Climate Change Vulnerability Index Report

Micranthes tischii (Olympic saxifrage)

Date: 17 November 2021 Synonym: *Saxifraga tischii*

Assessor: Walter Fertig, WA Natural Heritage Program

Geographic Area: Washington Heritage Rank: G2/S1?

Index Result: Highly 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	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	87.5
	-0.051 to -0.073	12.5
	-0.028 to -0.050	0
	>-0.028	0
Section B: Indirect Exposure to Climate Change		**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: Sensitivity and Adaptive Capacity		
1. Dispersal and movements		Increase
2ai Change in historical thermal niche		Greatly Increase
2aii. Change in physiological thermal niche		Greatly 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		Somewhat Increase
4a. Dependence on others species to generate required habitat		Neutral
4b. Dietary versatility		Not Applicable
4c. Pollinator versatility		Unknown
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	Somewhat Increase
D2. Modeled future (2050) change in population or range size	Increase
D3. Overlap of modeled future (2050) range with current range	Neutral
D4. Occurrence of protected areas in modeled future (2050) distribution	Neutral

Section A: Exposure to Local Climate Change

A1. Temperature: All 8 of the extant and historical occurrences of *Micranthes tischii* from the Olympic Range in Washington (100%) occur in areas with a projected temperature increase

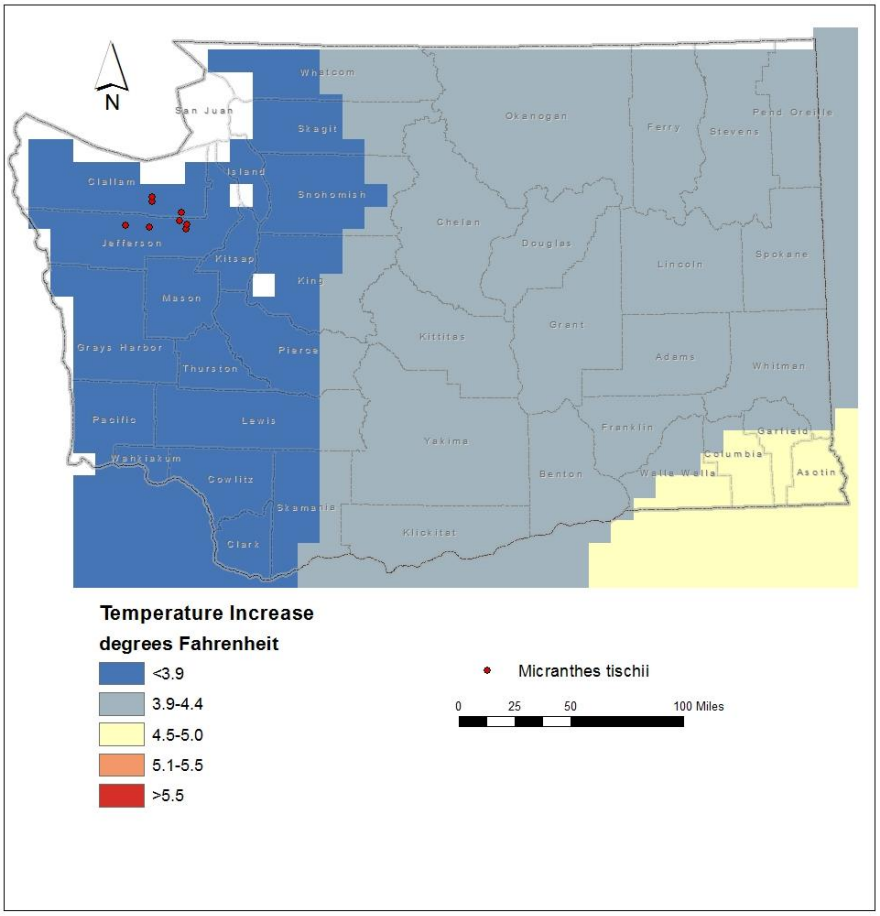

Figure 1. Exposure of *Micranthes tischii* occurrences in Washington to projected local temperature change. Base map layers from www.natureserve.org/ccvi

< 3.9˚ F (Figure 1). An additional report from Okanogan County may be a related species and is not included in this analysis.

