Climate Change Vulnerability Index Report

Carex rostrata (Beaked sedge)

Date: 5 November 2019

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Geographic Area: Washington Heritage Rank: G5/S2

Index Result: Highly 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	100
	-0.074 to - 0.096	0
	-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		Somewhat Increase
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		Increase
2bi. Changes in historical hydrological niche		Neutral
2bii. Changes in physiological hydrological niche		Increase
2c. Dependence on specific disturbance regime		Neutral
2d. Dependence on ice or snow-covered habitats		Neutral/Somewhat 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		Neutral

5b. Genetic bottlenecks	Unknown
5c. Reproductive system	Neutral
6. Phenological response to changing seasonal and precipitation dynamics	Unknown
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: The entire range of *Carex rostrata* (considered here in the narrow sense and excluding *C. utriculata*, which occurs commonly throughout Washington [Reznicek 1985, 1997])

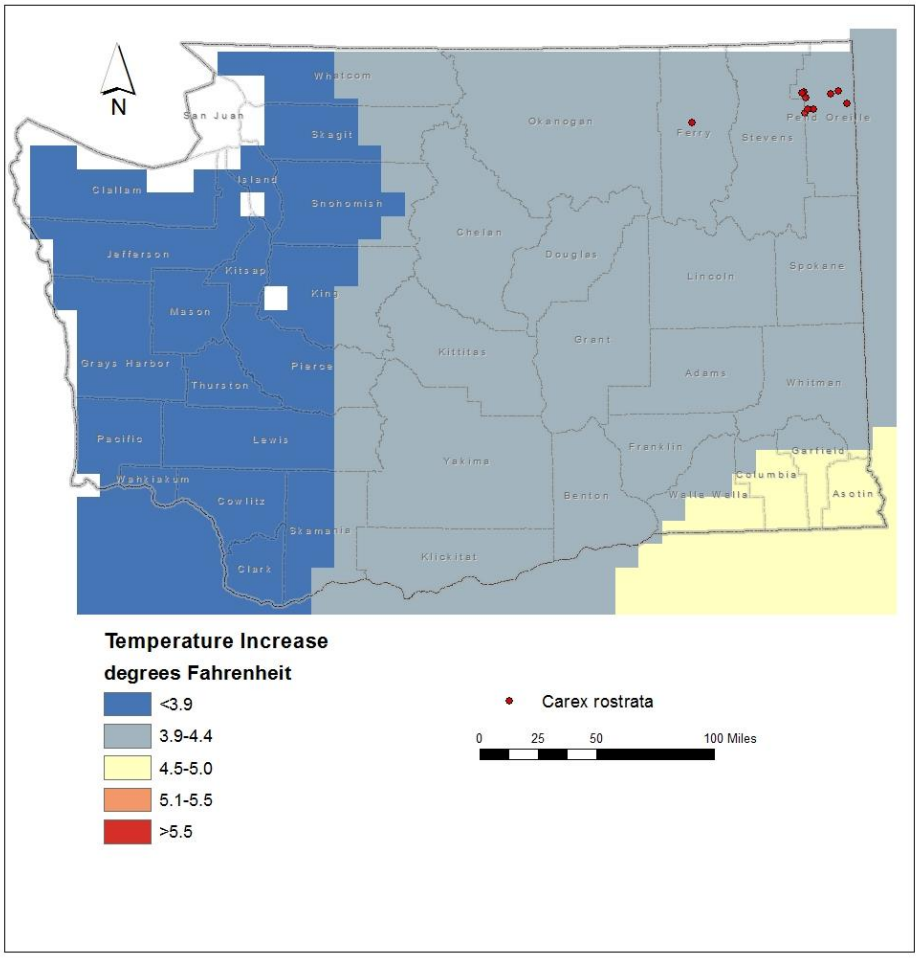

Figure 1. Exposure of *Carex rostrata* occurrences in Washington to projected local temperature change. Base map layers from www.natureserve.org/ccvi

is found within the area of the state with a projected temperature increase of 3.9-4.4˚ F (Figure 1).

A2. Hamon AET:PET Moisture Metric: In Washington, all confirmed occurrences of *Carex rostrata* 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).

