Climate Change Vulnerability Index Report

Carex anthoxanthea (Yellow-flowered sedge)

Date: 1 November 2019

Assessor: Walter Fertig, WA Natural Heritage Program

Geographic Area: Washington Heritage Rank: G5/S1

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	0
	<3.9° F (2.2°C) warmer	100
2. Hamon AET:PET moisture	< -0.119	0
	-0.097 to -0.119	0
	-0.074 to - 0.096	100
	-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		Neutral
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		Greatly Increase
2aii. Change in physiological thermal niche		Somewhat 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	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 single known occurrence of *Carex anthoxanthea* in Washington (100%) is found in an area with a projected temperature increase of less than 3.9˚F (Figure 1).

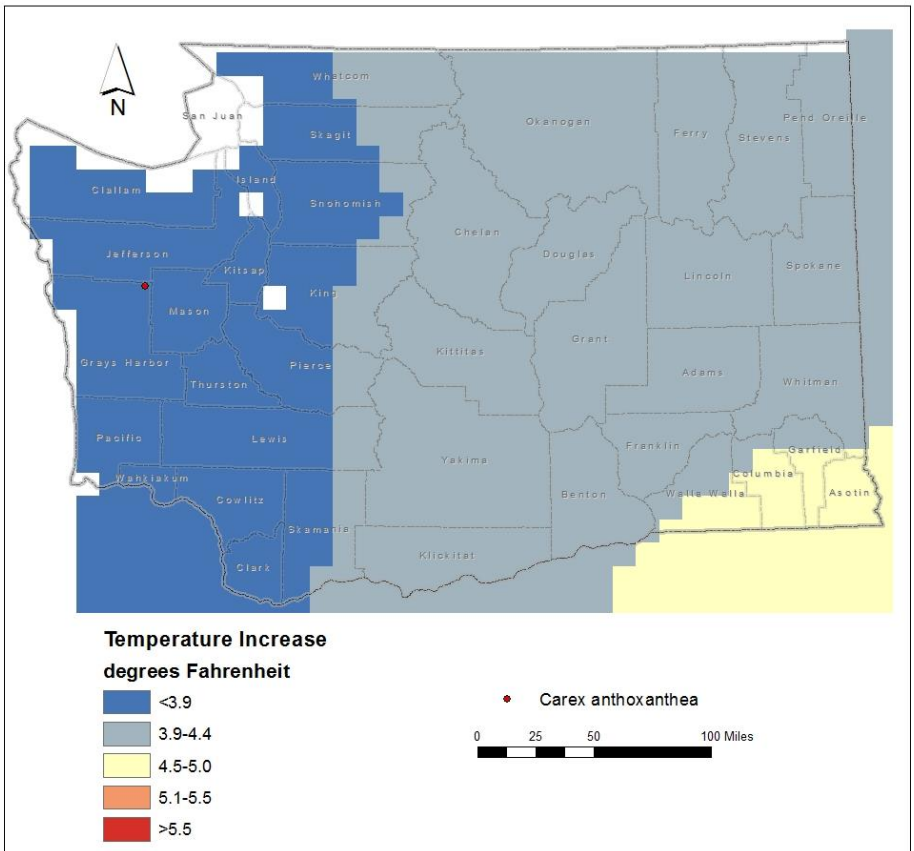

Figure 1. Exposure of *Carex anthoxanthea* occurrences in Washington to projected local temperature change. Base map layers from www.natureserve.org/ccvi

A2. Hamon AET:PET Moisture Metric: The sole occurrence of *Carex anthoxanthea* in Washington 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 -0.0474 to -0.096 (Figure 2).

