Climate Change Vulnerability Index Report

Juncus howellii (Howell's rush)

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Assessor: Walter Fertig, WA Natural Heritage Program

Geographic Area: Washington Heritage Rank: G4/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	100
	<3.9° F (2.2°C) warmer	0
2. Hamon AET:PET moisture	< -0.119	0
	-0.097 to -0.119	33
	-0.074 to - 0.096	67
	-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/Somewhat Increase
2b. Distribution relative to anthropogenic barriers		Neutral
3. Impacts from climate change mitigation		Neutral
Section C		
1. Dispersal and movements		Neutral
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		Somewhat 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		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		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	
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 three of the known occurrences of *Juncus howellii* in Washington (100%) occur in areas with a projected temperature increase of 3.9-4.4˚ F (Figure 1). Several unconfirmed populations have been reported from the Blue Mountains of SE Washington,

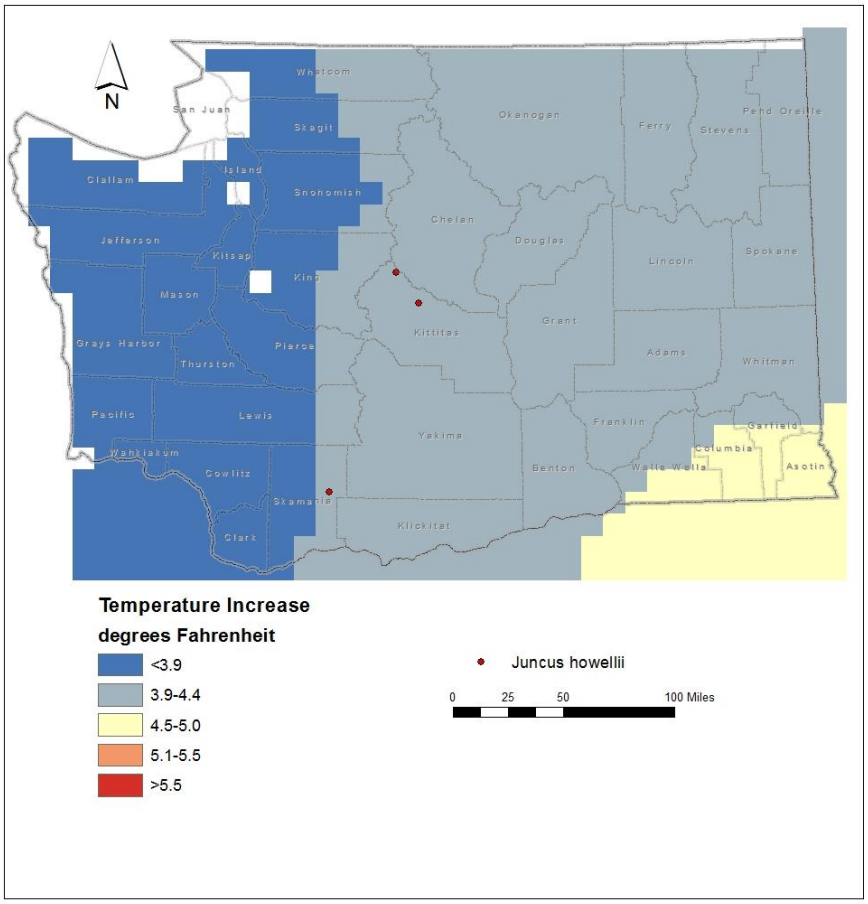

Figure 1. Exposure of *Juncus howellii* occurrences in Washington to projected local temperature change. Base map layers from www.natureserve.org/ccvi

within the area identified as having a projected temperature increase of 4.5-5.0˚ F, but are not included in this assessment. Other unverified (and probably erroneous) reports from Pierce and Whitman counties have also been excluded.