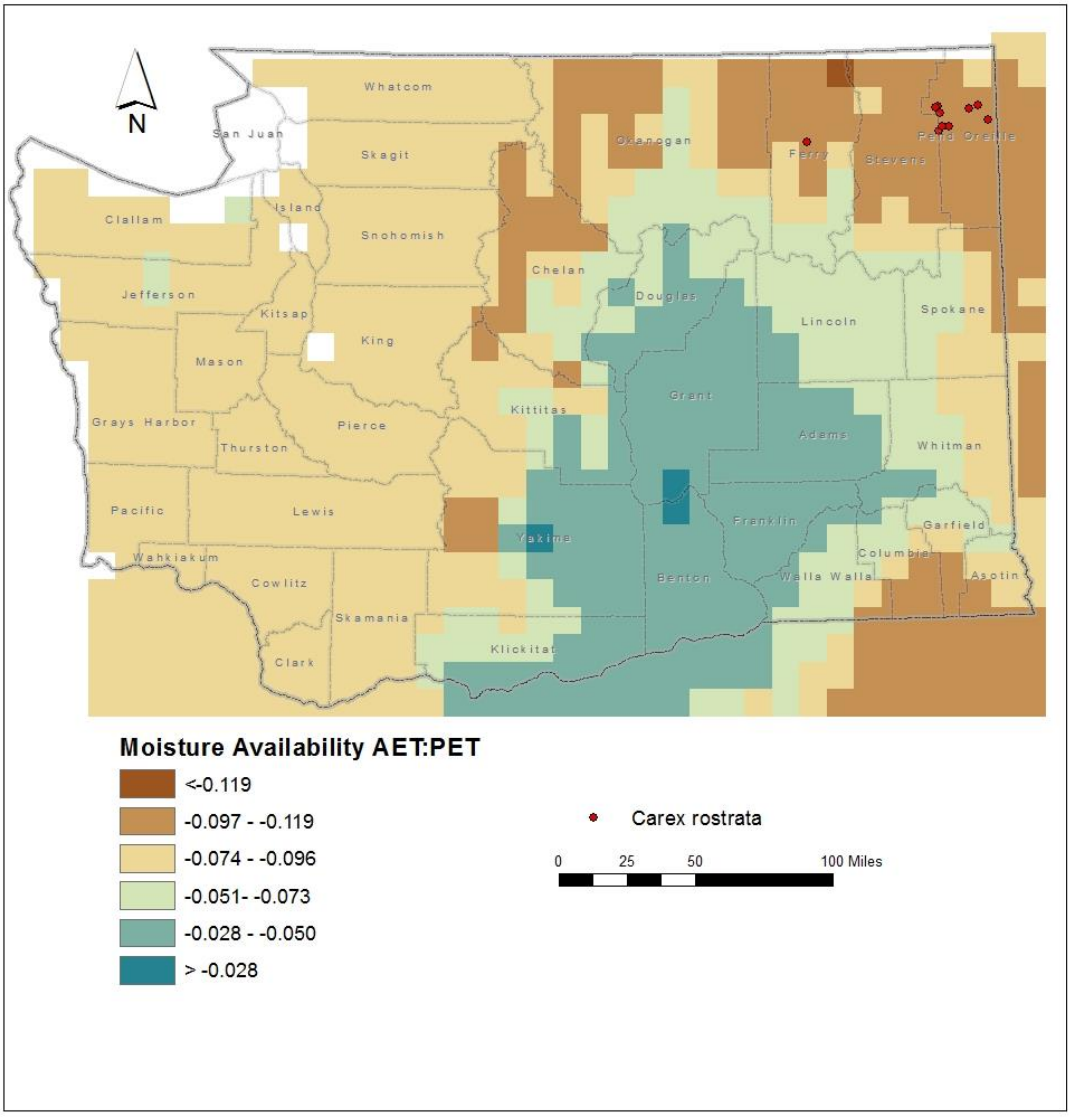

Figure 2. Exposure of *Carex rostrata* occurrences in Washington to projected moisture availability (based on ratio of actual to predicted evapotranspiration). Base map layers from www.natureserve.org/ccvi

Section B. Indirect Exposure to Climate Change

B1. Exposure to sea level rise: Neutral.
Washington occurrences of *Carex rostrata* are found at elevations of 3200-5120 ft (975-1560 m) (Camp and Gamon 2011) and would not be inundated by projected sea level rise.