A2. Hamon AET:PET Moisture Metric: Seven of the 8 occurrences (87.5%) of *Micranthes tischii* 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). One other population (12.5%) is from an area with a projected decrease from -0.051 to -0.073.

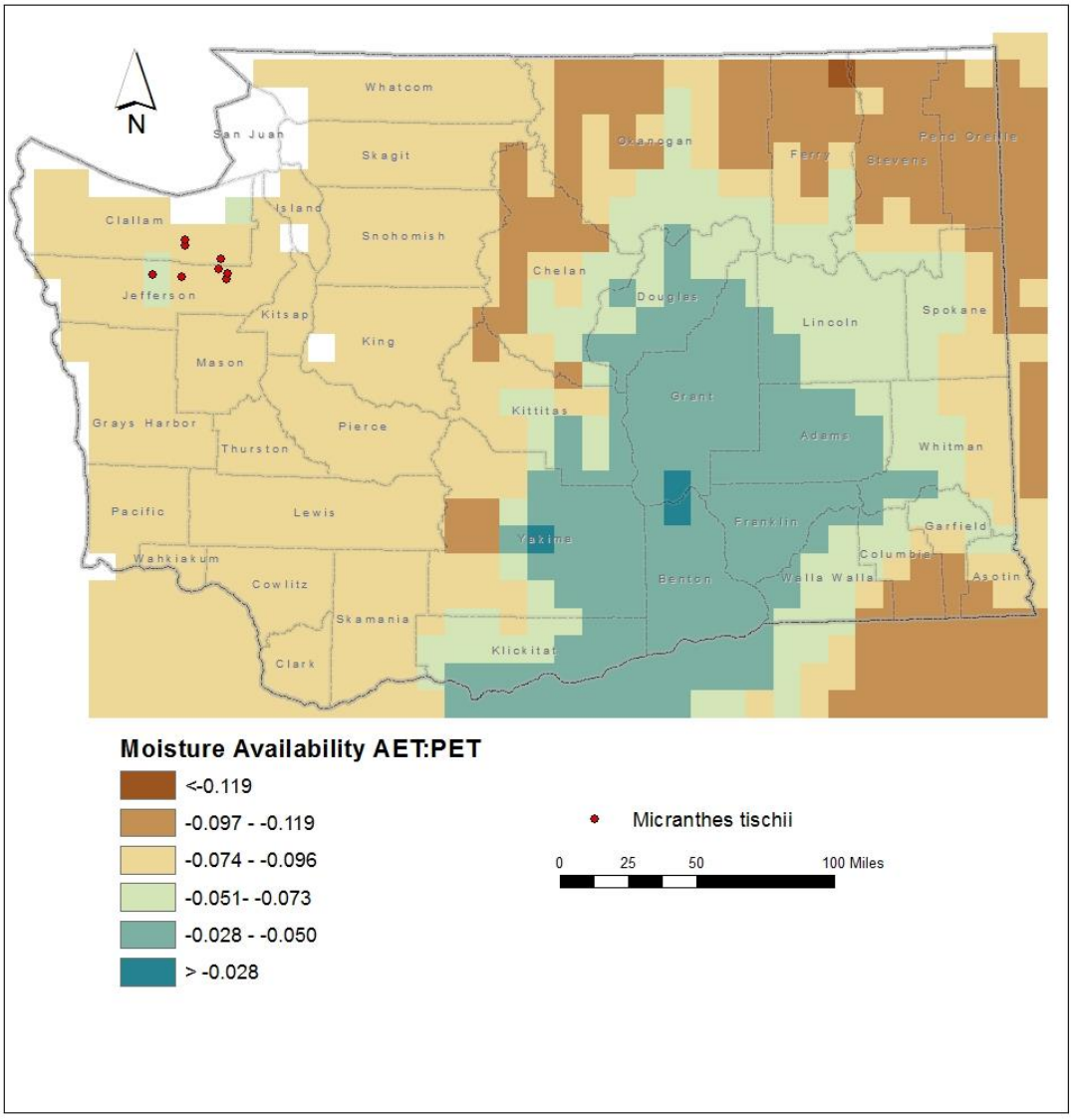

Figure 2. Exposure of *Micranthes tischii* occurrences in Washington to projected moisture availability (based on ratio of actual to predicted evapotranspiration). Base map layers from www.natureserve.org/ccvi

Section B. Indirect Exposure to Climate Change

B1. Exposure to sea level rise: Neutral.
Washington occurrences of *Micranthes tischii* are found at 4500-6500 feet (1370-1980 m) and would not be inundated by projected sea level rise.

B2a. Natural barriers: Somewhat Increase.
Micranthes tischii occurs primarily on cool, shady basalt ledges, basalt or sandstone scree slopes, and thin-soiled depressions below alpine snowbanks in the Olympic Range (Skelly 1988, Washington Natural Heritage Program 2021). This habitat is part of the North Pacific Alpine & Subalpine Bedrock and Scree ecological system (Rocchio and Crawford 2015). Populations are on peaks and ridgelines separated by 2.3-11.2 miles (3.8-18.2 km) of unoccupied and unsuitable river valley and lower elevation forested habitat that present a barrier to propagule dispersal. The Olympic Mountains are disjunct from other alpine mountain ranges to the north and east of the Salish Sea and Puget Sound in the Pacific Northwest, making potential migration more difficult.

B2b. Anthropogenic barriers: Neutral.
The range of *Micranthes tischii* in Washington is restricted to Olympic National Park and the Buckhorn Wilderness Area of Olympic National Forest (Fertig 2020). These areas have some hiking trails but otherwise receive minimal direct impacts from humans to limit dispersal.

