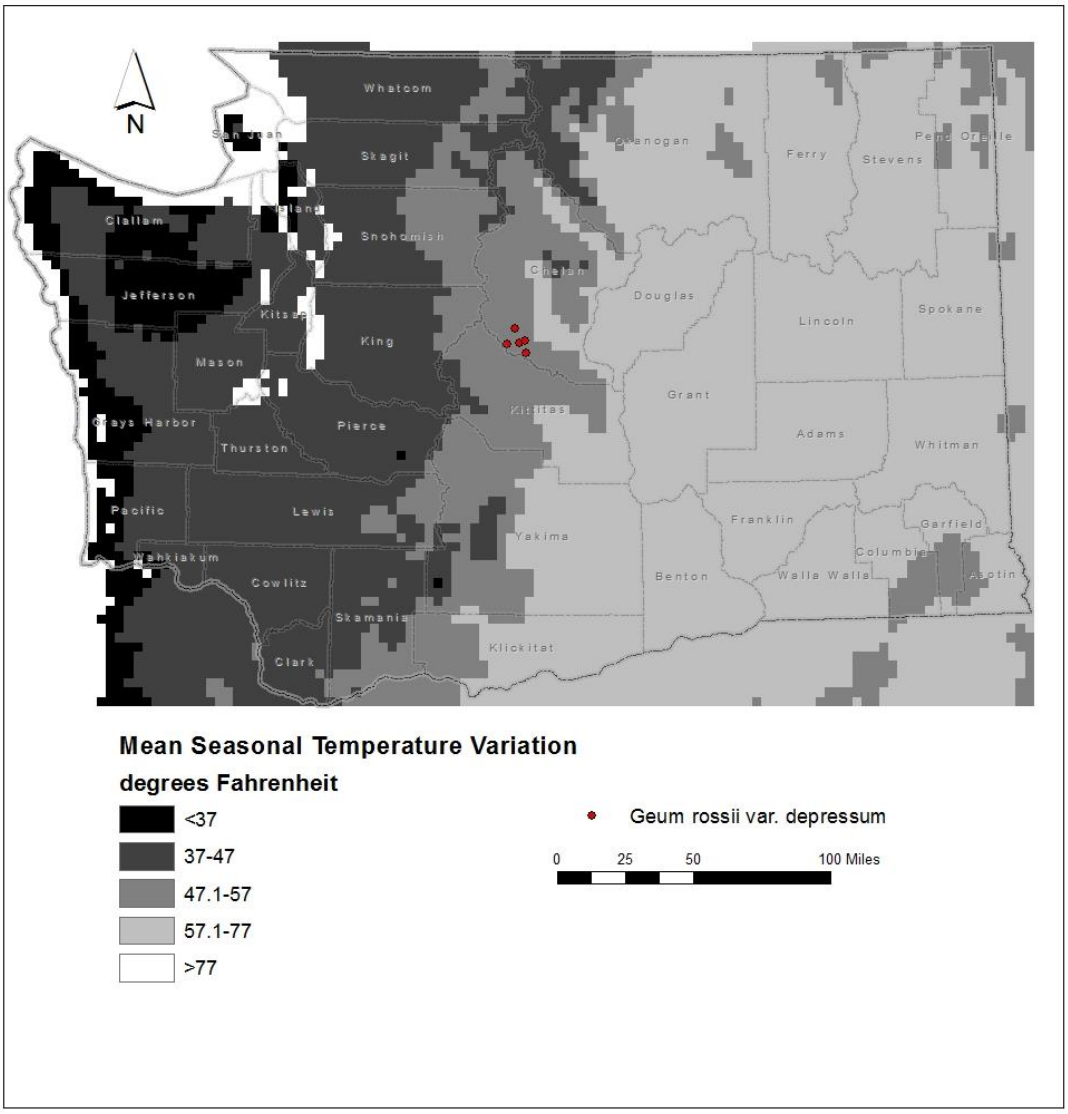

Figure 3. Historical thermal niche (exposure to past temperature variations) of *Geum rossii* var. *depressum* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2bi. Historical hydrological niche: Neutral.
All of the known populations of *Geum rossii* var. *depressum* in Washington (100%) are found in areas that have experienced greater than average precipitation variation in the past 50 years (>40 inches/1016 mm) (Figure 4). According to Young et al. (2016), these occurrences are neutral for climate change.

