Climate Change Vulnerability Index Report

Carex chordorrhiza (Cordroot sedge)

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Assessor: Walter Fertig, WA Natural Heritage Program

Geographic Area: Washington Heritage Rank: G5/S1

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		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		Somewhat Increase
4f. Sensitivity to competition from native or non-native species		Unknown
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 chordorrhiza* in Washington is found in an area with a projected temperature increase of 3.9 to 4.4˚F (Figure 1).

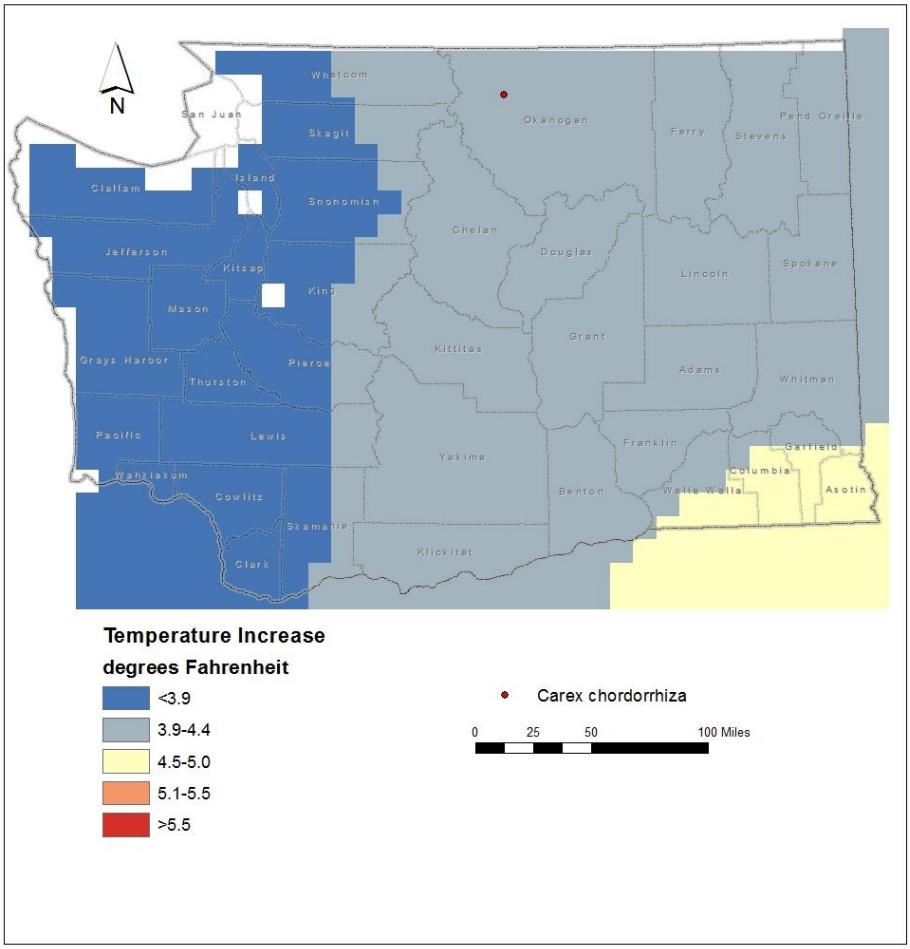

Figure 1. Exposure of *Carex chordorrhiza* occurrences in Washington to projected local temperature change. Base map layers from www.natureserve.org/ccvi

A2. Hamon AET:PET Moisture Metric: The sole occurrence of *Carex chordorrhiza* in Washington is found in an area with a projected decrease in available moisture (as measured by the ratio of actual to potential evapotranspiration) of -0.097 to -0.119 (Figure 2).

