Climate Change Vulnerability Index Report

Lomatium knokei (Knoke's desert-parsley)

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Assessor: Walter Fertig, WA Natural Heritage Program

Geographic Area: Washington Heritage Rank: G1/S1

Index Result: Highly Vulnerable Confidence: Moderate

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	0
	-0.074 to -0.096	0
	-0.051 to -0.073	100
	-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		Somewhat Increase
2bi. Changes in historical hydrological niche		Neutral
2bii. Changes in physiological hydrological niche		Increase
2c. Dependence on specific disturbance regime		Neutral/Somewhat Increase
2d. Dependence on ice or snow-covered habitats		Somewhat Increase
3. Restricted to uncommon landscape/geological features		Increase
4a. Dependence on others species to generate required habitat		Neutral/Somewhat Increase
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		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
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 *Lomatium knokei* in Washington (100%) occurs in areas with a projected temperature increase of 3.9-4.4˚ F (Figure 1).

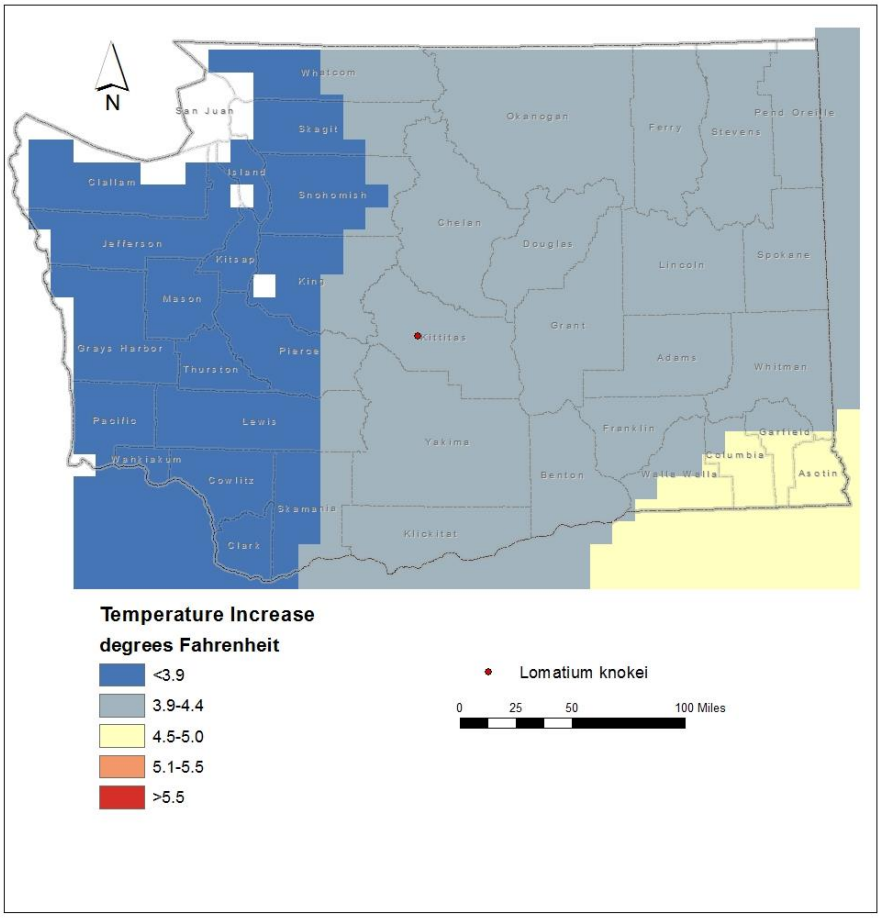

Figure 1. Exposure of *Lomatium knokei* occurrences in Washington to projected local temperature change. Base map layers from www.natureserve.org/ccvi

A2. Hamon AET:PET Moisture Metric: The single Washington occurrence of *Lomatium knokei* (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).