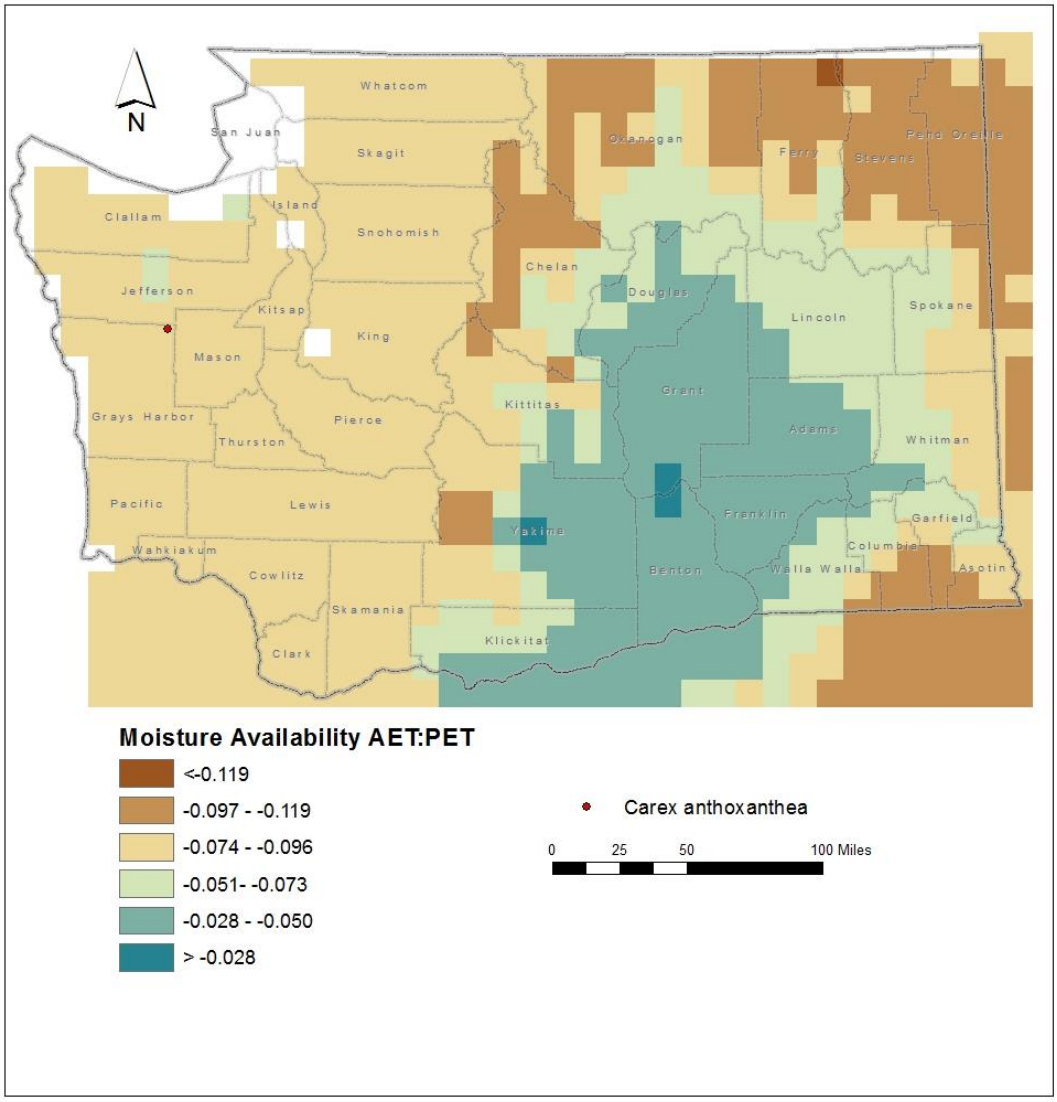

Figure 2. Exposure of *Carex anthoxanthea* occurrences in Washington to projected moisture availability (based on ratio of actual to predicted evapotranspiration). Base map layers from www.natureserve.org/ccvi

Section B. Indirect Exposure to Climate Change

B1. Exposure to sea level rise: Neutral.
The entire range of *Carex anthoxanthea* in Washington is at or above 2800 ft (853 m) and would not be inundated by projected sea level rise.

B2a. Natural barriers: Neutral.
In Washington, *Carex anthoxanthea* is found in wet seeps on cliffs, wet meadow fen complexes, and moist roadside ditches in mountainous areas of the Olympic Peninsula (Camp and Gamon 2011). This habitat conforms with the Temperate Pacific Subalpine-Montane Wet Meadow ecological system (Rocchio and Crawford 2015). These habitats are scattered across the landscape, but barriers are not sufficient to prevent potential dispersal.

B2b. Anthropogenic barriers: Neutral.
Some subpopulations of *Carex anthoxanthea* in Washington are bounded by roads and could be impacted by culvert maintenance (Camp and Gamon 2011; Wilson et al. 2014). Seeps and wet areas in roadcuts also provide habitat, however, so net effects are probably neutral.

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 anthoxanthea produces 1-seeded dry fruits that are light weight and passively dispersed by gravity, high winds, or running water, mostly within a short distance of the parent plant (<1000 m). Longer distance dispersal might occasionally be facilitated by the fruits adhering to mud on birds or mammals.

C2ai. Historical thermal niche: Greatly Increase.
Figure 3 depicts the distribution of *Carex anthoxanthea* in Washington relative to mean seasonal temperature variation for the period from 1951-2006 ("historical thermal niche"). The range of the species is limited to an area that has experienced very small (<37˚F/20.8˚C) temperature variation during the past 50 years. It is considered to have greatly increased vulnerability under projected climate change (Young et al. 2016).

