Climate Change Vulnerability Index Report

*Muhlenbergia glomerata* (Marsh muhly)

Date: 18 February 2020

Assessor: Walter Fertig, WA Natural Heritage Program

Geographic Area: Washington Heritage Rank: G5/S2

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 | 75 |
| | -0.074 to - 0.096 | 25 |
| | -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 | | Neutral |
| 2ai Change in historical thermal niche | | Neutral |
| 2aii. Change in physiological thermal niche | | Somewhat Increase |
| 2bi. Changes in historical hydrological niche | | Somewhat Increase |
| 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 | | Somewhat Increase |
| 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 | Somewhat Increase |
| 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 eight of the known occurrences of *Muhlenbergia glomerata* in Washington (100%) occur in areas with a projected temperature increase of 3.9-4.4˚ F (Figure 1).

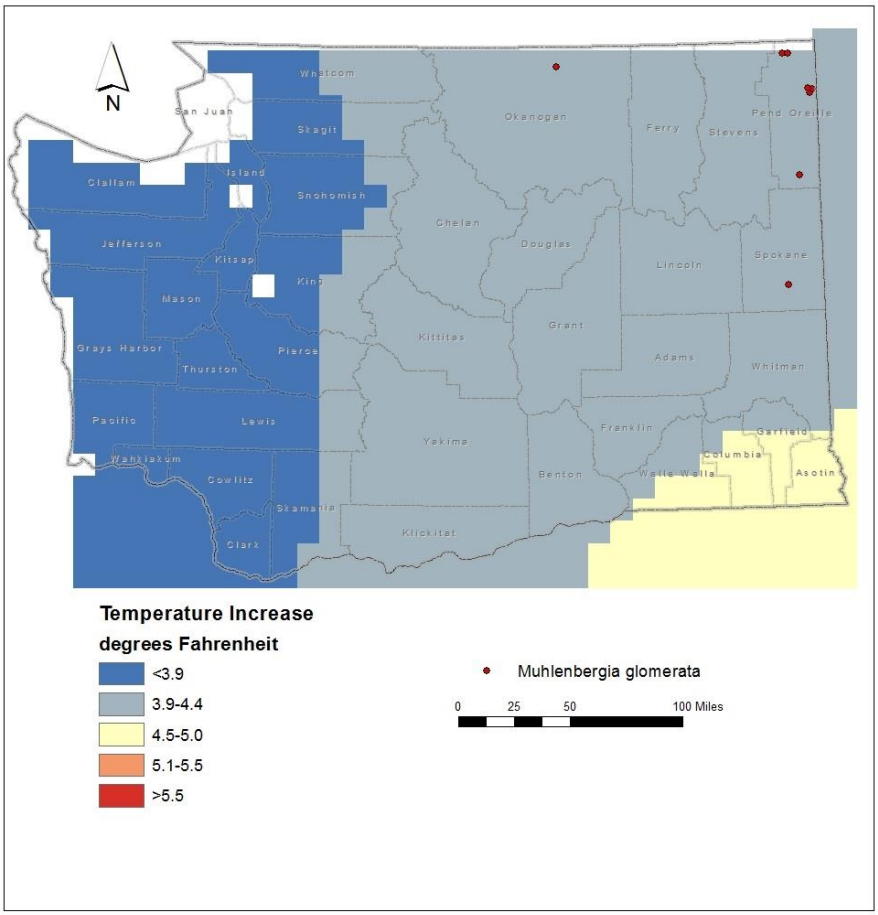


Figure 1. Exposure of *Muhlenbergia glomerata* occurrences in Washington to projected local temperature change. Base map layers from www.natureserve.org/ccvi

A2. Hamon AET:PET Moisture Metric: Two of the eight occurrences of *Muhlenbergia glomerata* (25%) in Washington 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 six occurrences (75%) are found in areas with a projected decrease in available moisture of – 0.097 to – 0.119.