A2. Hamon AET:PET Moisture Metric: Two of the three confirmed Washington occurrences of *Juncus howellii* (67%) 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 -0.074 to -0.096 (Figure 2). The other 33% of occurrences are in areas with projected decrease of -0.097 to -0.119. If accepted, populations from the Blue Mountains would fall in the latter range as well.

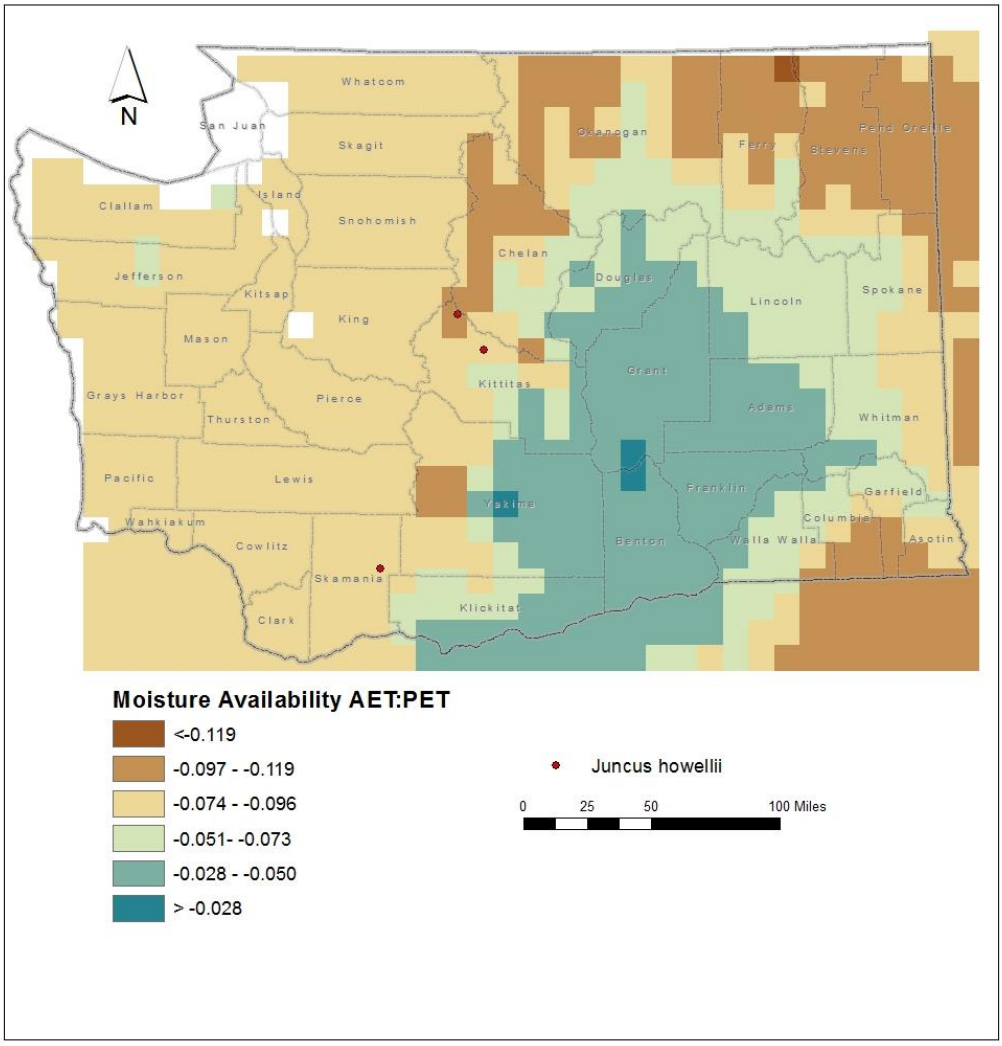

Figure 2. Exposure of *Juncus howellii* occurrences in Washington to projected moisture availability (based on ratio of actual to predicted evapotranspiration). Base map layers from www.natureserve.org/ccvi

Section B. Indirect Exposure to Climate Change

B1. Exposure to sea level rise: Neutral.
Washington occurrences of *Juncus howellii* are found at 2590-3500 feet (790-1070 m) and would not be inundated by projected sea level rise.