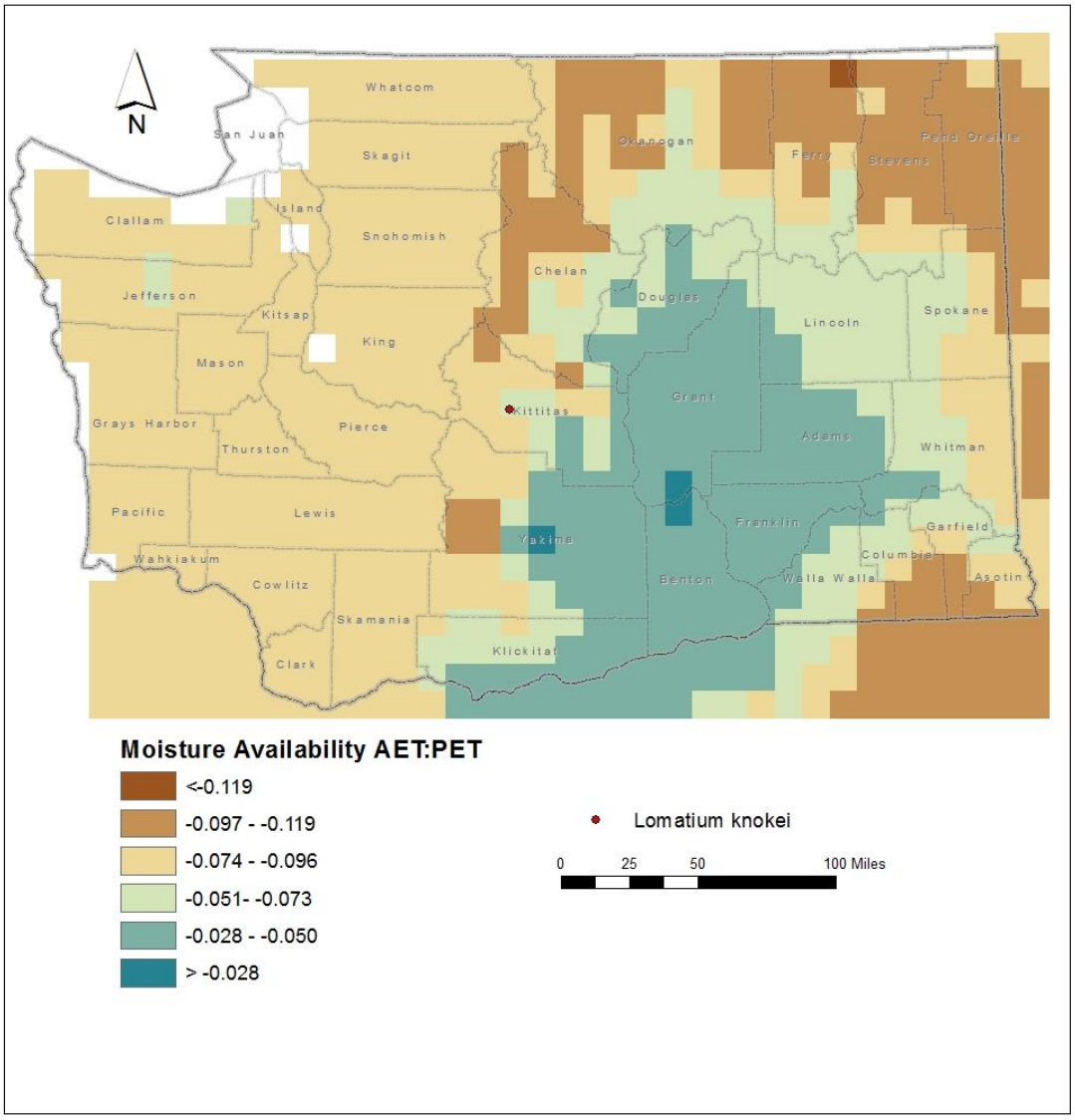

Figure 2. Exposure of *Lomatium knokei* occurrences in Washington to projected moisture availability (based on ratio of actual to predicted evapotranspiration). Base map layers from www.natureserve.org/ccvi

Section B. Indirect Exposure to Climate Change

B1. Exposure to sea level rise: Neutral.
Washington occurrences of *Lomatium knokei* are found at 3940-3985 feet (1200-1215 m) and would not be inundated by projected sea level rise.

