

Climate Change Vulnerability Index Report

Carex proposita (Smoky Mountain sedge)

Date: 5 November 2019

Assessor: Walter Fertig, WA Natural Heritage Program

Geographic Area: Washington

Heritage Rank: G4/S2

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	91
	<3.9° F (2.2°C) warmer	9
2. Hamon AET:PET moisture	< -0.119	0
	-0.097 to -0.119	55
	-0.074 to -0.096	45
	-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		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		Somewhat Increase
2aii. Change in physiological thermal niche		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		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		Neutral
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	
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: Ten of the 11 known occurrences of *Carex proposita* in Washington (91%) are found in areas with a projected temperature increase of 3.9-4.4° F (Figure 1). One other

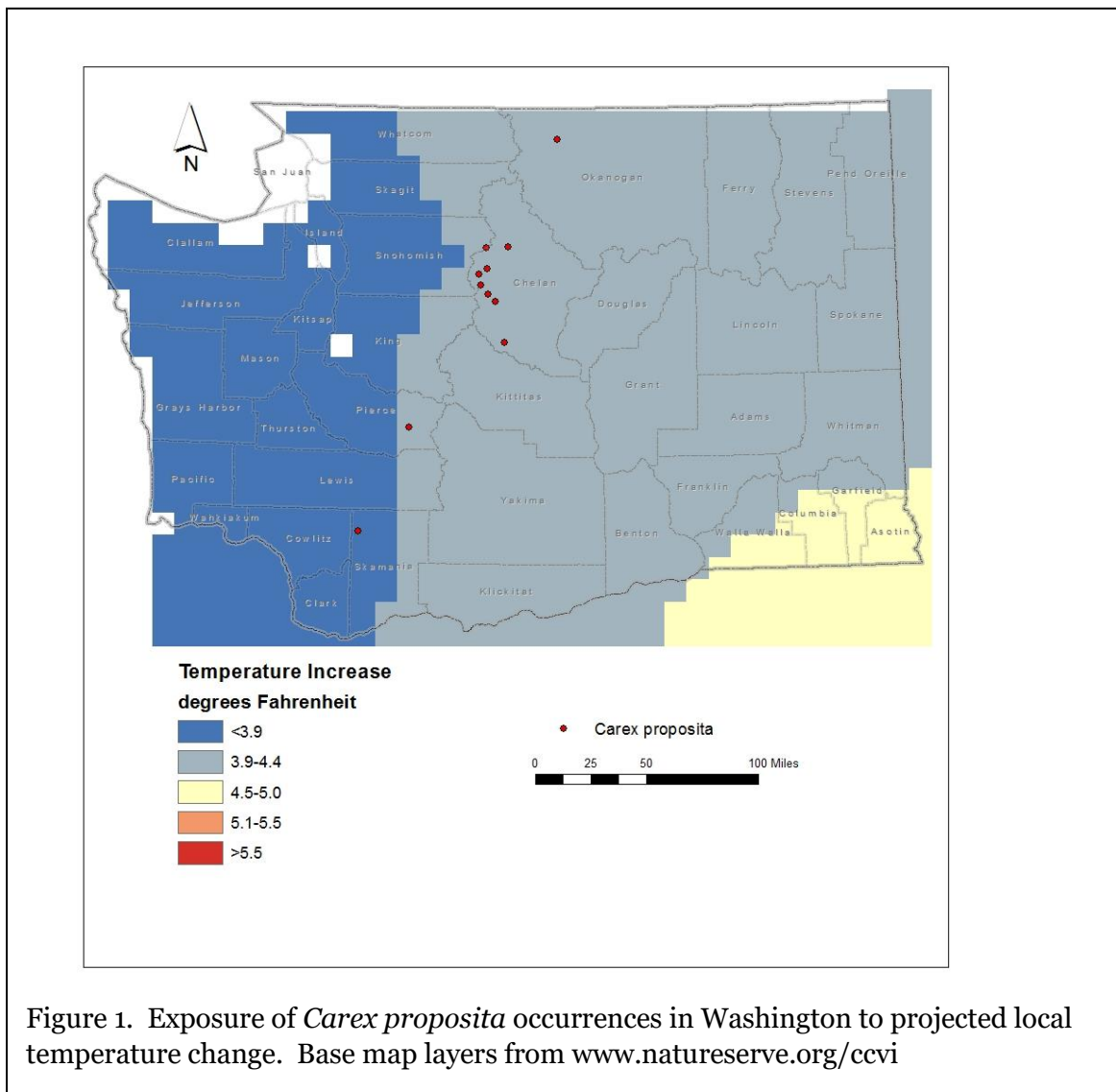


Figure 1. Exposure of *Carex proposita* occurrences in Washington to projected local temperature change. Base map layers from www.natureserve.org/ccvi

population (9%) has a projected future temperature increase of $< 3.9^{\circ}\text{F}$. This assessment excludes some recent erroneous reports of *C. proposita* from NE Washington.

