Climate Change Vulnerability Index Report

Juncus uncialis (Howell's rush)

Date: 7 September 2021

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Geographic Area: Washington Heritage Rank: G3G4/S2

Index Result: Moderately Vulnerable Confidence: Very High

Climate Change Vulnerability Index Scores

Section A: Local Climate	**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	0
	-0.074 to -0.096	0
	-0.051 to -0.073	91.7
	-0.028 to -0.050	8.3
	>-0.028	0
Section B: Indirect Exposure to Climate Change		**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: Sensitivity and Adaptive Capacity		
1. Dispersal and movements		Neutral
2ai Change in historical thermal niche		Neutral
2aii. Change in physiological thermal niche		Neutral/Somewhat Increase
2bi. Changes in historical hydrological niche		Somewhat Increase
2bii. Changes in physiological hydrological niche		Greatly 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		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		Neutral
4f. Sensitivity to competition from native or non-native species		Somewhat Increase
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: Documented or Modeled Response	
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: All 12 known occurrences of *Juncus uncialis* in Washington (100%) occur in areas with a projected temperature increase of 3.9-4.4˚ F (Figure 1).

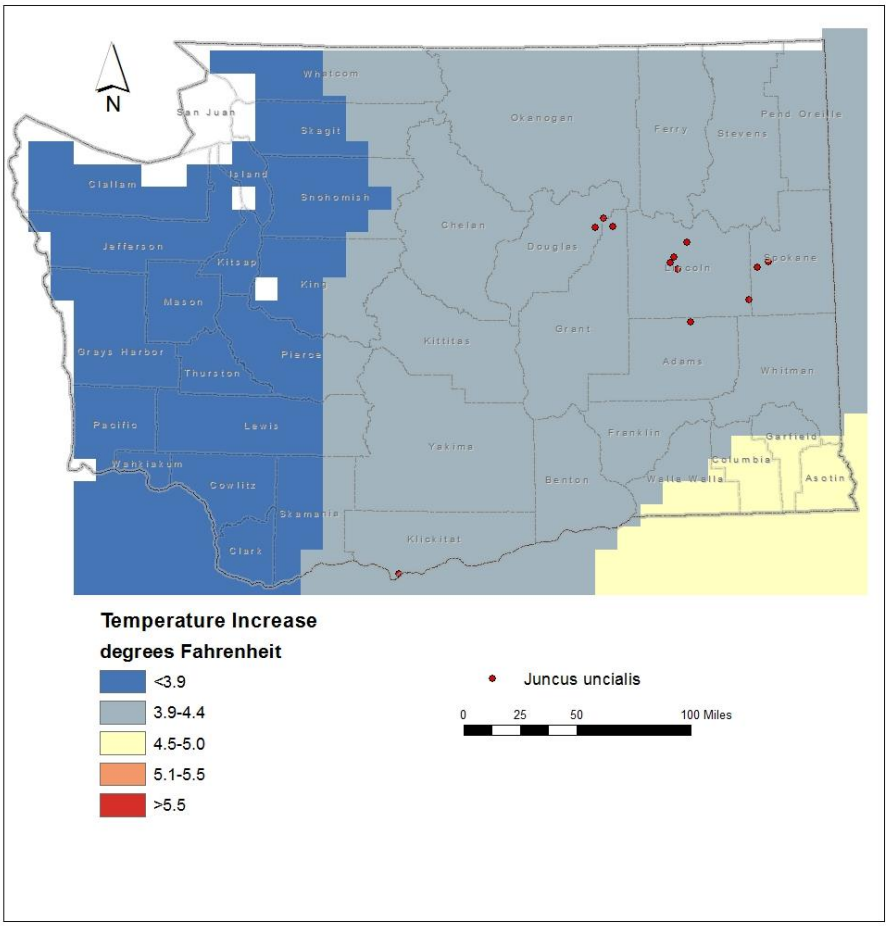

Figure 1. Exposure of *Juncus uncialis* occurrences in Washington to projected local temperature change. Base map layers from www.natureserve.org/ccvi

A2. Hamon AET:PET Moisture Metric: Eleven of the 12 Washington occurrences of *Juncus uncialis* (91.7%) 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 -0.051 to -0.073 (Figure 2). One other population (8.3%) is from an area with a projected decrease of -0.028 to -0.050.