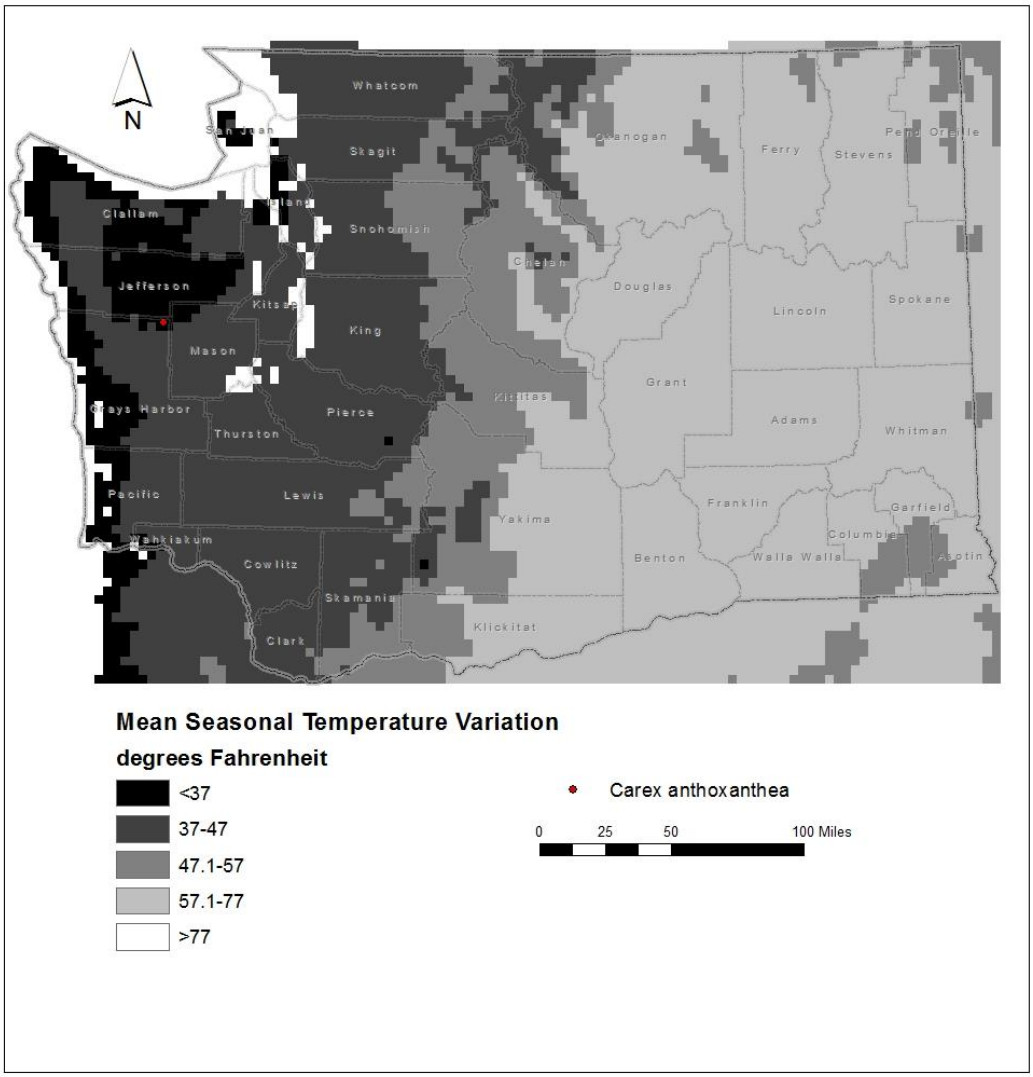

Figure 3. Historical thermal niche (exposure to past temperature variations) of *Carex anthoxanthea* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2aii. Physiological thermal niche: Somewhat Increase.
Several subpopulations of the single Washington occurrence of *Carex anthoxanthea* are found in wetlands associated with cool air drainages in mountain valleys.

C2bi. Historical hydrological niche: Neutral.
The entire range of *Carex anthoxanthea* in Washington occurs in areas that have experienced greater than average (>40 inches) precipitation variation in the past 50 years (Figure 4) and are considered neutral in terms of risk from climate change (Young et al. 2016).