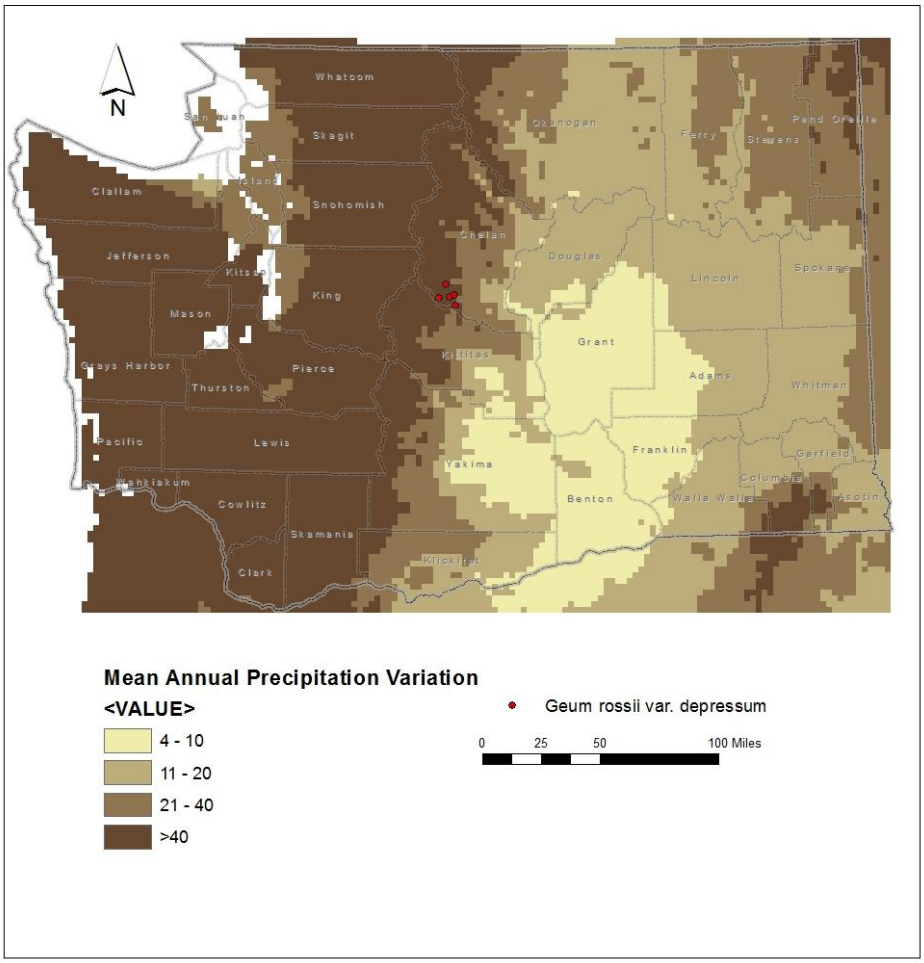

Figure 4. Historical hydrological niche (exposure to past variations in precipitation) of *Geum rossii* var. *depressum* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2bii. Physiological hydrological niche: Somewhat Increase.
This species is dependent on winter snow and summer precipitation for meeting its moisture needs, as populations are not associated with perennial wetlands or soils with a high water table. It could be vulnerable to changes in the timing or amount of snow and rainfall and earlier snowmelt related to warming temperatures (Rocchio and Ramm-Granberg 2017).

C2c. Dependence on a specific disturbance regime: Neutral.
Geum rossii var. *depressum* occurs in alpine talus and rock outcrop habitats that are subject to high winds. Other than occasional rock fall, these are largely undisturbed sites at present.

C2d. Dependence on ice or snow-cover habitats: Increase.
Populations of *Geum rossii* var. *depressum* in Washington are found on alpine talus slopes and ridgecrests associated with winter snow accumulation, though the areas may be free of snow due to evaporation or wind during the growing season. Reduced snowpack due to climate change would decrease the amount of moisture available through runoff (Rocchio and Ramm-Granberg 2017).

C3. Restricted to uncommon landscape/geological features: Increase.
Geum rossii var. *depressum* is found primarily on outcrops of the Mount Stuart Batholith (a pluton of gabbro, granite, and quartz diorite) (Washington Division of Geology and Earth Resources 2016). One historical population is also found on serpentine (Fertig 2020). These formations are uncommon in the East Cascades.

C4a. Dependence on other species to generate required habitat: Neutral.
The alpine talus habitat occupied by *Geum rossii* var. *depressum* is maintained largely by natural abiotic conditions.

C4b. Dietary versatility: Not applicable for plants

C4c. Pollinator versatility: Unknown.
Geum rossii has moderately large, bright yellow, cup-shaped flowers with numerous stamens and is likely pollinated by a variety of bees, flies, and butterflies. The specific pollinators of var. *depressum* in Washington are not known.

C4d. Dependence on other species for propagule dispersal: Neutral.
The dry achene fruits are dispersed by gravity or secondarily by insects, rodents, or pikas.