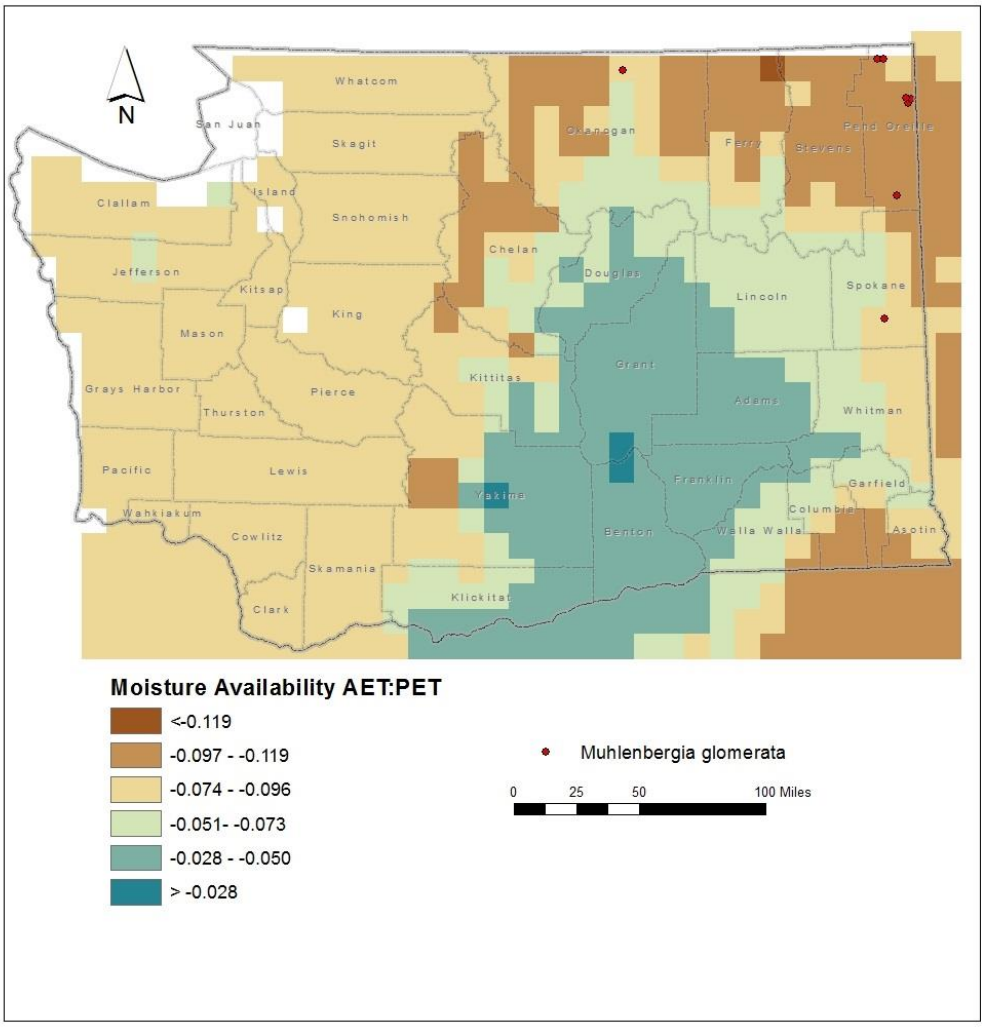


Figure 2. Exposure of *Muhlenbergia glomerata* occurrences in Washington to projected moisture availability (based on ratio of actual to predicted evapotranspiration). Base map layers from www.natureserve.org/ccvi

## Section B. Indirect Exposure to Climate Change

B1. Exposure to sea level rise: Neutral.
Washington occurrences of *Muhlenbergia glomerata* are found at 575-3600 feet (175-1100 m) and would not be inundated by projected sea level rise.

B2a. Natural barriers: Somewhat Increase.
In Washington, *Muhlenbergia glomerata* is found in calcareous fens, wet meadows, and streambanks and pond edges in mountains and valleys. Historically, the species was also found in a wet Palouse Prairie site near Spangle (Camp and Gamon 2011, WNHP records). These habitats are included within the Rocky Mountain Subalpine-Montane Fen and Rocky Mountain Alpine-Montane Wet Meadow ecological systems (Rocchio and Crawford 2015). *M. glomerata* is unusual for a fen species in having the water-conserving $C_4$ photosynthetic pathway and may be adapted to slightly drier microsites on hummocks formed by ants (Kublen and Sage 2003, Lesica and Kannowski 1998). Individual populations occupy small areas and are separated by 4-158 km (2.25-100 miles). These specialized habitats are naturally isolated from each other with mostly unsuitable habitat in-between.