B2a. Natural barriers: Neutral/Somewhat Increase.
In Washington, *Juncus howellii* is found in wet meadows, moist boulder areas below basalt cliffs, and sunny, damp roadsides and narrow riparian areas (Fertig and Kleinknecht 2020). These sites are a component of the Temperate Pacific Subalpine-Montane Wet Meadow ecological system (Rocchio and Crawford 2015). Washington populations are separated by 17-94 miles (28-150 km). The large gap between known occurrences may be due to incomplete sampling, significant dispersal barriers, or site-specific adaptations.

B2b. Anthropogenic barriers: Neutral.
The wet meadow and riparian habitat of *Juncus howellii* is associated with mountainous areas of Washington, where the human footprint is less extensive than in lowland areas.

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

Section C: Sensitive and Adaptive Capacity

C1. Dispersal and movements: Neutral.
Juncus howellii produces dry capsules containing numerous, minute seeds with short tail-like appendages at both tips. These seeds are small enough to be dispersed short distances through the air, or longer distances by flowing water or attached to feathers or muddy feet of waterfowl. While many seeds may 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: Somewhat Increase.
Figure 3 depicts the distribution of *Juncus howellii* in Washington relative to mean seasonal temperature variation for the period from 1951-2006 ("historical thermal niche"). Two of the three confirmed occurrences (67%) 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 and are considered at Somewhat Increased vulnerability to climate change. One of three occurrences (33%) is found in an area with small temperature variation (37-47˚F/20.8-26.3˚C) in the same period and is at increased vulnerability. This factor is scored as Somewhat Increase because the majority of occurrences fall in this category.