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

Section C: Sensitive and Adaptive Capacity

C1. Dispersal and movements: Increase.
Micranthes tischii produces dry, follicle-like fruits that split at maturity to passively release small seeds. The seeds lack hairs, spines, hooks, barbs, wings, or other features to facilitate dispersal by wind or for attaching to animal vectors. Dispersal distances are reported as small for European species of *Micranthes* (Alsos et al. 2012) and probably average less than 100 meters. Young et al. (2016) and Alsos et al. (2012) rate species with this dispersal distance as having increased vulnerability to climate change.

C2ai. Historical thermal niche: Greatly Increase.
Figure 3 depicts the distribution of *Micranthes tischii* in Washington relative to mean seasonal temperature variation for the period from 1951-2006 ("historical thermal niche"). Seven of the 8 known occurrences in the state (87.5%) are found in areas that have experienced very small (<37˚F/20.8˚C) temperature variation during the past 50 years and are considered at greatly increased vulnerability to climate change (Young et al. 2016). One other occurrence (12.5%) is from an area with small temperature variation (37-47˚F/20.8-26.3˚C) over the same period and is at increased vulnerability to climate change.

C2aii. Physiological thermal niche: Greatly Increase.
Micranthes tischii is restricted to alpine scree slopes and shaded ledges entirely within a cold climate zone during the flowering season and are highly vulnerable to temperature increases from climate change.