B2a. Natural barriers: Somewhat Increase.
In Washington, *Lomatium knokei* is found in seasonally wet depressions in forb-rich mountain meadows surrounded by Douglas-fir (*Pseudotsuga menziesii*), grand fir (*Abies grandis*) and lodgepole pine (*Pinus contorta* var. *latifolia*) forests (Darrach 2014; Fertig 2020; Washington Natural Heritage Program 2021). This habitat is a component of the Rocky Mountain Alpine-Montane Wet Meadow ecological system (Rocchio and Crawford 2015. Additional areas of suitable potential habitat in the East Cascades are separated by dense forests or broad valleys which present a barrier to seed dispersal.

B2b. Anthropogenic barriers: Neutral.
The limited range of *Lomatium knokei* is bisected by roads, including one through the core of its main subpopulation. These disturbances may create some of the rutted depression habitat in which this species grows. Dispersal is probably more constrained by large blocks of unsuitable forest or dry valleys that isolate areas of seasonal wetland habitat.

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

Section C: Sensitivity and Adaptive Capacity

C1. Dispersal and movements: Increase.
Lomatium knokei produces dry, flattened, elliptical fruits (schizocarps) that split at maturity into two one-seeded segments. Each fruit segment has a narrow, membranous wing along the margins to facilitate dispersal by wind. Other structures, such as hooks, barbs, or rough hairs for attachment to animals are not present. In general, *Lomatium* species have poor dispersal ability (less than 100 meters) which may account for their unusually high degree of endemism in western North America (Marisco and Hellman 2009).

C2ai. Historical thermal niche: Somewhat Increase.
Figure 3 depicts the distribution of *Lomatium knokei* in Washington relative to mean seasonal temperature variation for the period from 1951-2006 ("historical thermal niche"). The single occurrence (100%) is found in an area that has experienced slightly lower than average temperature variation (47.1-57˚F/26.3-31.8˚C) during the past 50 years and is considered at somewhat increased risk from climate change (Young et al. 2016).