B2a. Natural barriers: Somewhat Increase.
In Washington, *Carex rostrata* is found in fens and floating mats of peat (*Sphagnum*) along lakes and streams (Camp and Gamon 2011; Kovalchik and Mastrogiuseppe 1991; Wilson et al. 2014). These wetlands are part of the Rocky Mountain Subalpine-Montane Fen ecological system (Rocchio and Crawford 2015). Populations in northeastern Washington are separated by 1.3-10 miles (2-15.5 km). Occupied habitat is patchy and embedded in a matrix of unsuitable forest habitat, which creates a barrier for dispersal.

B2b. Anthropogenic barriers: Somewhat Increase.
The habitat of *Carex rostrata* in NE Washington is bisected by paved highways and gravel Forest Service roads, agricultural lands, sites managed for forestry, and residential areas.

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 rostrata produces 1-seeded dry fruits within a beaked, sac-like perigynium that is lightweight and passively dispersed by gravity, high winds, or water. Most dispersal probably occurs within less than 1000 m of the parent plant. Longer distance dispersal is facilitated by fruits adhering to mud on birds or mammals.

C2ai. Historical thermal niche: Neutral.
Figure 3 depicts the distribution of *Carex rostrata* in Washington relative to mean seasonal temperature variation for the period from 1951-2006 ("historical thermal niche"). Thirty percent of the Washington occurrences 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 are considered to have somewhat increased vulnerability under projected climate change (Young et al. 2016). The remaining 70% of known *C. rostrata* occurrences in the state are from areas with average (57.1-77˚F/31.8 – 43.0˚C) temperature variation over the same historic period and are ranked as neutral for climate change impacts. Since the majority of Washington populations are in the latter category, the species is ranked neutral for the whole state.