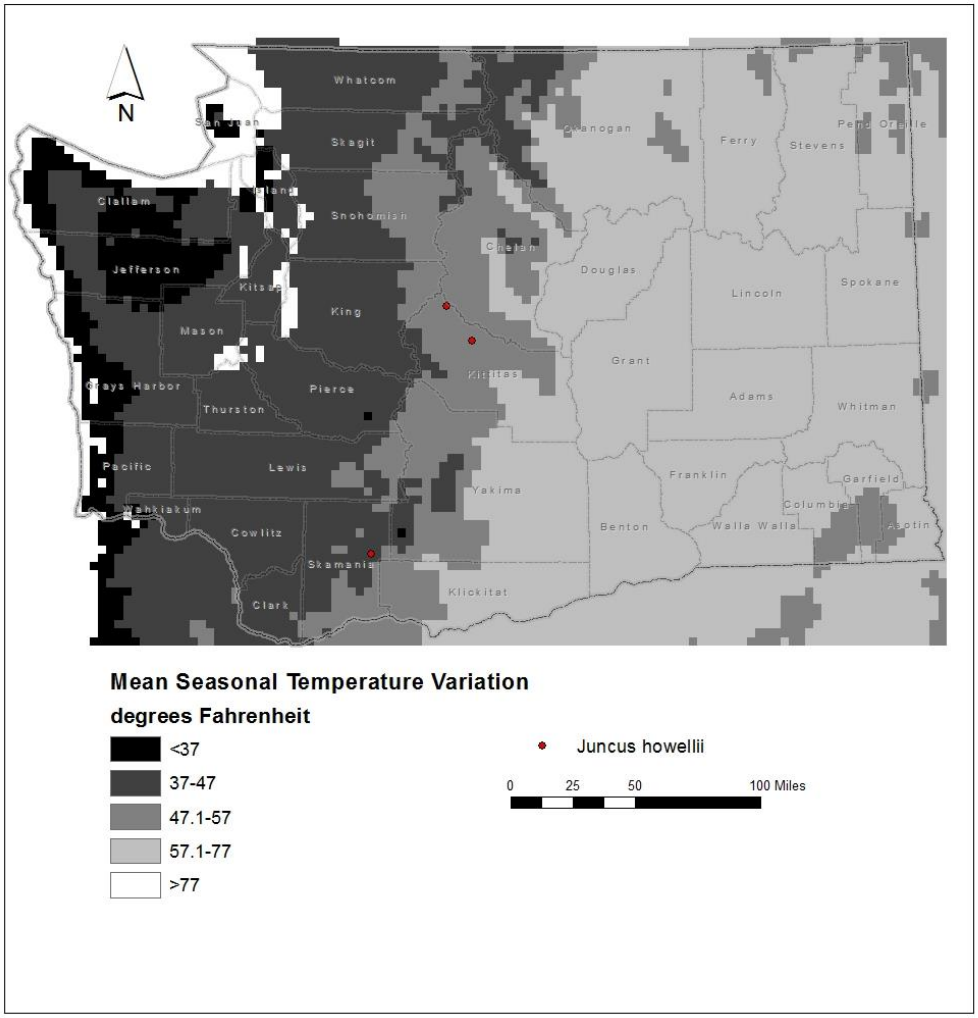

Figure 3. Historical thermal niche (exposure to past temperature variations) of *Juncus howellii* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2aii. Physiological thermal niche: Somewhat Increase.
The lower montane wetland habitat of *Juncus howellii* is associated with cool temperatures during the growing season and would be vulnerable to hotter temperatures predicted through climate change. Increased summer drought and increased susceptibility to wildfire would make wet meadow communities prone to shifts in species composition towards drier habitat types (Rocchio and Ramm-Granberg 2017).

C2bi. Historical hydrological niche: Neutral.
All three confirmed populations of *Juncus howellii* in Washington (100%) are found in areas that have experienced average or greater than average (>20 inches/508 mm) precipitation variation in the past 50 years (Figure 4). According to Young et al. (2016), these occurrences are at neutral vulnerability from climate change.