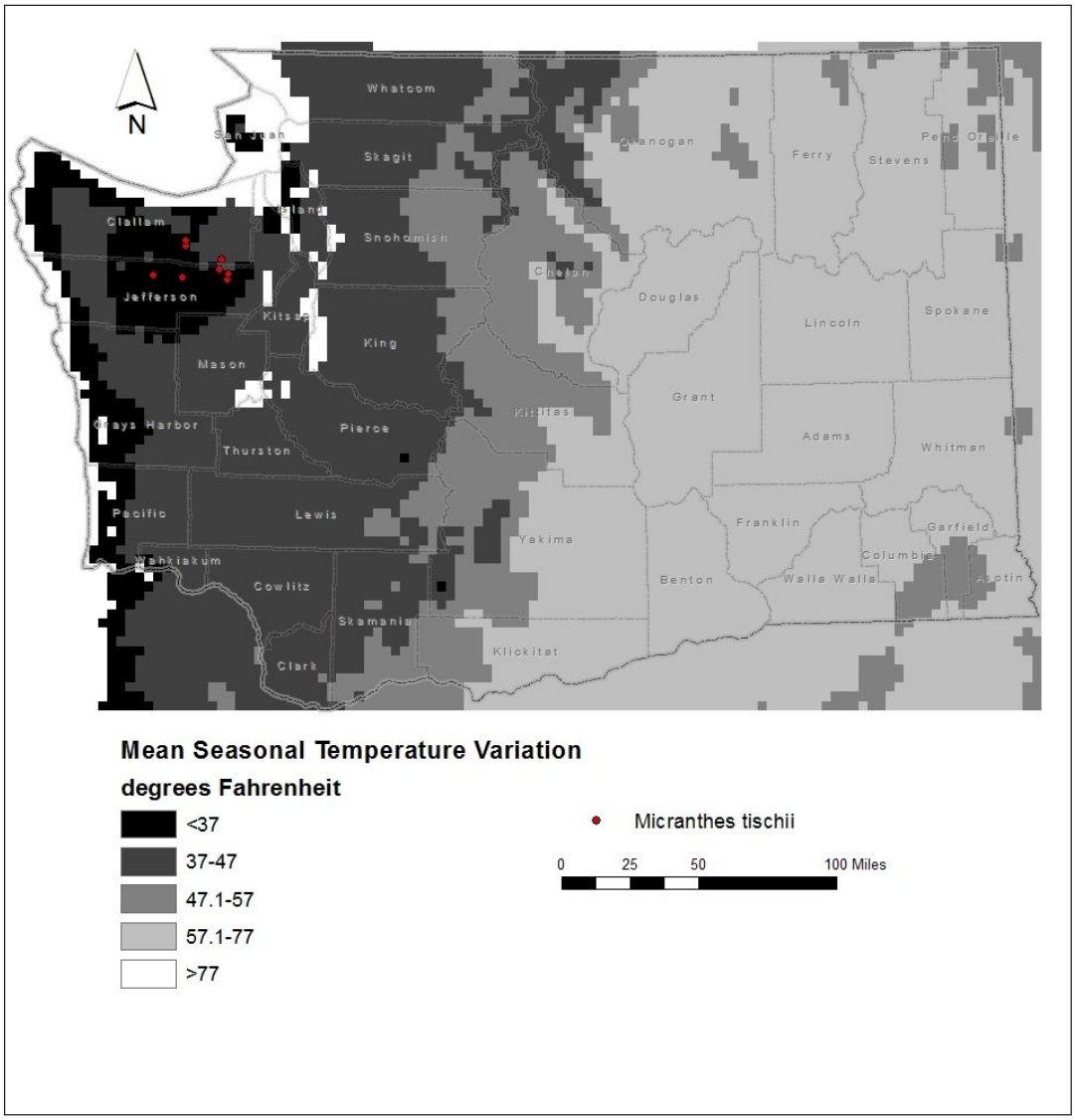

Figure 3. Historical thermal niche (exposure to past temperature variations) of *Micranthes tischii* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2bi. Historical hydrological niche: Neutral.

All of the known populations of *Micranthes tischii* in Washington are found in areas that have experienced greater than average precipitation variation in the past 50 years (>40 inches/1016 mm) (Figure 4). According to Young et al. (2016), these occurrences are neutral for climate change.