A2. Hamon AET:PET Moisture Metric: Six of 11 occurrences of *Carex proposita* (55%) 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 -0.097 to -0.119 (Figure 2). The remaining five occurrences (45%) are in the range from -0.074 to -0.096 .

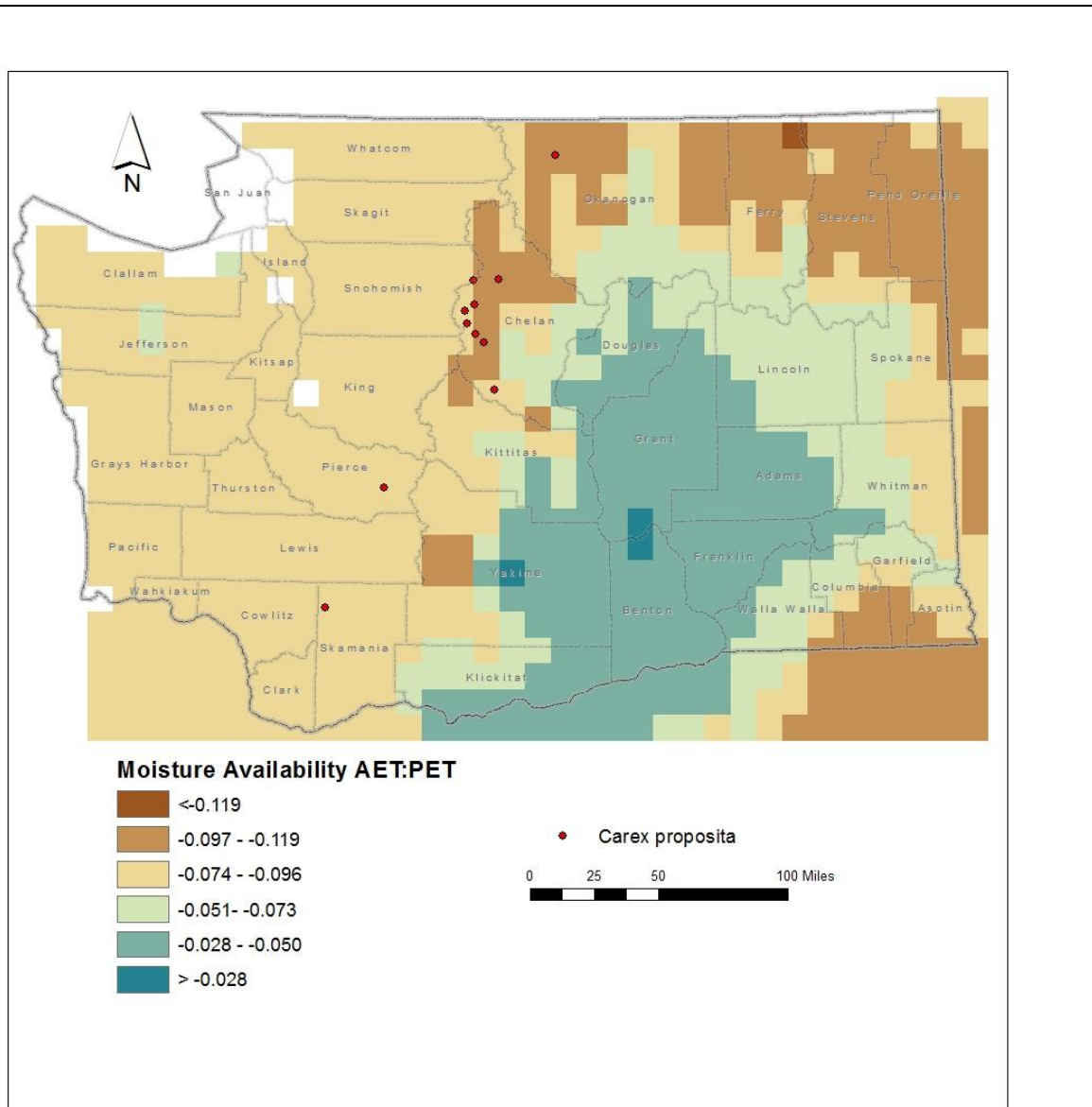


Figure 2. Exposure of *Carex proposita* occurrences in Washington to projected moisture availability (based on ratio of actual to predicted evapotranspiration). Base map layers from www.natureserve.org/ccvi