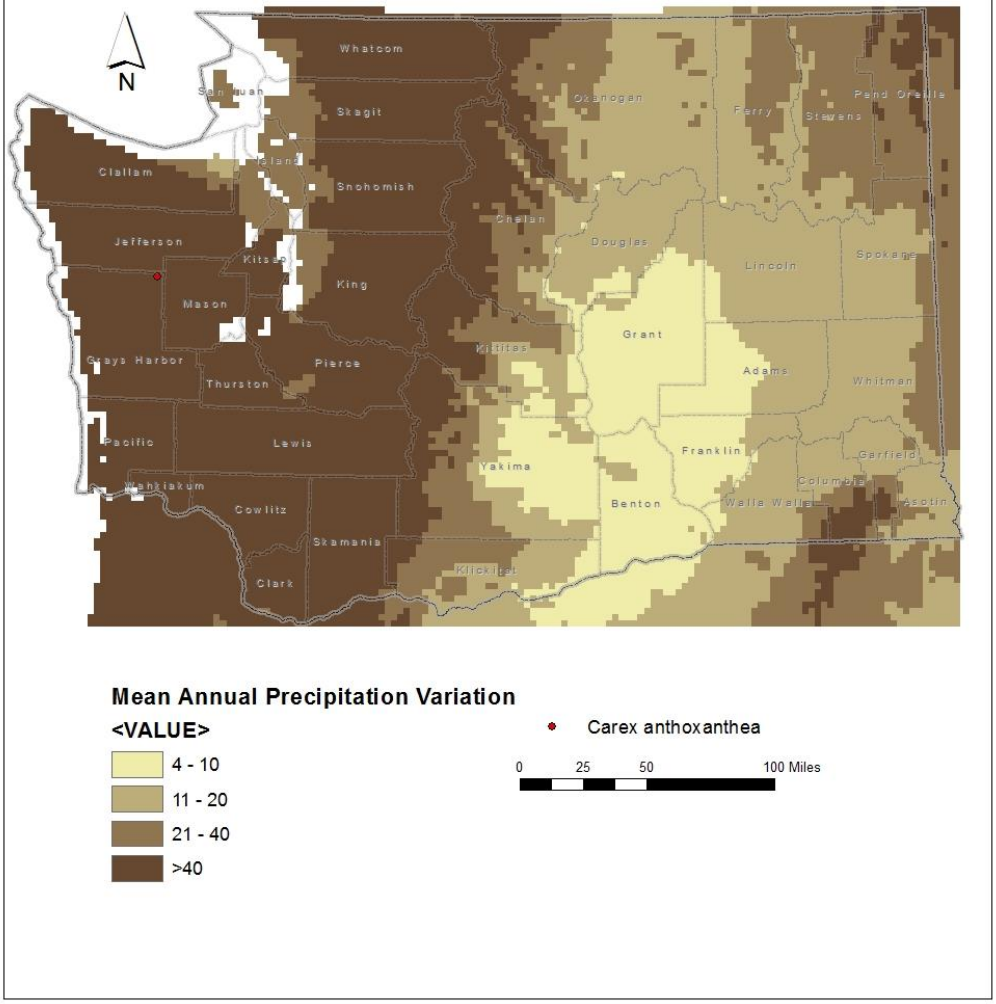

Figure 4. Historical hydrological niche (exposure to past variations in precipitation) of *Carex anthoxanthea* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2bii. Physiological hydrological niche: Somewhat Increase.
Carex anthoxanthea is dependent on wet seeps derived from groundwater (and ultimately from snowpack) that is augmented by spring and summer precipitation. Changes in the timing and amount of rainfall in the growing season or increases in temperature could convert montane wet meadows to drier meadows for forests (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: Increase.
In Washington, *Carex anthoxanthea* occurs in areas of high snowfall in the Olympic Mountains. Changes in the amount of snow accumulation or timing of snow melt could negatively imact groundwater-fed seeps and result in the conversion of wet meadows utilized by *C. anthoxanthea* to unsuitable dry meadows (Rocchio and Ramm-Granberg 2017).

C3. Restricted to uncommon landscape/geological features: Neutral.
Washington populations of *Carex anthoxanthea* are found on cliffs and soils derived from Eocene-Paleocene marine clastic rock (lithic sandstone). This substrate is widespread in the Olympic Mountains.

C4a. Dependence on other species to generate required habitat: Neutral.
This species is not dependent on other species to maintain its seep-fed wet meadow habitat.

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 abetted by animal vectors transporting fruit embedded in mud.

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.
Carex anthoxanthea in Washington is sometimes found in densely vegetated wet meadows (Camp and Gamon 2011). Most competition for niche space is from other native species.

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

C5a. Measured genetic variation: Unknown.
No data are available on genetic variability in the Washington occurrence. This population is the southern-most known occurrence, however, and might be expected to have lower genetic variation than populations closer to the core of the species' range.

C5b. Genetic bottlenecks: Unknown.

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

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

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.