Climate Change Vulnerability Index Report

Carex tenuiflora (Sparse-flowered sedge)

Date: 8 November 2019

Assessor: Walter Fertig, WA Natural Heritage Program

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		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		Somewhat 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		Somewhat Increase
3. Restricted to uncommon landscape/geological features		Somewhat Increase
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		Unknown
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	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: all seven of the known occurrences of *Carex tenuiflora* in Washington are found in areas with a projected temperature increase of 3.9-4.4˚ F (Figure 1).

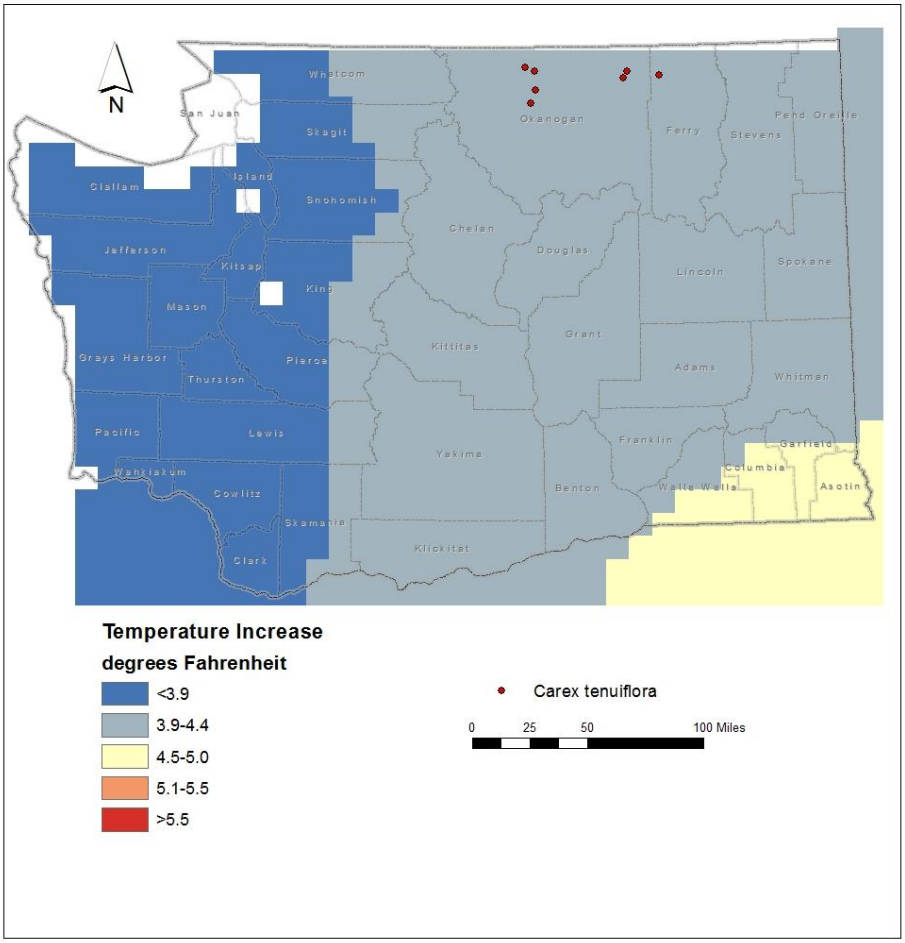

Figure 1. Exposure of *Carex tenuiflora* occurrences in Washington to projected local temperature change. Base map layers from www.natureserve.org/ccvi

A2. Hamon AET:PET Moisture Metric: All Washington occurrences of *Carex tenuiflora* 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).