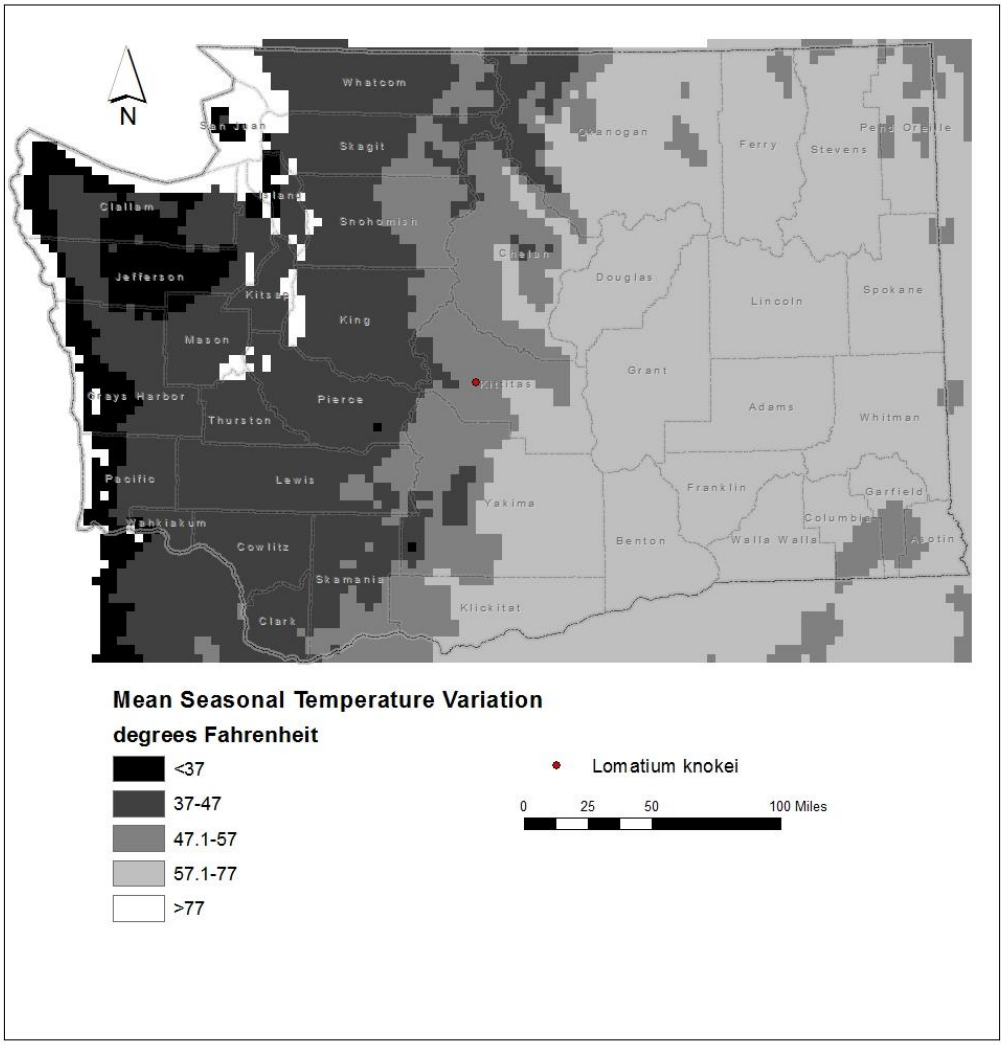

Figure 3. Historical thermal niche (exposure to past temperature variations) of *Lomatium knokei* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2aii. Physiological thermal niche: Somewhat Increase.
The seasonally wet montane meadow areas inhabited by *Lomatium knokei* are associated with cold air drainage during the growing season and could be vulnerable to increased temperatures associated with climate change.

C2bi. Historical hydrological niche: Neutral.
The single known population of *Lomatium knokei* in Washington (100%) is found in an area that has experienced greater than average (>40 inches/1016 mm) precipitation variation in the past 50 years (Figure 4) and is at neutral vulnerability from climate change (Young et al. 2016).