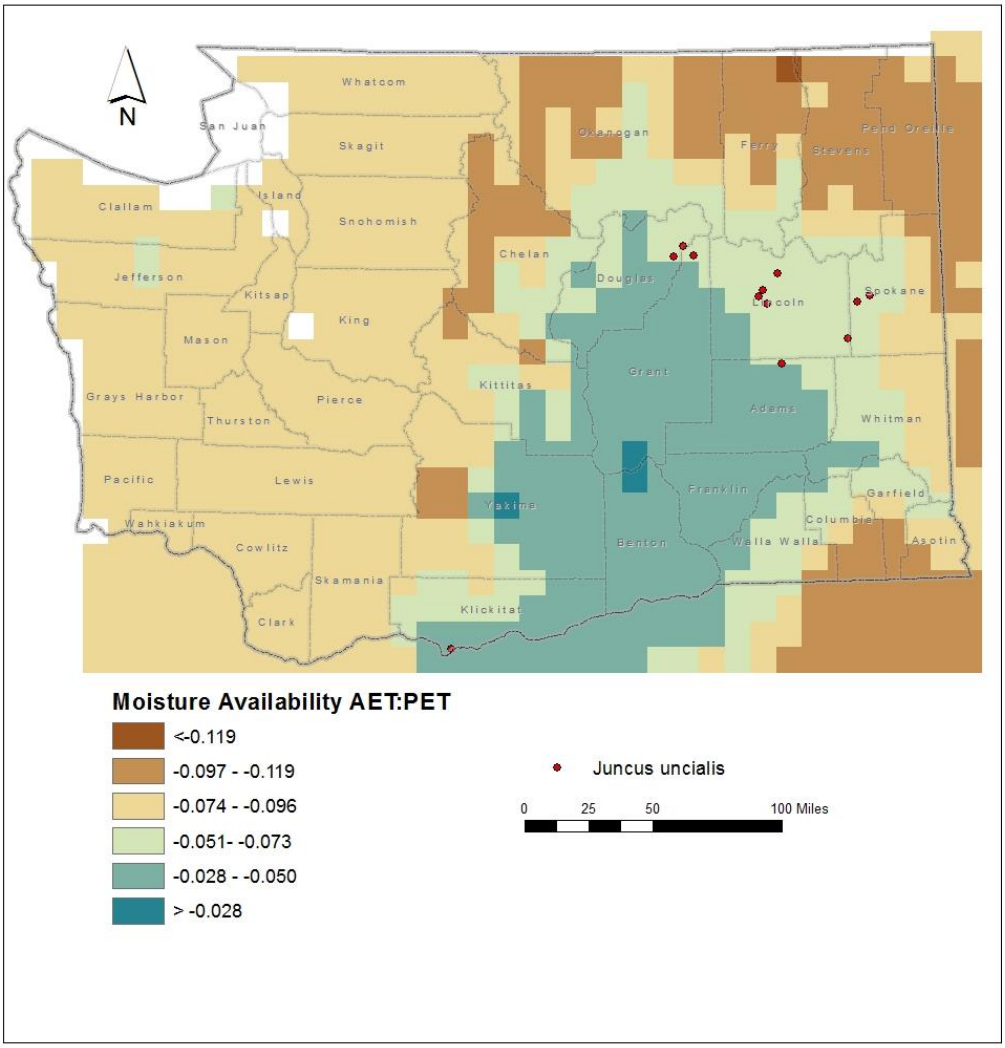

Figure 2. Exposure of *Juncus uncialis* occurrences in Washington to projected moisture availability (based on ratio of actual to predicted evapotranspiration). Base map layers from www.natureserve.org/ccvi

Section B. Indirect Exposure to Climate Change

B1. Exposure to sea level rise: Neutral.
Washington occurrences of *Juncus uncialis* are found at 300-2500 feet (90-760 m) and would not be inundated by projected sea level rise.