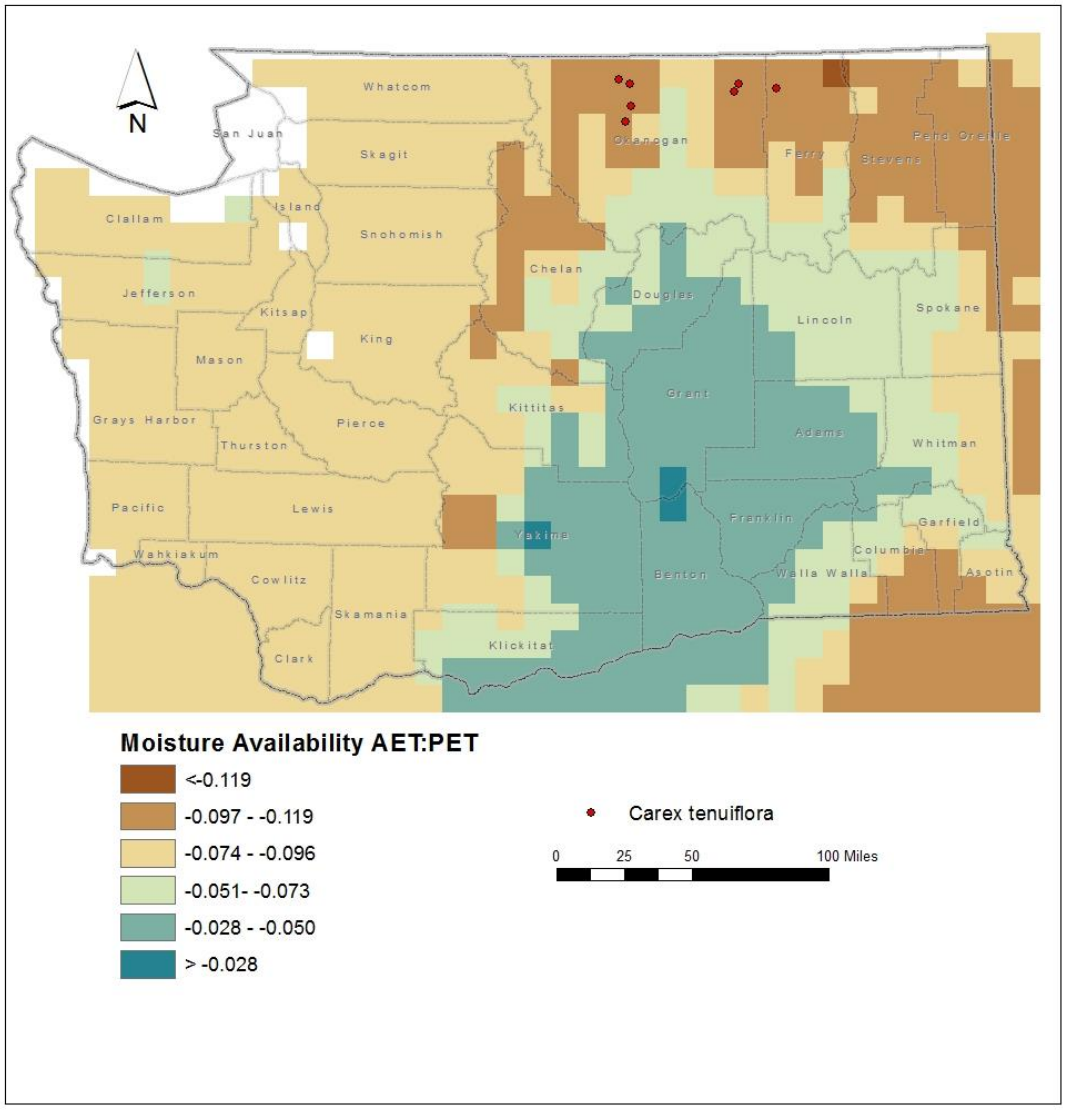

Figure 2. Exposure of *Carex tenuiflora* occurrences in Washington to projected moisture availability (based on ratio of actual to predicted evapotranspiration). Base map layers from www.natureserve.org/ccvi

Section B. Indirect Exposure to Climate Change

B1. Exposure to sea level rise: Neutral.
Washington occurrences of *Carex tenuiflora* are found at 1660-6250 ft (595-1905 m) and would not be inundated by projected sea level rise.

B2a. Natural barriers: Somewhat Increase.
Carex tenuiflora is restricted to intermediate to rich calcareous fens found in glacial basins, the margins of beaver ponds, and small wetlands on relatively level topography within a matrix of forest (WNHP element occurrence records; Camp and Gamon 2011; Wilson et al. 2014). These habitats correspond to the Rocky Mountain Subalpine-Montane Fen ecological system (Rocchio and Crawford 2015). Washington populations are separated by 3.5 to 38 miles (4.7-61 km), reflecting the scattered and isolated distribution of fen habitat in the eastern portion of the state.

B2b. Anthropogenic barriers: Neutral.
Most populations of *Carex tenuiflora* in Washington are found in mountainous areas with relatively few roads or other human imprints.

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 tenuiflora produces 1-seeded dry fruits enclosed in bladder-like sacs that are lightweight and passively dispersed by gravity, high winds, or running water. Dispersal is probably mostly within a short distance of the parent plant (<1000m). Longer distance dispersal might occasionally be facilitated by fruits adhering to mud on birds or mammals.

C2ai. Historical thermal niche: Somewhat Increase.
Figure 3 depicts the distribution of *Carex tenuiflora* in Washington relative to mean seasonal temperature variation for the period from 1951-2006 ("historical thermal niche"). Four of the seven Washington occurrences (57%) 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). Three of the seven state populations (43%) 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 former category, the species is ranked as "Somewhat Increased" vulnerability for the whole state.