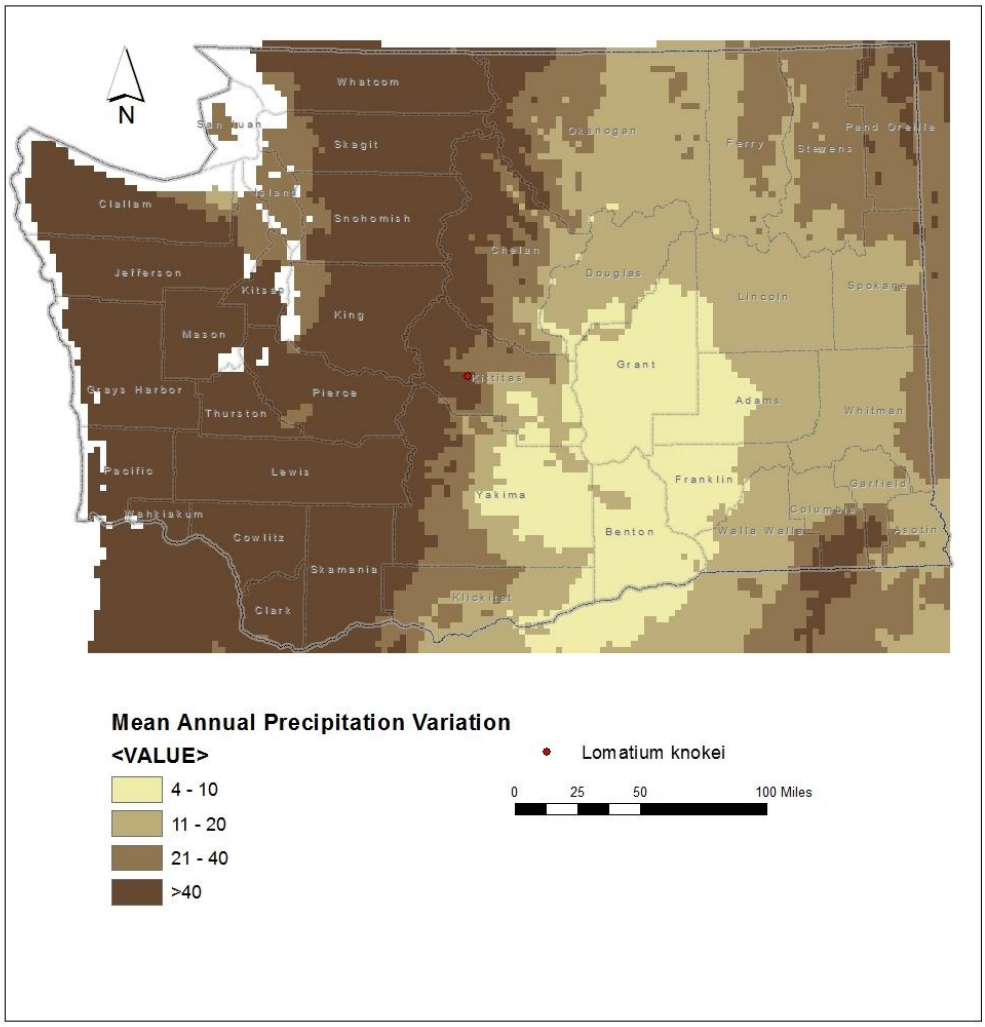

Figure 4. Historical hydrological niche (exposure to past variations in precipitation) of *Lomatium knokei* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2bii. Physiological hydrological niche: Increase.
Lomatium knokei is found in seasonally wet depressions in clay-rich soils in montane meadows. These sites do not appear to be associated with springs, but rather represent low spots in the landscape where snow drifts or spring melt-water accumulates. Changes in the amount of snowfall and the timing of snowmelt resulting from warmer temperatures could have significant impacts on *Lomatium knokei* and its habitat (Darrach 2014). Decreases in summer precipitation and rising temperatures could also affect these meadow sites by favoring the spread of more drought-tolerant herbaceous species, or encroachment by trees and shrubs (Rocchio and Ramm-Granberg 2017).

C2c. Dependence on a specific disturbance regime: Neutral/Somewhat Increase.
Lomatium knokei is found in low depressions that may be formed by erosion or wallowing by elk or deer. These depressions may also be associated with ruts from dirt roads. Periodic wildfire may be important in keeping meadow sites open and free from encroachment by woody species. Wildfire is likely to increase in the future due to summer drought and reduced precipitation (Rocchio and Ramm-Granberg 2017).

C2d. Dependence on ice or snow-cover habitats: Somewhat Increase.
Lomatium knokei occurs in areas of moderate accumulation of snow. Drifting or late-melting snow is an important source of spring moisture during the flowering and fruiting period of *L. knokei* (Darrach 2014).

C3. Restricted to uncommon landscape/geological features: Increase.
Lomatium knokei is restricted to the Hakker soil series which is a seasonally wetted, fine-grained clay-loam (Darrach 2014) derived from colluvium and basalt bedrock of the Grande Ronde Basalt (Washington Division of Geology and Earth Resources 2016). The Hakker series is not widespread in the mountains south of Cle Elum. This species may also be dependent on a landscape feature (depressions that are seasonally wet) that is not widespread.