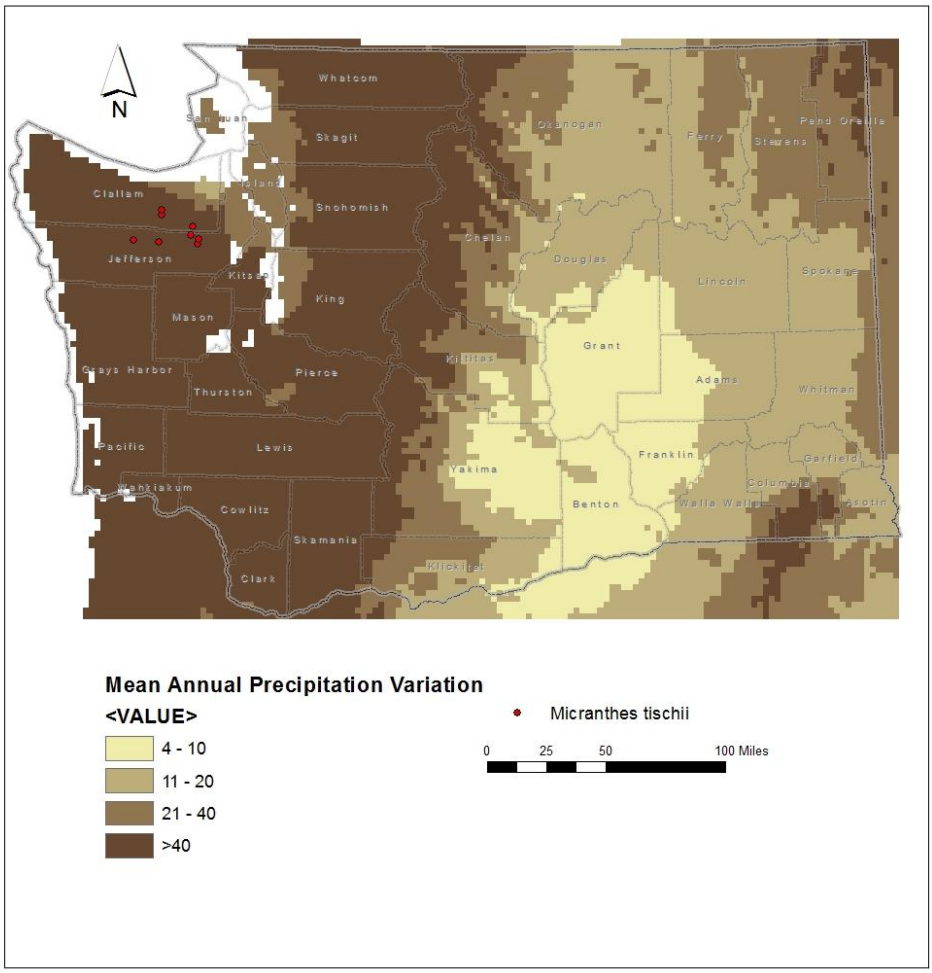

Figure 4. Historical hydrological niche (exposure to past variations in precipitation) of *Micranthes tischii* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2bii. Physiological hydrological niche: Somewhat Increase.
Micranthes tischii occurs in shady, cool, basalt ledges, or exposed scree slopes below snowdrifts. It is strongly reliant on adequate snowpack and the timing of snowmelt to provide sufficient moisture during the growing season (see C2d below). Increasing temperatures could shift snow to winter rain or lead to earlier snowmelt and runoff in the alpine zone (Rocchio and Ramm-Granberg 2017).

C2c. Dependence on a specific disturbance regime: Neutral.
The alpine cliff and scree habitat of *Micranthes tischii* is maintained by a short growing season, high winds that scours fine soil, and late-lying snowdrifts that prevent tree species from becoming established. Increased temperatures could eventually make these areas more suitable

to invasion by meadow species from lower elevations as rock weathers and soil accumulates. Climate change could increase the area available to this species, however, as formerly glaciated areas melt and convert to alpine bedrock and scree habitat (Rocchio and Ramm-Granberg 2017).