B2a. Natural barriers: Increase.
In Washington, *Juncus uncialis* is mostly associated with vernal pools and the edges of small ponds within channeled scablands (Camp and Gamon 2011, Fertig and Kleinknecht 2020). One site in Klickitat County is in a vernal pool on basalt tablelands in the Columbia River Gorge. These sites are components of the Columbia Basin Vernal Pool and Modoc Basalt Flow Vernal Pool ecological systems (Rocchio and Crawford 2015). Populations from eastern Washington are separated by 3-29 miles (4.7-47 km). A gap of 170 miles (274 km) exists between the populations from eastern Washington and Klickitat County (although populations also occur across the Columbia River in Wasco County, Oregon). Vernal pool habitats are strongly tied to landscape features that are themselves widely scattered and isolated by strong natural barriers reducing the likelihood of successful dispersal.

B2b. Anthropogenic barriers: Neutral.
The range of *Juncus uncialis* is naturally fragmented. Historically, some vernal pool habitat has been lost to human impacts, but overall anthropogenic barriers are less significant than natural ones.

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

Section C: Sensitive and Adaptive Capacity

C1. Dispersal and movements: Neutral.
Juncus uncialis produces dry capsules containing up to 140 seeds that are 0.4 mm long or less (Ertter 1986). These tiny seeds may be dispersed short distances through the air, or longer distances by flowing water or attached to feathers or muddy feet of waterfowl. While most seeds probably travel short distances from their parent, the potential for medium to long-distance travel (over 1 km) suggests that this factor should be scored as neutral.

C2ai. Historical thermal niche: Neutral.
Figure 3 depicts the distribution of *Juncus uncialis* in Washington relative to mean seasonal temperature variation for the period from 1951-2006 ("historical thermal niche"). All 12 occurrences (100%) are found in areas that have experienced average (57.1-77˚F/31.8-43.0˚C) temperature variation during the past 50 years and are considered at neutral vulnerability to climate change.

C2aii. Physiological thermal niche: Neutral/Somewhat Increase.
The vernal pool habitat occupied by *Juncus uncialis* is not associated with cold air drainage during the growing season. Shallow vernal pools would be vulnerable to long-term persistent drought exacerbated by increased temperatures (Rocchio and Ramm-Granberg 2017).

C2bi. Historical hydrological niche: Somewhat Increase.
All 12 populations of *Juncus uncialis* in Washington (100%) are found in areas that have experienced slightly lower than average (11-20 inches/255-508 mm) precipitation variation in the past 50 years (Figure 4). According to Young et al. (2016), these occurrences are at somewhat increased vulnerability from climate change.