Section B. Indirect Exposure to Climate Change

B1. Exposure to sea level rise: Neutral.

Washington populations of *Carex proposita* range in elevation from 1370-2450m (4500-8040 ft) and would not be inundated by projected sea level rise.

B2a. Natural barriers: Increase.

In Washington, populations of *Carex proposita* are found in rocky alpine ridges, on granite talus, and dry meadows near lakes above tree line (Camp and Gamon 2011; Wilson et al. 2014). This habitat conforms to the North Pacific Dry and Mesic Alpine Dwarf-Shrubland, Fell-field and Meadow and Rocky Mountain Alpine Dwarf Shrubland, Fell-field, and Turf ecological systems (Rocchio and Crawford 2015). Washington populations are separated by distances of 4-68 miles (8-110 km). Along the crest of the northern Cascades, these habitats may be relatively continuous, but elsewhere in the state they are widely isolated by dissimilar forest and valley sites that would be a significant barrier for dispersal.

B2b. Anthropogenic barriers: Neutral.

Anthropogenic barriers, such as roads, agricultural developments, and urban areas exist at low elevations between populations of *Carex proposita*, but dispersal is primarily limited by natural barriers encircling high elevation occurrences.

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

Section C: Sensitive and Adaptive Capacity

C1. Dispersal and movements: Somewhat Increase.

Carex proposita produces 1-seeded dry fruits contained within winged sac-like perigynia that are passively dispersed by gravity or high winds, mostly within a short distance of the parent plant (< 1000 m).

C2ai. Historical thermal niche: Somewhat Increase.

Figure 3 depicts the distribution of *Carex proposita* in Washington relative to mean seasonal temperature variation for the period from 1951-2006 (“historical thermal niche”). Eight of the 11 known occurrences (73%) 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. These populations have somewhat increased vulnerability to climate change (Young et al. 2016). The other three occurrences (27%) are found in areas that have experienced small (37-47°F/20.8-26.3°C) temperature variation in the same time span and have increased vulnerability under projected climate change (Young et al. 2016).