C4a. Dependence on other species to generate required habitat: Neutral/Somewhat Increase.
The seasonally flooded depressions within montane meadows occupied by *Lomatium knokei* may be formed or maintained by wallowing ungulates.

C4b. Dietary versatility: Not applicable for plants

C4c. Pollinator versatility: Unknown.
The specific pollinators of *Lomatium knokei* are not known, but other tuberous *Lomatium* species are pollinated by solitary bees, syrphid flies, tachinid flies, muscid flies, bee flies, and beetles (Schlessman 1982).

C4d. Dependence on other species for propagule dispersal: Neutral.
The dry, one-seeded fruits of *Lomatium knokei* are dispersed primarily by wind, gravity, or other passive means. The species is not dependent on animals for transport.

C4e. Sensitivity to pathogens or natural enemies: Neutral.
Impacts from pathogens are not known. Darrach (2014) noted that *Lomatium knokei* is sometimes infested with aphids and gall-forming insects, which may be an important source of herbivory.

C4f. Sensitivity to competition from native or non-native species: Somewhat Increase.
The seasonally wet depressions occupied by *Lomatium knokei* could be vulnerable to invasion by competing native or introduced species under prolonged periods of drought (Rocchio and Ramm-Granberg 2017). This species appears to be absent or sparse in adjacent meadow areas with dense cover of other herbaceous species.

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

C5a. Measured genetic variation: Unknown.
Data are not available on genetic diversity within *Lomatium knokei*.

C5b. Genetic bottlenecks: Unknown.

C5c. Reproductive System: Neutral.
Lomatium knokei is andromonoecious and produces compound umbels with individual umbellets comprised of all staminate flowers or a mix of staminate and pistillate flowers (and some perfect flowers) (Darrach 2014). Occasional plants may also be monoecious. The presence of separate gendered flowers that mature at different times promotes outcrossing and leads to higher genetic variability (Schlessman 1982).

C6. Phenological response to changing seasonal and precipitation dynamics: Neutral.
Onset of flowering in *Lomatium knokei* appears to be tied to the melting of mountain snow, which may vary from early April to mid May. The timing of flowering has not changed significantly, however, since the species was first documented in 2002 (Darrach 2014).

Section D: Documented or Modeled Response to Climate Change

D1. Documented response to recent climate change: Neutral.
Lomatium knokei was first recognized in 2002 and was not formally described as a new species until 2014 (Darrach 2014). To date, it is known only from 3 small patches within a single population in the mountains south of Cle Elum, Washington (Fertig 2020). Searches of other potential seasonal wetland sites in the vicinity have not located any additional populations. Due to the paucity of baseline data, no inferences can be made about impacts of climate change to this species since its discovery.

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

Darrach, M.E. 2014. *Lomatium knokei* (Apiaceae), a new, narrowly endemic species from Washington state. Phytoneuron 2014-108:1-12.

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.

Fertig, W. and J. Kleinknecht. 2020. Conservation status and protection needs of priority plant species in the Columbia Plateau and East Cascades ecoregions. Natural Heritage Report 2020-02. Washington Natural Heritage Program, WA Department of Natural Resources, Olympia, WA. 173 pp.

Marsico, T.D. and J.J. Hellman. 2009. Dispersal limitation inferred from an experimental translocation of *Lomatium* (Apiaceae) species outside their geographic ranges. Oikos 118:1783-1792.

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.

Schlessman, M.A. 1982. Expression of andromonoecy and pollination of tuberous *Lomatium*s (Umbelliferae). Systematic Botany 7(2): 134-149.

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

Washington Natural Heritage Program. 2021-. *Lomatium knokei*. In: Field Guide to the Rare Plants of Washington. (https://fieldguide.mt.gov/wa/?species=lomatium%20knokei). Accessed 28 September 2021.

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.