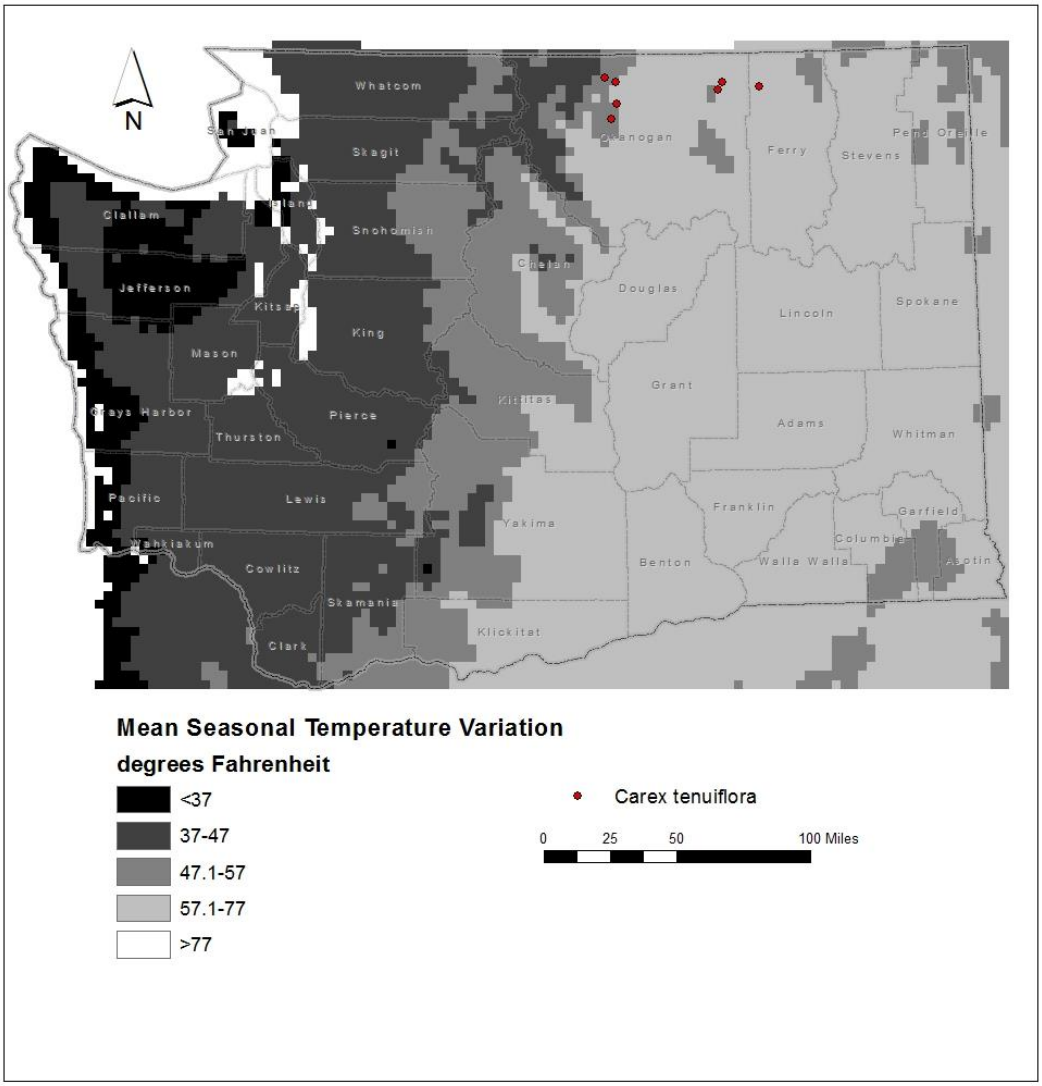

Figure 3. Historical thermal niche (exposure to past temperature variations) of *Carex tenuiflora* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2aii. Physiological thermal niche: Somewhat Increase.
Washington occurrences of *Carex tenuiflora* are found mostly in cold air drainages in montane valleys that are cooler than the surrounding matrix vegetation or landforms.

C2bi. Historical hydrological niche: Neutral.
Six of the seven known occurrences of *Carex tenuiflora* in Washington (86%) are found in areas that have experienced average (20 inches/508 mm) precipitation variation in the past 50 years. These areas have neutral impacts from climate change according to Young et al. (2016). One Washington occurrence is from an area with slightly lower than average (11-20 inches/255-508

mm) precipitation variation and are considered at Somewhat Increased vulnerability to climate change.