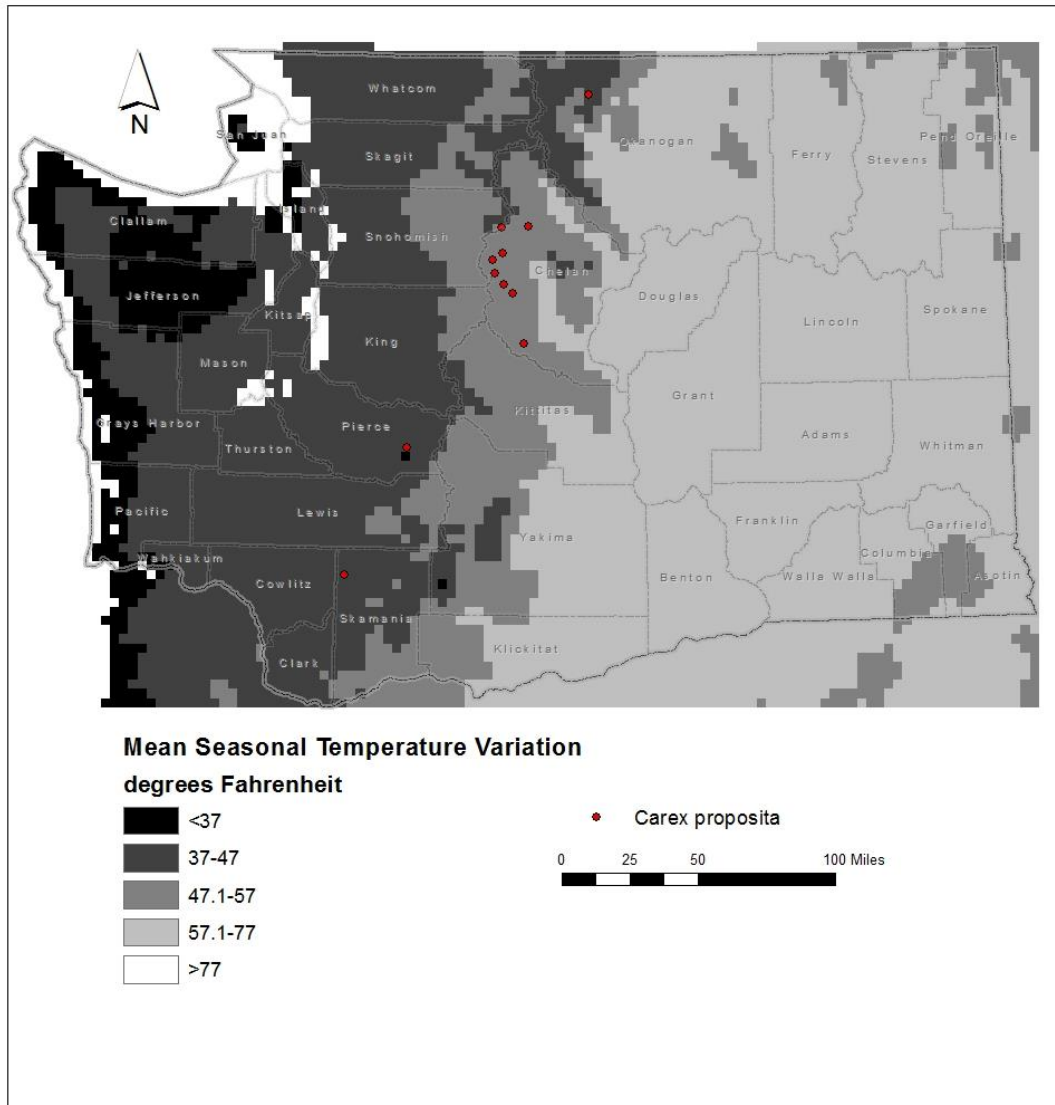


Figure 3. Historical thermal niche (exposure to past temperature variations) of *Carex proposita* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2aii. Physiological thermal niche: Increase.

Carex proposita is found mostly at or above treeline in the alpine zone of Washington mountains in areas subjected to cool temperatures in the growing season.

C2bi. Historical hydrological niche: Neutral.

The entire range of *Carex proposita* in Washington occurs in areas that have experienced average or greater than average (>20 inches/508 mm) precipitation variation in the past 50 years (Figure 4) and is at neutral vulnerability from climate change (Young et al. 2016).