C2d. Dependence on ice or snow-cover habitats: Increase.
The Olympic Mountains average over 10 meters (400 inches) of snow each winter. The alpine cliff and scree habitat of *Micranthes tischii* is often located below late-lying snowbanks (Washington Natural Heritage Program 2021). This species is dependent on high volumes of snow and predictable snowmelt for its moisture requirements during the growing season. Changes in the amount of snowpack or timing of snowmelt resulting from climate change is likely to have a significant negative impact on *M. tischii* (Rocchio and Ramm-Granberg 2017).

C3. Restricted to uncommon landscape/geological features: Somewhat Increase.
Micranthes tischii is found primarily on outcrops of Oligocene to Eocene-aged marine sedimentary rocks (mostly thin to medium-bedded shale or sandstone). This geologic type forms the core of the Olympic Range, but is otherwise uncommon in Washington. Two occurrences in the eastern Olympics are associated with the Eocene-age Crescent Basalt, which is limited to the northern and eastern rim of the range (Washington Division of Geology and Earth Resources 2016).

C4a. Dependence on other species to generate required habitat: Neutral.
The alpine talus and cliff habitat occupied by *Micranthes tischii* is maintained largely by natural abiotic conditions.

C4b. Dietary versatility: Not applicable for plants

C4c. Pollinator versatility: Unknown.
The specific pollinators of *Micranthes tischii* are not known. Related species of *Saxifraga* and *Micranthes* are pollinated by a variety of small bees, wasps, and flies (Soltis 2007).

C4d. Dependence on other species for propagule dispersal: Neutral.
The fruits of *Micranthes tischii* split open at maturity to release seeds passively by gravity. Secondary dispersal may occur by rodents or insects collecting seeds for food, but *M. tischii* is not reliant on other species for dispersal.

C4e. Sensitivity to pathogens or natural enemies: Neutral.
This species is not known to be impacted by pathogens or herbivory.

C4f. Sensitivity to competition from native or non-native species: Somewhat Increase.
Wendy Gibble has observed lower elevation *Micranthes* species moving uphill into the alpine zone occupied by *M. tischii* (Fertig 2020). Other lower elevation plant species may also be able to invade alpine cliff and scree habitats in the future under projected warmer conditions, increasing competition for space and nutrients (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.
No data are available on the genetic diversity of populations of *Micranthes tischii*. Studies of related alpine species in Europe suggest that genetic diversity is likely to decrease in the future if ranges shrink due to climate change (Alsos et al. 2012).

C5b. Genetic bottlenecks: Unknown.
Not known.

C5c. Reproductive System: Neutral.
Micranthes tischii appears to be an obligate outcrosser and is not limited by pollinators or dispersal, so is presumed to have average genetic variation.

C6. Phenological response to changing seasonal and precipitation dynamics: Neutral.
Based on herbarium records in the Consortium of Pacific Northwest Herbaria website (pnwherbaria.org), *Micranthes tischii* has not changed its typical blooming time since it was first collected in the early 1900s.

Section D: Documented or Modeled Response to Climate Change

D1. Documented response to recent climate change: Somewhat Increase.
Four of the known occurrences of *Micranthes tischii* in Washington are historical and have not been relocated since 1976 and are considered historical. Whether these populations have been overlooked or are extirpated is not known. The potential contraction of its range may be due to climate change rather than habitat loss, as all populations are from protected areas.

D2. Modeled future (2050) change in population or range size: Increase.
Wershow and DeChaine (2018) did not include this species in their study of climate change impacts on alpine endemics of the Olympic Range, but found that taxa from similar habitats were likely to lose 85-99% of their available habitat by 2080.

D3. Overlap of modeled future (2050) range with current range: Neutral.
Based on the projected future range modeling of other alpine endemic plant species of the Olympic Range (Wershow and DeChaine 2018), the range of *Micranthes tischii* is likely to contract rather than shift in distribution northward in the future.

D4. Occurrence of protected areas in modeled future (2050) distribution: Neutral.
Despite the predicted contraction of potential habitat due to climate change, the entire range of *Micranthes tischii* in Washington will still be restricted to Olympic National Park and the Buckhorn Wilderness Area of Olympic National Forest.

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