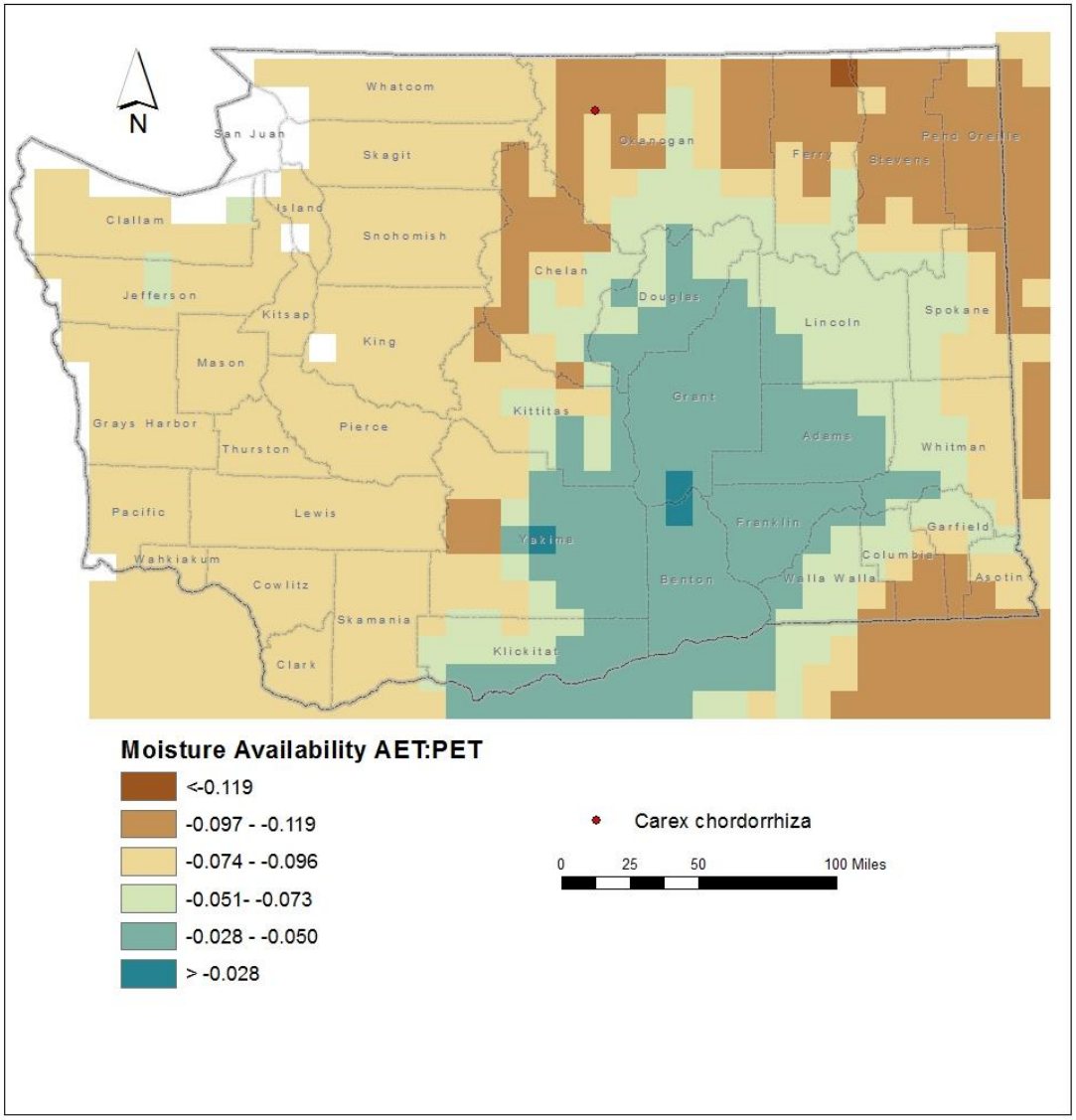

Figure 2. Exposure of *Carex chordorrhiza* occurrences in Washington to projected moisture availability (based on ratio of actual to predicted evapotranspiration). Base map layers from www.natureserve.org/ccvi

Section B. Indirect Exposure to Climate Change

B1. Exposure to sea level rise: Neutral.
The entire range of *Carex chordorrhiza* in Washington is at 4520 ft (1380 m) and would not be inundated by projected sea level rise.

B2a. Natural barriers: Somewhat Increase.
In Washington, *Carex chordorrhiza* is restricted to a rare rich fen community dominated by *Carex* and mosses other than *Sphagnum* in water 4 inches deep within a red cedar/willow community (Camp and Gamon 2011; Wilson et al. 2014). This habitat is part of the Rocky Mountain Subalpine-Montane Fen ecological system (Rocchio and Crawford 2015). The surrounding matrix forested vegetation provides a barrier for natural dispersal.

B2b. Anthropogenic barriers: Neutral.
Although there are roads to the north and west of the single *Carex chordorrhiza* occurrence in Washington, they may not be restricting dispersal of this species. Populations of *C. chordorrhiza* from cultivated cranberry farms in Oregon are believed to have been introduced accidently by humans (Zika 2003), suggesting that this is an alternative dispersal pathway.

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 chordorrhiza 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 fruits adhering to mud on birds or mammals.

C2ai. Historical thermal niche: Increase.
Figure 3 depicts the distribution of *Carex chordorrhiza* 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 small (37-47˚F/20.8-26.3˚C) temperature variation during the past 50 years. It is considered to have increased vulnerability under projected climate change (Young et al. 2016).