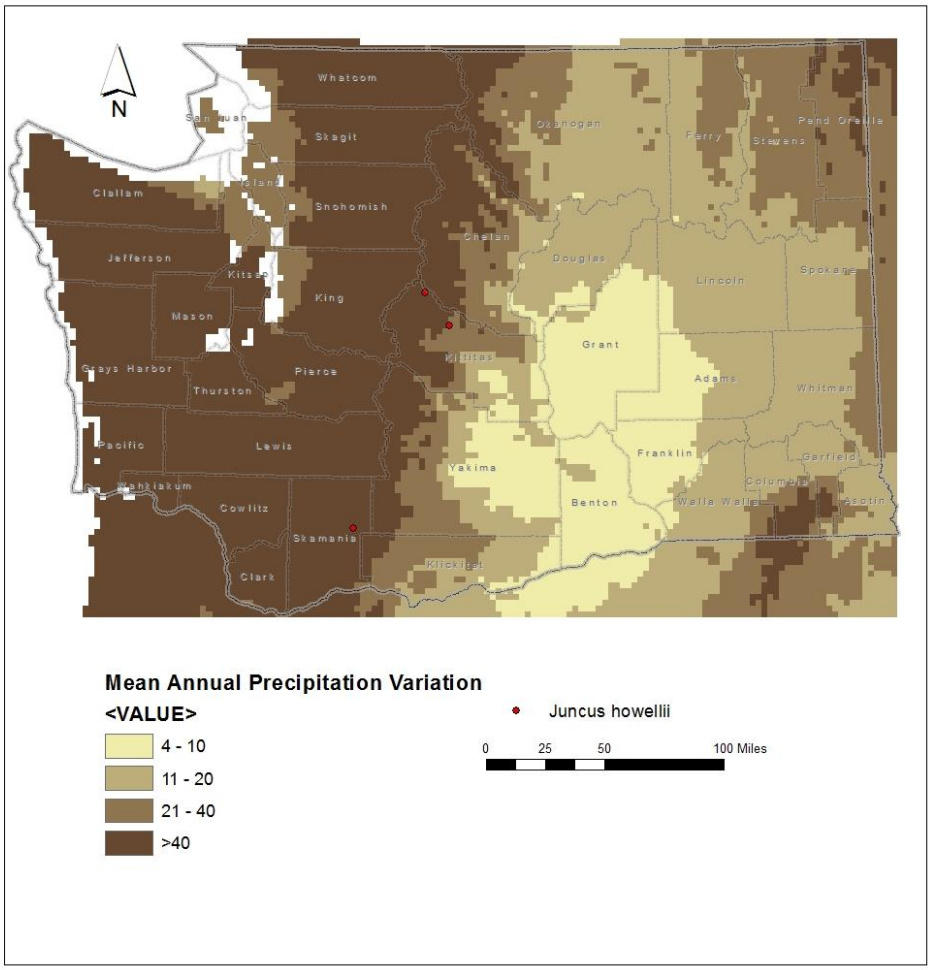

Figure 4. Historical hydrological niche (exposure to past variations in precipitation) of *Juncus howellii* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2bii. Physiological hydrological niche: Somewhat Increase.
The wet meadow and narrow streamside habitat of *Juncus howellii* may be impacted by shifts in timing and amount of precipitation, resulting in lowered stream flows and increased drought.

This could result in invasion of woody shrubs and trees or increased competition with dry meadow or invasive plant species (Rocchio and Ramm-Granberg 2017). See also "Dependence on ice or snow-cover habitats" below.

C2c. Dependence on a specific disturbance regime: Neutral.
Juncus howellii is found in moist meadows and narrow riparian corridors, with one occurrence also reported from a moist roadside. The disturbance from the roadside may be less critical for its presence than the open canopy created by the road. This species does not appear to be disturbance-dependent for its habitat and is scored as neutral.

C2d. Dependence on ice or snow-cover habitats: Somewhat Increase.
The populations of *Juncus howellii* in Washington occur in wet meadows and narrow streamsides in mountainous areas that may be dependent on late-lying snow for groundwater recharge, especially when droughty conditions arise in summer (Rocchio and Ramm-Granberg 2017). Reduction in the amount of snowpack, or changes in snowmelt patterns could make these habitats more drought-prone and less suitable for *J. howellii*.

C3. Restricted to uncommon landscape/geological features: Neutral.
Juncus howellii occurrences are not associated with any unusual geologic substrate or land form.

C4a. Dependence on other species to generate required habitat: Neutral
The wet meadow and riparian habitat occupied by *Juncus howellii* is maintained by natural abiotic processes.

C4b. Dietary versatility: Not applicable for plants

C4c. Pollinator versatility: Neutral.
Juncus howellii, 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 howellii seeds are small and have tiny tail-like appendages for dispersal by air, water, or on feathers 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 howellii* is edible for wildlife and grazing is cited as a potential threat (Fertig and Kleinknecht 2020). Whether climate change would exacerbate these threats is not known.

C4f. Sensitivity to competition from native or non-native species: Somewhat Increase.
Projected climate change could make montane wet meadow habitats more susceptible to drought and invasion by dry meadow species (native and introduced) that could increase competition (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.

C5b. Genetic bottlenecks: Unknown.

C5c. Reproductive System: Neutral
Juncus howellii is presumed to be an outcrosser and primarily wind pollinated suggesting that genetic variability should be average to high rangewide. Washington populations are at the northern edge of the species' range and might have lower total diversity due to founder effects.

C6. Phenological response to changing seasonal and precipitation dynamics: Neutral.
No changes have been detected in phenology in recent years.

Section D: Documented or Modeled Response to Climate Change

D1. Documented response to recent climate change: Neutral.
No change has been detected to date.

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.

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