B2b. Anthropogenic barriers: Neutral.
The range of *Muhlenbergia glomerata* is naturally fragmented. Human impacts on the landscape of northeastern Washington have little effect on this condition.

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

## Section C: Sensitive and Adaptive Capacity

C1. Dispersal and movements: Neutral.
*Muhlenbergia glomerata* produces small, dry, one-seeded fruits (caryopses) with a tuft of hairs at the base that are readily dispersed by wind or small animals. Although average travel distances may be relatively short, the species is capable of long-distance dispersal of at least 1 km.

C2ai. Historical thermal niche: Neutral.
Figure 3 depicts the distribution of *Muhlenbergia glomerata* in Washington relative to mean seasonal temperature variation for the period from 1951-2006 ("historical thermal niche"). All eight of the known 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 risk to climate change.

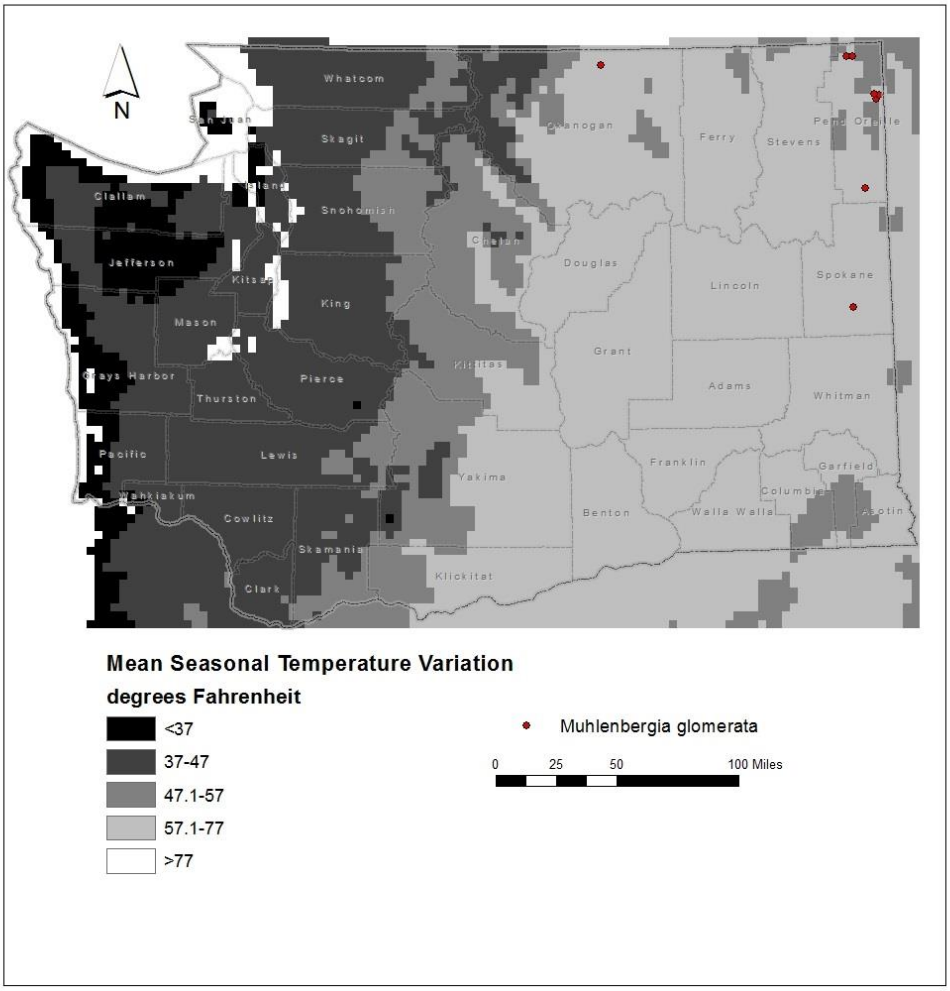


Figure 3. Historical thermal niche (exposure to past temperature variations) of *Muhlenbergia glomerata* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2aii. Physiological thermal niche: Somewhat Increase.