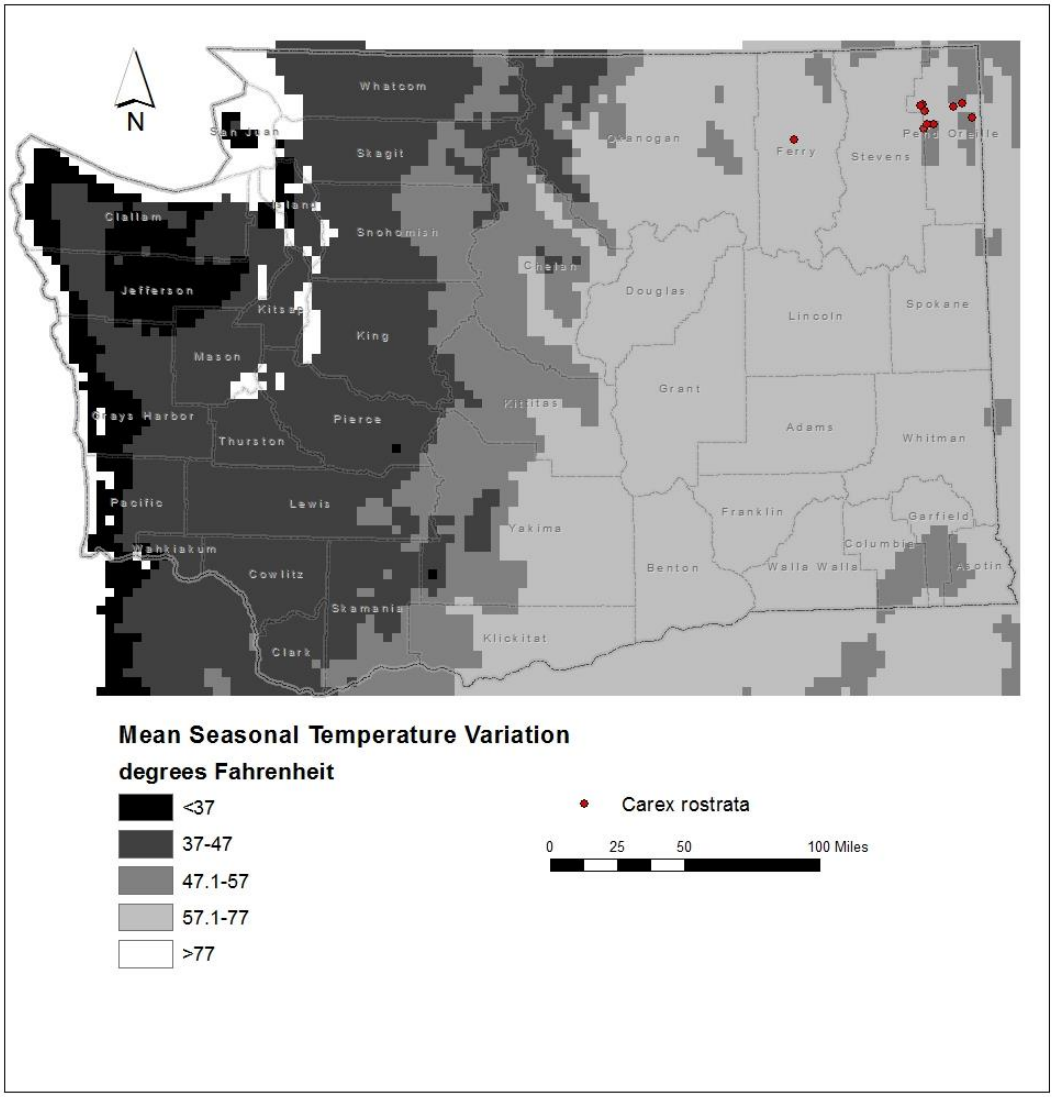

Figure 3. Historical thermal niche (exposure to past temperature variations) of *Carex rostrata* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2aii. Physiological thermal niche: Increase.
More than half of the Washington occurrences of *Carex rostrata* are found in cold air drainages in valley bottoms and fen depressions that are cooler microsites than the matrix vegetation, and so potentially at increased risk from climate change.

C2bi. Historical hydrological niche: Neutral.
The entire range of *Carex rostrata* in Washington is found in areas that have experienced average (>20 inches) or greater than average (>40 inches) precipitation variation in the past 50

years (Figure 4). These populations are considered neutral in terms of risk from climate change by Young et al. (2016).