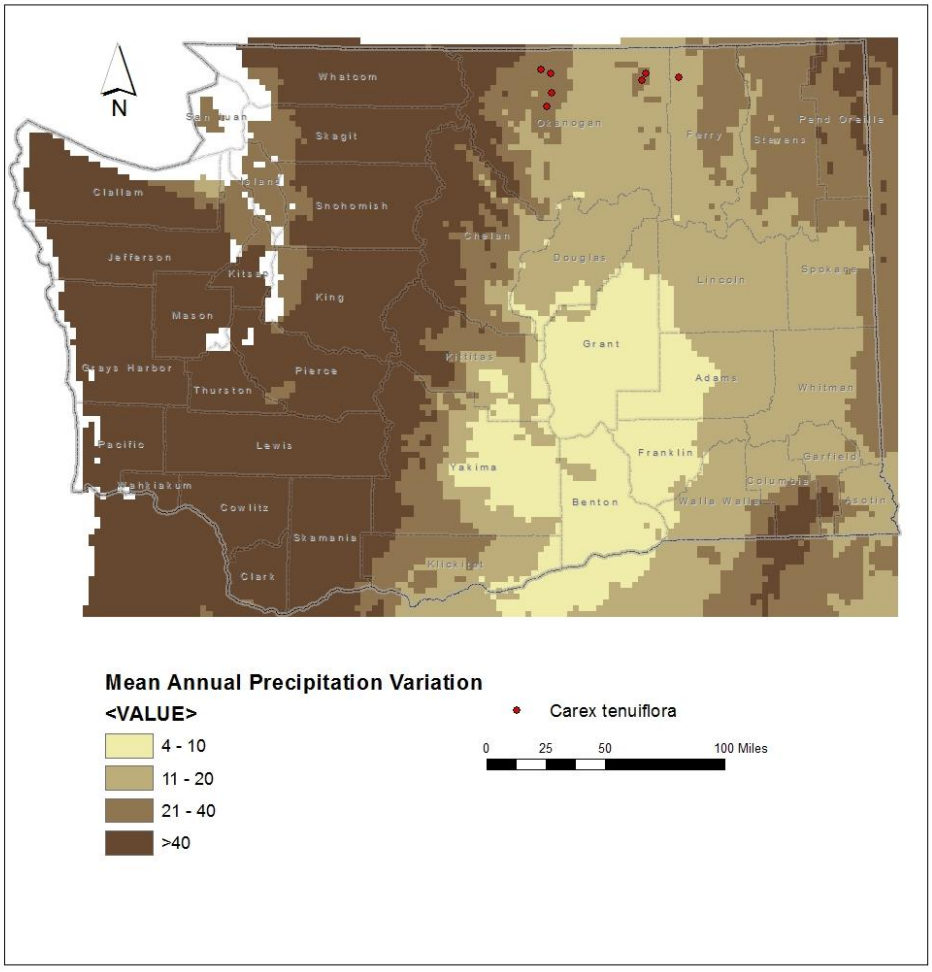

Figure 4. Historical hydrological niche (exposure to past variations in precipitation) of *Carex tenuiflora* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2bii. Physiological hydrological niche: Increase.
Carex tenuiflora is restricted to fens dependent on adequate year-round moisture (especially from groundwater). It is vulnerable to changes in water availability, especially from reduced snowpack, under projected climate change scenarios. Changes in the timing and amount of precipitation and increasing temperatures could convert fen habitats to drier wet meadows (Rocchio and Ramm-Granberg 2017).

C2c. Dependence on a specific disturbance regime: Neutral.
This species is not dependent on disturbance to maintain its wetland habitat.

C2d. Dependence on ice or snow-cover habitats: Somewhat Increase.
In Washington, *Carex tenuiflora* is found in areas of moderate snowfall in the foothills of the Okanogan and Kettle mountains and might be adversely impacted by ant climate-related decrease in snowfall or spring melting of the snowpack (Rocchio and Ramm-Granberg 2017).

C3. Restricted to uncommon landscape/geological features: Somewhat Increase.
Carex tenuiflora is restricted to fens in glacial depression or relatively flat drainage bottoms in the mountains, often associated with acidic intrusive soils within uplifted volcanic batholiths.

C4a. Dependence on other species to generate required habitat: Neutral.
At least one Washington occurrence is associated with a beaver dam that is raising the water table, potentially affecting the *Sphagnum* community with which *Carex tenuiflora* is associated. Other known *C. tenuiflora* occurrences are not dependent on animal ecosystem engineers.

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: Unknown.
Camp and Gamon (2011) cite livestock grazing as a potential threat. Impacts from native grazers currently or in the future are poorly known.

C4f. Sensitivity to competition from native or non-native species: Neutral.

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. Populations in the state are at the southern edge of the species' range and would be expected to have lower overall genetic diversity.

C5b. Genetic bottlenecks: Unknown.

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

C6. Phenological response to changing seasonal and precipitation dynamics: Unknown.

Section D: Documented or Modeled Response to Climate Change

D1. Documented response to recent climate change: Unknown.
No changes have been observed in the distribution of this species in Washington in recent years.

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.

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.