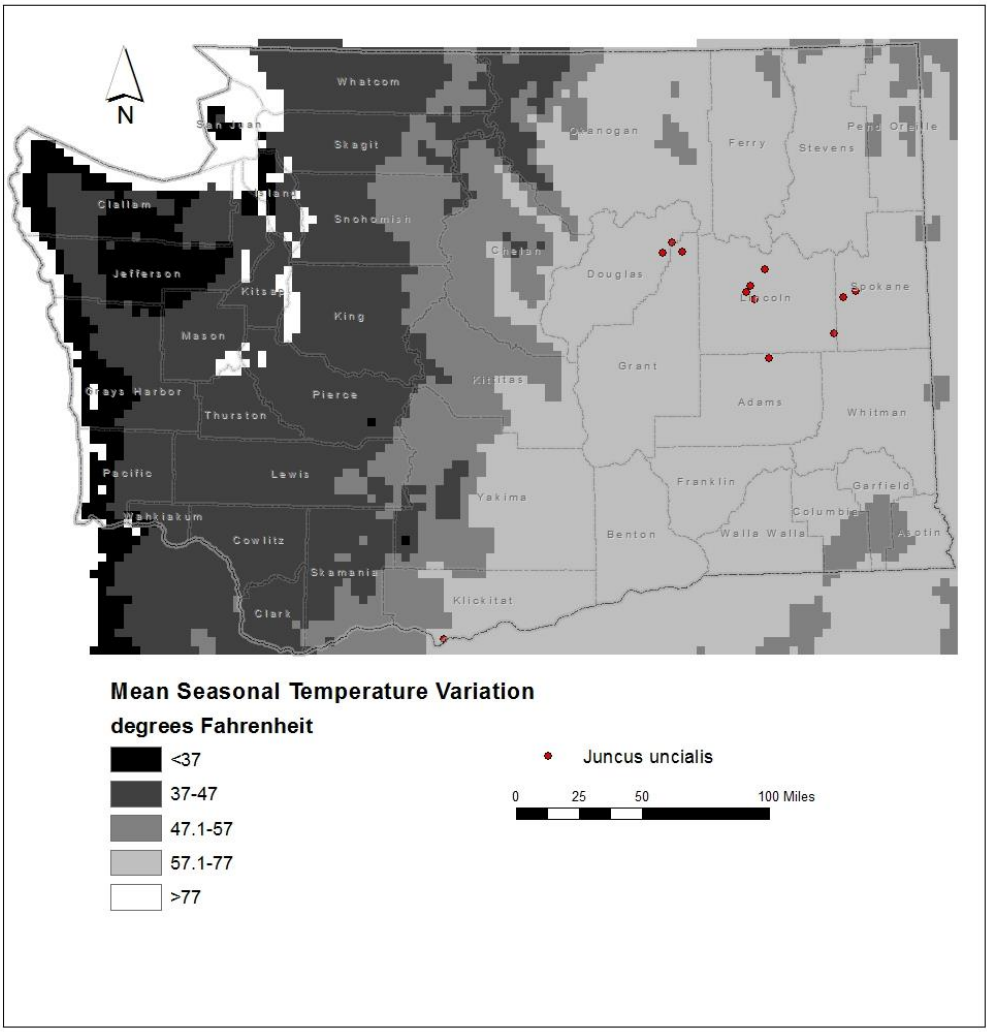

Figure 3. Historical thermal niche (exposure to past temperature variations) of *Juncus uncialis* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2bii. Physiological hydrological niche: Greatly Increase.
Juncus uncialis is dependent on winter and early spring precipitation and snow melt followed by drought to maintain its specialized vernal pool habitat. It is especially vulnerable to changes in the timing or amount of precipitation or snowmelt (Rocchio and Ramm-Granberg 2017). Potentially higher amounts of precipitation in winter could be offset by higher temperatures and greater evapotranspiration in spring. Unpredictable climatic events could also be significant on this annual species which must rely on a seed bank to persist through unfavorable years.