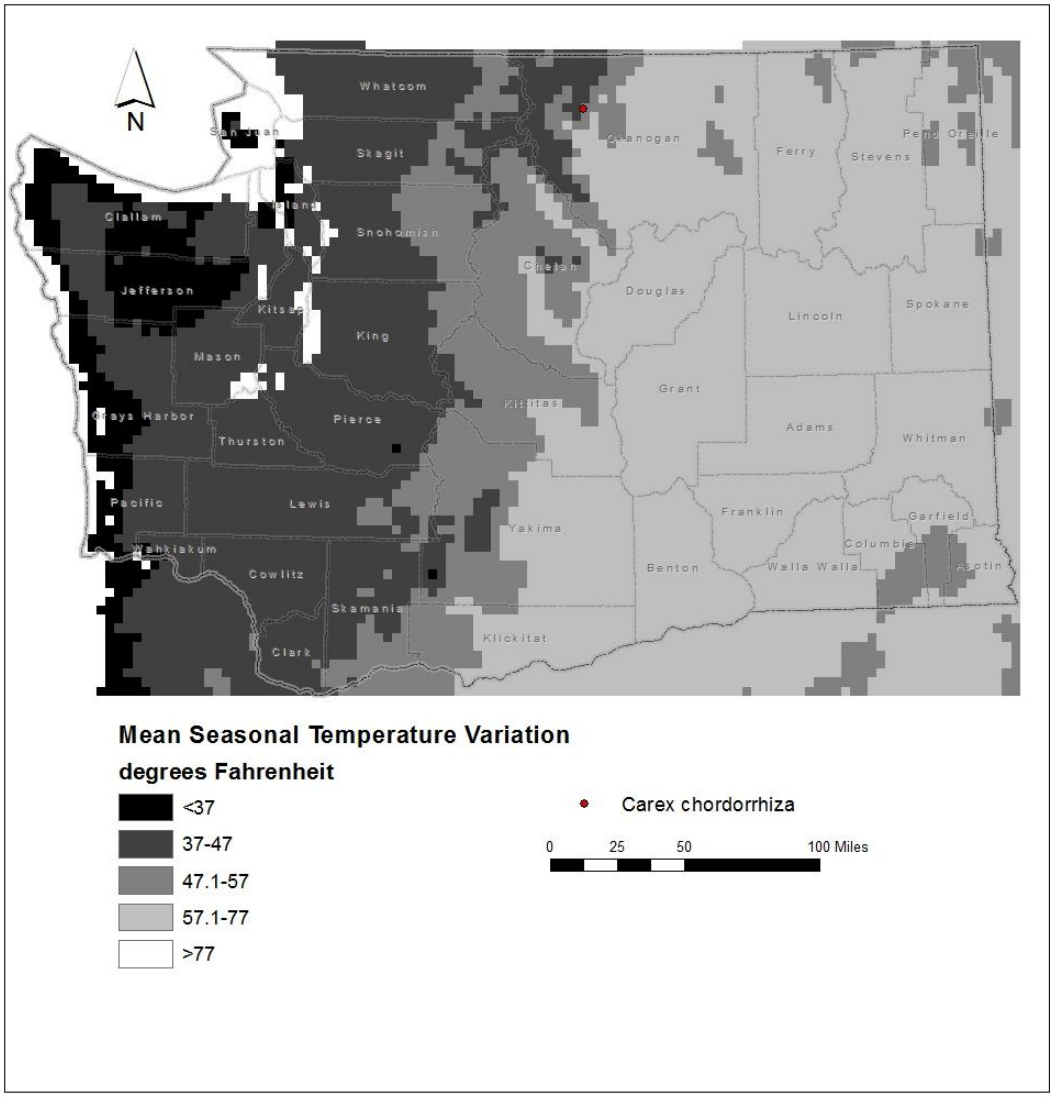

Figure 3. Historical thermal niche (exposure to past temperature variations) of *Carex chordorrhiza* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2aii. Physiological thermal niche: Somewhat Increase.
The single Washington occurrence of *Carex chordorrhiza* is found in fen wetlands associated with cold air drainages in mountain valleys. These microhabitats are cooler than the general landscape matrix.

C2bi. Historical hydrological niche: Neutral.
The entire range of *Carex chordorrhiza* in Washington occurs in areas that have experienced average (21-40 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).