C4e. Sensitivity to pathogens or natural enemies: Neutral.
Impacts from pathogens are not known. Overall herbivory appears to be low.

C4f. Sensitivity to competition from native or non-native species: Neutral/Somewhat Increase.
Presently, competition from non-native species is minor, as few introduced plants are adapted to the harsh environmental conditions of the alpine zone. Vegetation cover is low in rocky talus slopes and fell-fields due to the paucity of germination sites and periodic rock fall. 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.
Geum rossii occurs from Alaska to Nunavut, south to northern British Columbia and in the Rocky Mountains from central Idaho and southwestern Montana to Nevada, Arizona and New Mexico with a disjunct population in the Wenatchee Mountains of north-central Washington. These three main population centers have been recognized as separate taxa, with var. *rossii* present in Alaska and Canada, var. *turbinatum* in the Rocky Mountains, and var. *depressum* endemic to Washington. These varieties differ in calyx color and venation, petal length, and leaf pubescence (Hitchcock and Cronquist 1961). Rohrer (2015) and Hitchcock and Cronquist

(2018) no longer recognize these varieties as taxonomically distinct. Surprisingly little genetic research has been done on the species, despite chromosome counts showing a range from $2n$ = 56 to 70 (Löve et al. 1971). Genetic data are lacking for Washington populations.

C5b. Genetic bottlenecks: Unknown.
Not known.

C5c. Reproductive System: Neutral/Somewhat Increase.
Geum rossii var. *depressum* has floral characteristics suggesting it is an outcrosser and likely to have normal genetic variability across its range. The isolated populations in Washington probably have reduced genetic diversity, however, due to genetic drift or founder effects.

C6. Phenological response to changing seasonal and precipitation dynamics: Neutral.
Based on herbarium specimens in the Consortium of Pacific Northwest Herbaria website (pnwherbaria.org) and WNHP records, the flowering period of *Geum rossii* var. *depressum* has not changed significantly in the last 50 years.

Section D: Documented or Modeled Response to Climate Change

D1. Documented response to recent climate change: Somewhat Increase.
Two occurrences of *Geum rossii* var. *depressum* in Washington are historical (not relocated in the last 40 years) and a third was not relocated in a recent site visit. The decline of these populations could be associated with climate change.

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.

Fertig, W. 2020. Potential federal candidate plant species of Washington. Natural Heritage Report 2020-01. Washington Natural Heritage Program, WA Department of Natural Resources, Olympia, WA. 97 pp.

Hitchcock, C.L. and A. Cronquist. 1961. Part 3: Saxifragaceae to Ericaceae. Pp. 1-614. In: C.L. Hitchcock, A. Cronquist, M. Ownbey, and J.W. Thompson, eds. Vascular Plants of the Pacific Northwest. University of Washington Press, Seattle, WA.

Hitchcock, C.L. and A. Cronquist. 2018. Flora of the Pacific Northwest, an illustrated manual, second edition. Edited by D.E. Giblin, B.S. Legler, P.F. Zika, and R.G. Olmstead. University of Washington Press and Burke Museum of Natural History and Culture, Seattle, WA. 882 pp.

Huntly, N.J., A.T. Smith, and B.L. Ivins. 1986. Foraging behavior of the pika (*Ochotona princeps*), with comparisons of grazing versus haying. Journal of Mammalogy 67(1): 139-148.

Löve, Á., D. Löve, and B.M. Kapoor. 1971. Cytotaxonomy of a century of Rocky Mountain orophytes. Arctic and Alpine Research 3(2): 139-165.

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.

Rocchio F.J. and T. Ramm-Granberg. 2017. Ecological System Climate Change Vulnerability Assessment. Unpublished Report to the Washington Department of Fish and Wildlife. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.

Rohrer, J.R. 2015. *Geum*. Pp. 58-70. In: Flora of North America Editorial Committee. Flora of North America North of Mexico. Volume 9 Magnoliophyta: Picramniaceae to Rosaceae. Oxford University Press, New York. 713 pp.

Spence, J.R. and R.J. Shaw. 1983. Observations on alpine vegetation near Schoolroom Glacier, Teton Range, Wyoming. Great Basin Naturalist 43(3): 483-491.

Washington Division of Geology and Earth Resources. 2016. Surface geology, 1:100,000--GIS data, November 2016: Washington Division of Geology and Earth Resources Digital Data Series DS-18, version 3.1, previously released June 2010. http://www.dnr.wa.gov/publications/ger_portal_surface_geology_100k.zip

Young, B.E., E. Byers, G. Hammerson, A. Frances, L. Oliver, and A. Treher. 2016. Guidelines for using the NatureServe Climate Change Vulnerability Index. Release 3.02. NatureServe, Arlington, VA. 48 pp. + app.