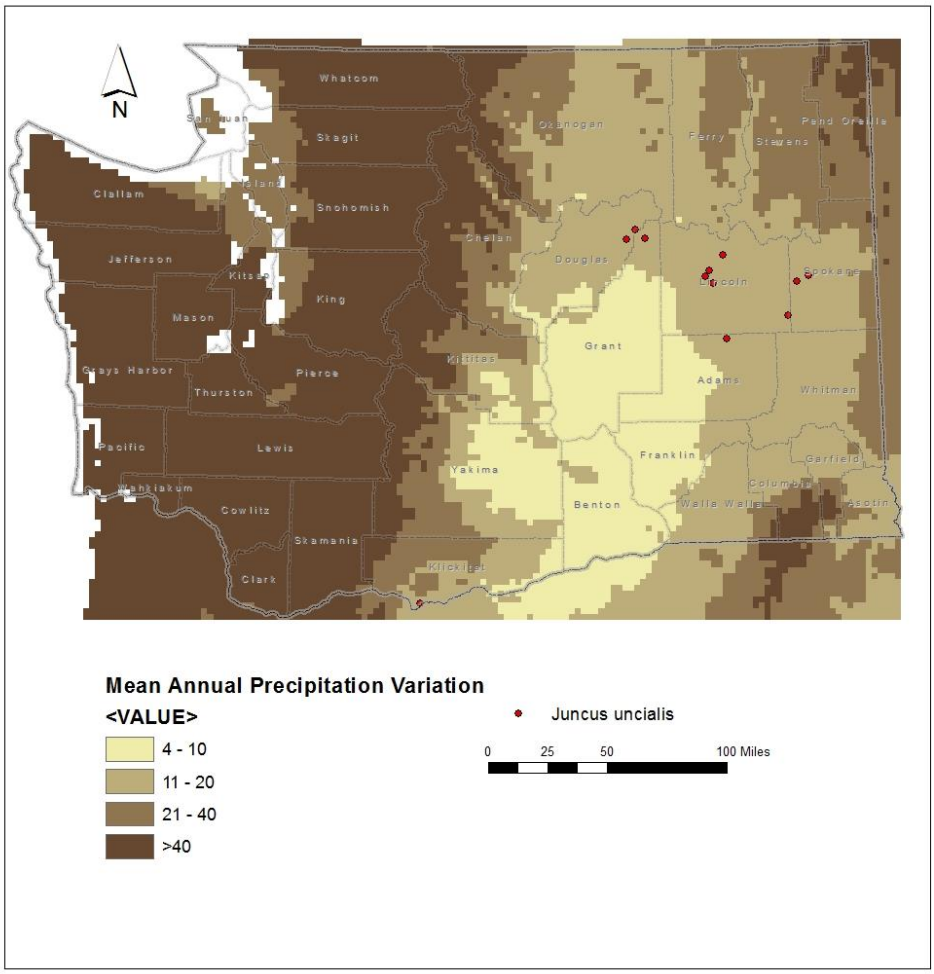

Figure 4. Historical hydrological niche (exposure to past variations in precipitation) of *Juncus uncialis* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2c. Dependence on a specific disturbance regime: Neutral.
Juncus uncialis is not dependent on disturbance to maintain its vernal pool habitat. It would, however, be detrimentally impacted by increased summer temperatures, drought, or decreased snowpack that could lead to a shift to other plant communities or invasive annuals (Rocchio and Ramm-Granberg 2017).

C2d. Dependence on ice or snow-cover habitats: Somewhat Increase.
Although *Juncus uncialis* occurs in areas with moderate winter snowfall, reductions in snowpack or changes in the timing of snow melt could reduce the amount of available water in

its vernal pool habitat, favoring the transition of these sites to less mesic community types (Rocchio and Ramm-Granberg 2017).

C3. Restricted to uncommon landscape/geological features: Increase.
Juncus uncialis is found on Miocene-age Wanapum Basalt beds found widely across the channeled scablands or eastern Washington and the Columbia River Gorge (Washington Division of Geology and Earth Resources 2016). While this geologic formation is common, specific landform characteristics associated with vernal pools (shallow depressions that are deep enough to be flooded in winter and early spring, but shallow enough to become dry in late spring and summer) are an uncommon feature, making this species a habitat specialist.

C4a. Dependence on other species to generate required habitat: Neutral
The vernal pool habitat occupied by *Juncus uncialis* is maintained by natural abiotic processes and geological conditions, rather than interactions with other species.

C4b. Dietary versatility: Not applicable for plants.

C4c. Pollinator versatility: Neutral.
Juncus uncialis, like other members of the genus *Juncus*, is presumed to be primarily wind-pollinated. Recent research suggests that some *Juncus* species can be insect pollinated and capable of selfing too (Huang et al. 2013).

C4d. Dependence on other species for propagule dispersal: Neutral.
Juncus uncialis seeds are tiny and well-suited for dispersal by air, water, or on muddy feathers, feet, or fur of animals. It is not dependent on any single species of animal for dispersal, and so this factor is scored as neutral.

C4e. Sensitivity to pathogens or natural enemies: Neutral.
Impacts from pathogens are not known. *Juncus uncialis* is edible for wildlife and grazing is cited as a potential threat (Camp and Gamon 2011; Fertig and Kleinknecht 2020). Whether climate change would exacerbate these threats is poorly known.

C4f. Sensitivity to competition from native or non-native species: Somewhat Increase.
Juncus uncialis could be sensitive to competition from other plant species (particularly invasive, non-native annual grasses) if its vernal pool habitat is converted to upland vegetation due to climate change (Rocchio and Ramm-Granberg 2017).

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

C5a. Measured genetic variation: Unknown.
Data are not available on the genetic diversity of this species. *Juncus uncialis* is known to have a base chromosome number of $n = 16$ (Ertter 1986).

C5b. Genetic bottlenecks: Unknown.

C5c. Reproductive System: Neutral
Juncus uncialis is presumed to be an outcrosser and primarily wind pollinated suggesting that genetic variability should be average to high rangewide. Populations from eastern Washington are at the northern edge of the species' range and somewhat disjunct from other occurrences along the lower Columbia River and might have lower total diversity due to founder effects or inbreeding.

C6. Phenological response to changing seasonal and precipitation dynamics: Neutral.
Based on information from WNHP records and specimens in the Consortium of Pacific Northwest Herbaria, no changes have been detected in phenology in the past 40 years.

Section D: Documented or Modeled Response to Climate Change

D1. Documented response to recent climate change: Neutral.
The range of this species in Washington has not changed significantly since it was first documented in the state in 1983.

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

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