The fen and wet meadow habitat of *Muhlenbergia glomerata* is associated with cold air drainage during the growing season and would have increased vulnerability to rising temperatures from climate change. Increased drought and higher susceptibility to wildfire would make these habitats prone to conversion to drier forest or meadow habitats (Rocchio and Ramm-Granberg 2017).

C2bi. Historical hydrological niche: Neutral.
Six of the eight populations of *Muhlenbergia glomerata* in Washington (75%) 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 to climate change. Two of the eight occurrences (25%) are from areas that have experienced slightly lower than average (11-20 inches/255-508 mm) variation in precipitation over the same period and are considered at somewhat increased vulnerability.

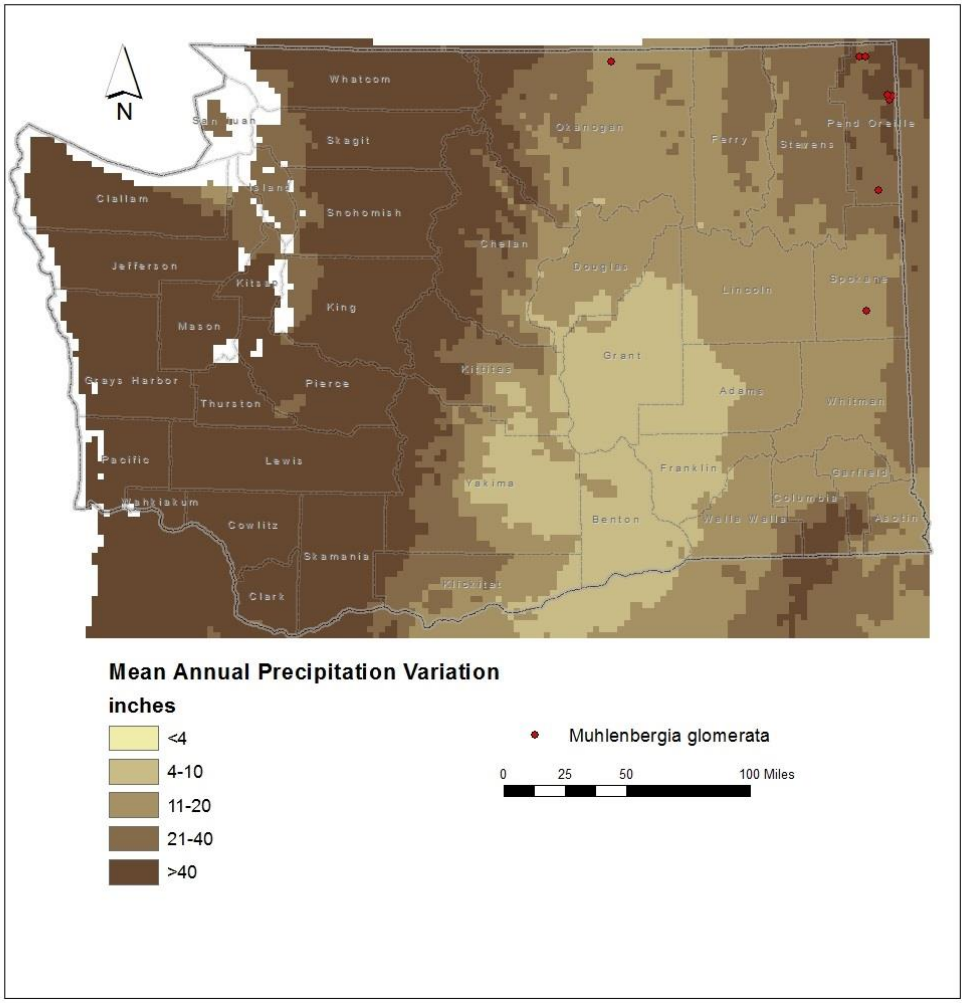


Figure 4. Historical hydrological niche (exposure to past variations in precipitation) of *Muhlenbergia glomerata* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2bii. Physiological hydrological niche: Somewhat Increase.
This species is dependent on a specific wetland habitat that is vulnerable to increased drought, changes in the timing or amount of precipitation, increased wildfire, or change in snowpack (Rocchio and Ramm-Granberg 2017).