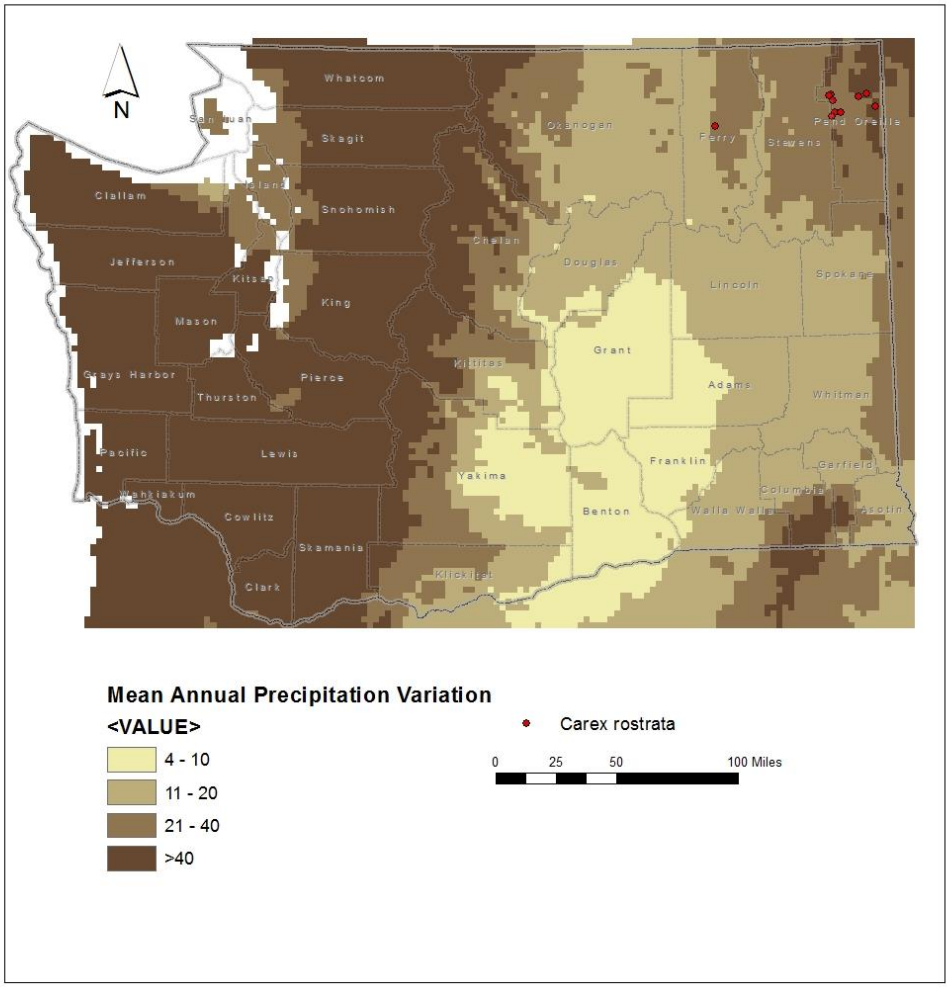

Figure 4. Historical hydrological niche (exposure to past variations in precipitation) of *Carex rostrata* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2bii. Physiological hydrological niche: Increase.
Carex rostrata populations in Washington are dependent on a very specific wetland ecological system (fen with floating *Sphagnum* mats) in which water chemistry may be extremely important. These habitats are also dependent on groundwater and can be negatively impacted by decreased snow accumulation. Changes in the timing and amount of precipitation and increasing temperatures could shift these communities towards drier wet meadows (Rocchio and Ramm-Granberg 2017).

C2c. Dependence on a specific disturbance regime: Neutral.

C2d. Dependence on ice or snow-cover habitats: Neutral/Somewhat Increase.
The habitat of *Carex rostrata* in northeast Washington is not characterized by exceptionally high amounts of ice or snow, but reduced snowpack could impact groundwater recharge (Rocchio and Ramm-Granberg 2017).

C3. Restricted to uncommon landscape/geological features: Neutral.
Some *Carex rostrata* occurrences in Washington are associated with areas of glacial drift, which is relatively widespread in NE Washington. Water chemistry, however, may be important for this species.

C4a. Dependence on other species to generate required habitat: Neutral.
Some wet meadows occupied by *Carex rostrata* in NE Washington are associated with old beaver dams and ponds.

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, water, high winds), but occasionally may also occur by animal vectors transporting fruit embedded in mud.

C4e. Sensitivity to pathogens or natural enemies: Neutral.
Carex rostrata is palatable and grazed by livestock, which has been identified as a threat at some sites (Camp and Gamon 2011).

C4f. Sensitivity to competition from native or non-native species: Neutral.
Carex rostrata is often locally dominant within its specialized habitat.

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

C5a. Measured genetic variation: Neutral.
Ford et al. (1993) studied genetic variation among species in *Carex* Section *Vesicariae* and found significant variability within and between populations of *Carex rostrata* and *C. utriculata*.

C5b. Genetic bottlenecks: Unknown.

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

C6. Phenological response to changing seasonal and precipitation dynamics: Unknown.
Significant changes in the onset of flowering or fruiting have not been detected in *Carex rostrata*.

Section D: Documented or Modeled Response to Climate Change

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.

References

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

Ford, B.A., P.W. Ball, and K. Ritland. 1993. Genetic and macromorphologic evidence bearing on the evolution of members of *Carex* section *Vesicariae* (Cyperaceae) and their natural hybrids. Canadian Journal of Botany 71(3):486-500.

Kovalichik, B.L. and J. Mastrogiuseppe. 1991. First record of the real *Carex rostrata* in Washington. Douglasia 15(3):3-4.

Reznicek, A.A. 1985. What is *Carex rostrata* Stokes? American Journal of Botany 72:966.

Reznicek, A.A. 1997. The true *Carex rostrata* in the American Rockies. Sage Notes 19(4):11-13.

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.

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.

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.