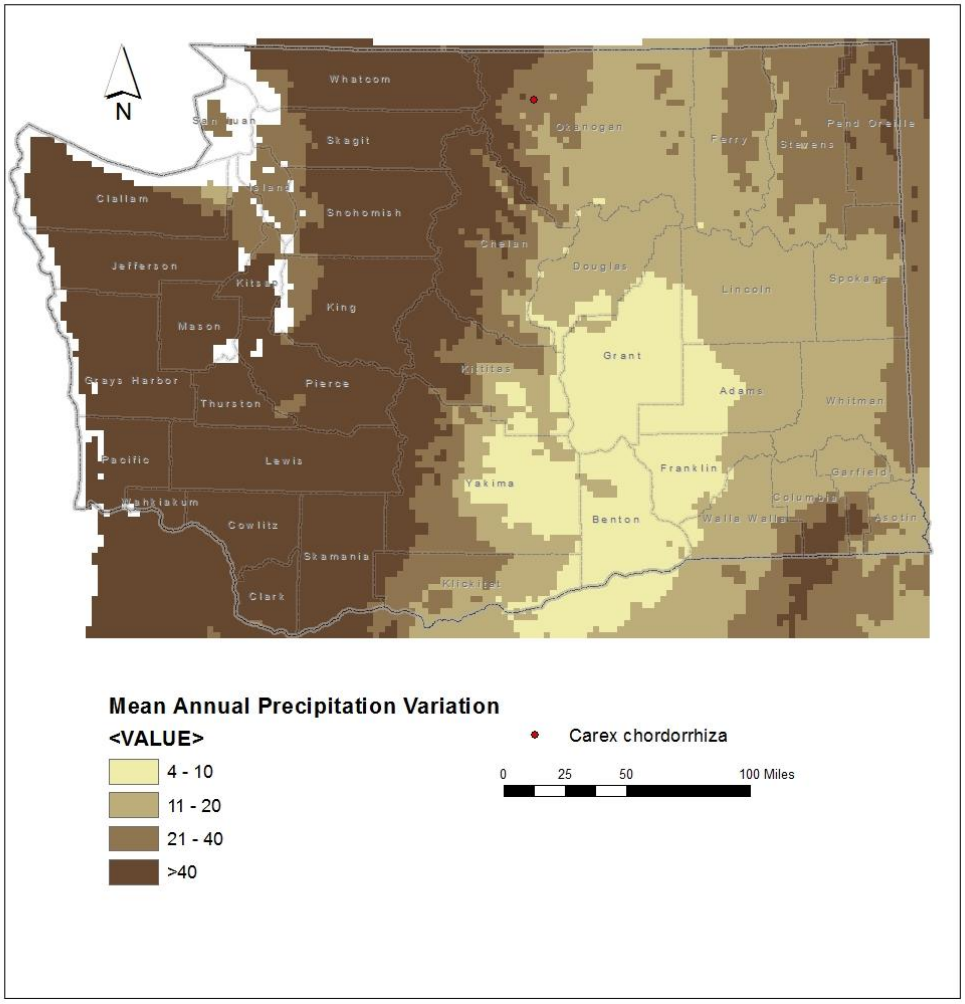

Figure 4. Historical hydrological niche (exposure to past variations in precipitation) of *Carex chordorrhiza* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2bii. Physiological hydrological niche: Somewhat Increase.
Carex chordorrhiza is restricted to an unusual rich fen habitat dependent on adequate year-round moisture. Much of the moisture in this system is derived from groundwater, which is ultimately fed by snowpack. The yearly water balance is augmented by summer precipitation, which could be reduced under projected climate change. Increased summer temperatures and drought or changes in water chemistry could shift this vegetation type towards drier meadow conditions and make the site unsuitable for *C. chordorrhiza* (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 chordorrhiza* occurs in areas of moderate snowfall in the foothills of the Okanogan Mountains. Snowpack, however, is critical for maintaining groundwater supplies for fen wetlands (Rocchio and Ramm-Granberg 2017). Changes in the amount of snow and timing of melting could have long-term negative impacts on this ecological system, changing fen conditions to mesic or dry meadows.

C3. Restricted to uncommon landscape/geological features: Neutral.
Washington populations of *Carex chordorrhiza* are found on glacial outwash and alluvium restricted to valley bottoms in the Okanogan Range. This feature is relatively widespread in northeastern Washington.

C4a. Dependence on other species to generate required habitat: Neutral.

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 fruits embedded in mud.

C4e. Sensitivity to pathogens or natural enemies: Somewhat Increase.
Grazing has been identified as a significant threat to Washington populations of *Carex chordorrhiza* (Camp and Gamon 2011; Wilson et al. 2014).

C4f. Sensitivity to competition from native or non-native species: Neutral.
Carex chordorrhiza in Washington is found in rich fen habitats with low cover of non-native species. Competition with other native species is currently not a threat, but future changes in species composition due to climate change are unknown.

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 native occurrences (some introduced populations are also found in Oregon [Wilson et al. 2014; Zika 2003]), however, and is disjunct from populations in south-central British Columbia. It 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 chordorrhiza* 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 chordorrhiza*.

Section D: Documented or Modeled Response to Climate Change

D1. Documented response to recent climate change: Neutral.
No changes have been documented in the range of this species in Washington.

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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