C2c. Dependence on a specific disturbance regime: Neutral.
*Muhlenbergia glomerata* is not dependent on periodic disturbances to maintain its fen or wet meadow habitat. The species could, however, be detrimentally affected by increased summer temperatures, drought, or decreased snowpack that might favor conversion of this habitat to forest or meadows (Rocchio and Ramm-Granberg 2017).

C2d. Dependence on ice or snow-cover habitats: Increase.
The populations of *Muhlenbergia glomerata* in Washington are found mostly in montane wetlands that are dependent on snow for recharging groundwater. These sites are highly dependent on moisture from late-lying snowbanks (Rocchio and Ramm-Granberg 2017). Changes in the amount of snow or when the snow melts could lead to shifts in the dominance of herbaceous species or invasion of trees or shrubs.

C3. Restricted to uncommon landscape/geological features: Neutral.
*Muhlenbergia glomerata* is found mostly on glacial drift deposits, which are widespread in northeastern Washington.

C4a. Dependence on other species to generate required habitat: Somewhat Increase
The wetland habitat occupied by *Muhlenbergia glomerata* is maintained primarily by natural abiotic processes. In Montana and Wyoming, *M. glomerata* is often associated with semi-dry hummocks formed by ant colonies (Fertig 1998; Lesica and Kannowski 1998). Similar relationships may be present in Washington.

C4b. Dietary versatility: Not applicable for plants

C4c. Pollinator versatility: Neutral.
*Muhlenbergia glomerata* is entirely wind-pollinated.

C4d. Dependence on other species for propagule dispersal: Neutral.
Seeds are mostly dispersed passively by wind, but the short-awned lemmas of the florets might also facilitate dispersal by animals.

C4e. Sensitivity to pathogens or natural enemies: Neutral.
Impacts from pathogens are not known. This species is not a preferred forage for livestock and may increase in early seral sites grazed by cattle (Hansen et al. 1995).

C4f. Sensitivity to competition from native or non-native species: Somewhat Increase.
*Muhlenbergia glomerata* could be sensitive to competition from other plant species if its specialized wetland habitat became drier due to drought or reduced snowpack and water recharge under future 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.
Mitchell and Pohl (1966) report that *Muhlenbegia glomerata* is ordinarily a diploid and outcrosser, but that aneuploids have been documented that may persist through selfing, which is an unusual characteristic for a wind-pollinated grass species. The aneuploids may have also arisen from hybridization with *M. mexicana*, a species more typical of mesic rather than fen or wet meadow habitats. The aneuploids may be more adapted to drier conditions and might actually be favored under changing climatic conditions (Mitchell 1962, Mitchell and Pohl 1966). Population-level genetic data, however, are not available for Washington occurrences to infer genetic variability.

C5b. Genetic bottlenecks: Unknown.

C5c. Reproductive System: Neutral
*Muhlenbergia glomerata* produces small, wind-pollinated flowers, which is typically associated with out-crossing and at least average genetic diversity (Young et al. 2016). Mitchell and Pohl (1966) have demonstrated that *M. glomerata* is capable of self-pollination. This and its scattered distribution across the west would suggest that local populations may be genetically diverging. In either situation, the reproductive system would be considered neutral for impacts from climate change.

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: Somewhat Increase.
Low elevation populations of *Muhlenbergia glomerata* in the Columbia Plateau have not been relocated in recent years and are probably extirpated. Whether this is due primarily to alteration of its wetland habitat or climate change is poorly known. These low elevation sites are no longer suitable habitat, however, and the species is unlikely to become re-established under present or anticipated future climatic conditions.

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

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