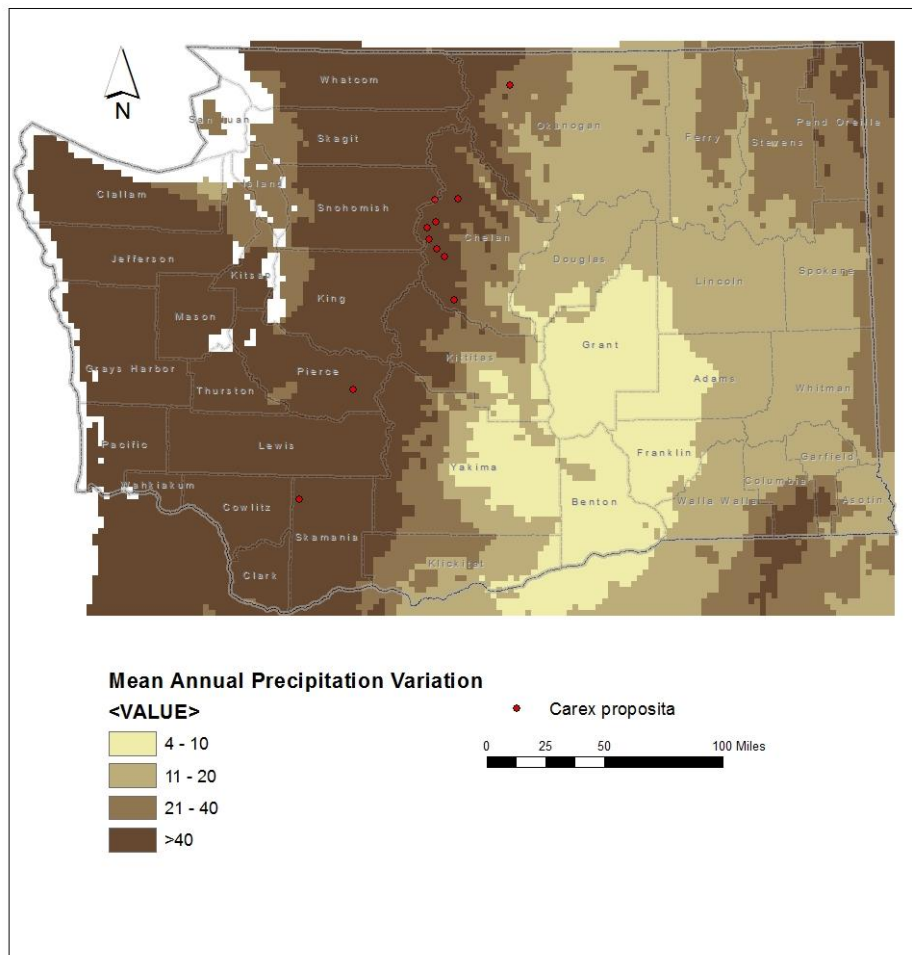


Figure 4. Historical hydrological niche (exposure to past variations in precipitation) of *Carex proposita* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2bii. Physiological hydrological niche: Somewhat Increase.

In Washington, *Carex proposita* occurs at high elevation rocky ridge and meadow sites that are dependent primarily on snow or summer rainfall for moisture. Changes in the timing of precipitation, or reduction in the amount, coupled with increases in temperature, would favor conversion of these communities to meadow communities currently found at lower elevations (Rocchio and Ramm-Granberg 2017).

C2c. Dependence on a specific disturbance regime: Neutral.

The alpine meadow and talus habitat of this species is not dependent on periodic disturbances to be maintained.

C2d. Dependence on ice or snow-cover habitats: Increase.
Snowpack is a primary moisture source for this species in its treeline and alpine habitat, making it vulnerable to reduced snow cover and changes in the timing of snow melt under climate change scenarios (Rocchio and Ramm-Granberg 2017).

C3. Restricted to uncommon landscape/geological features: Neutral.
Washington occurrences of *Carex proposita* are associated with pyroclastic volcanic rock or metamorphic quartz or gneiss batholiths. These are relatively widespread geologic types in the Cascade Range.

C4a. Dependence on other species to generate required habitat: Neutral.
The habitat of *Carex proposita* is maintained primarily by abiotic factors.

C4b. Dietary versatility: Not applicable for plants.

C4c. Pollinator versatility: Neutral.
Carex species are entirely wind pollinated.

C4d. Dependence on other species for propagule dispersal: Neutral.
Dispersal of fruits is predominantly passive (gravity or high winds), but occasionally may occur by animal vectors, such as ants.

C4e. Sensitivity to pathogens or natural enemies: Neutral.
Grazing or disease has not been identified as a significant threat.

C4f. Sensitivity to competition from native or non-native species: Neutral.
Non-native species are currently a minor component of the habitat of *Carex proposita*. Competition is relatively low in its rocky habitat.

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

C5a. Measured genetic variation: Unknown.
No data are available on genetic variability in Washington. The species has an unusual global range consisting of three disjunct population centers: north-central Washington, southern Idaho and NW Wyoming, and east-central California. It is plausible that these populations are sufficiently isolated to reduce gene flow and are probably diverging genetically, but more research is needed.

C5b. Genetic bottlenecks: Unknown.

C5c. Reproductive System: Neutral.
As a wind-pollinated, obligate out-crosser, *Carex proposita* would be expected to have reasonably high genetic variability.

C6. Phenological response to changing seasonal and precipitation dynamics: Neutral.
Significant changes in the onset of flowering or fruiting have not yet been detected in this species in Washington.

Section D: Documented or Modeled Response to Climate Change

D1. Documented response to recent climate change: Neutral

Although some individual populations of *Carex proposita* (such as Mount Rainier) have not been relocated since the 1930s, the overall range of the species has not contracted in Washington. Historical occurrences could be extirpated or no attempt has been made to relocate them.

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.

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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Wilson, B.L., R.E. Brainerd, D. Lytjen, B. Newhouse, and N. Otting. 2014. Field Guide to the Sedges of the Pacific Northwest, second edition. Oregon State University Press, Corvallis, OR. 432 pp.

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