Climate Change Vulnerability Index Report

*Thelypodium sagittatum* ssp. *sagittatum* (Arrow thelypody)

**Date:** 2 March 2020

**Assessor:** Walter Fertig, WA Natural Heritage Program

**Geographic Area:** Washington  
**Heritage Rank:** G4T4/S1

**Index Result:** Moderately Vulnerable  
**Confidence:** Very High

## Climate Change Vulnerability Index Scores

<table>
<thead>
<tr>
<th>Section A</th>
<th>Severity</th>
<th>Scope (% of range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Temperature Severity</td>
<td>&gt;6.0° F (3.3°C) warmer</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>5.6-6.0°F (3.2-3.3°C) warmer</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>5.0-5.5°F (2.8-3.1°C) warmer</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>4.5-5.0°F (2.5-2.7°C) warmer</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>3.9-4.4°F (2.2-2.4°C) warmer</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>&lt;3.9°F (2.2°C) warmer</td>
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</tr>
<tr>
<td>2. Hamon AET:PET moisture</td>
<td>&lt; -0.119</td>
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</tr>
<tr>
<td></td>
<td>-0.097 to -0.119</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>-0.074 to -0.096</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>-0.051 to -0.073</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>-0.028 to -0.050</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>&gt;=-0.028</td>
<td>0</td>
</tr>
</tbody>
</table>

### 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  
   Neutral

2a(ii). Change in physiological thermal niche  
   Neutral

2bi. Changes in historical hydrological niche  
   Somewhat Increase

2bii. Changes in physiological hydrological niche  
   Increase

2c. Dependence on specific disturbance regime  
   Neutral

2d. Dependence on ice or snow-covered habitats  
   Neutral

3. Restricted to uncommon landscape/geological features  
   Somewhat Increase

4a. Dependence on other 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  
   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
Section D

<table>
<thead>
<tr>
<th>Question</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1. Documented response to recent climate change</td>
<td>Neutral</td>
</tr>
<tr>
<td>D2. Modeled future (2050) change in population or range size</td>
<td>Unknown</td>
</tr>
<tr>
<td>D3. Overlap of modeled future (2050) range with current range</td>
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</tr>
<tr>
<td>D4. Occurrence of protected areas in modeled future (2050) distribution</td>
<td>Unknown</td>
</tr>
</tbody>
</table>

Section A: Exposure to Local Climate Change

A1. Temperature: All five of the known occurrences of *Thelypodium sagittatum* ssp. *sagittatum* in Washington (100%) occur in an area with a projected temperature increase of 3.9-4.4° F (Figure 1).

![Temperature Increase Map](www.natureserve.org/ccvi)
A2. Hamon AET:PET Moisture Metric: Four of the five Washington occurrence of *Thelypodium sagittatum* ssp. *sagittatum* (80%) are found in an area 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 (20%) is found in an area with a projected decrease in moisture of − 0.028 to − 0.050.

Figure 2. Exposure of *Thelypodium sagittatum* ssp. *sagittatum* 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

Washington occurrences of *Thelypodium sagittatum* ssp. *sagittatum* are found at 1600-2300 feet (500-700 m) and would not be inundated by projected sea level rise.

In Washington, *Thelypodium sagittatum* ssp. *sagittatum* is found in shallow, alkali marshes, moist swales, and salt flats over basalt within a matrix of upland sagebrush and bunchgrass vegetation (Camp and Gamon 2011, Fertig and Kleinknecht 2020). This habitat is a component of the North American Arid West Emergent Marsh ecological system (though grading towards the Northern Columbia Plateau Basalt Pothole Ponds system) (Rocchio and Crawford 2015). Washington populations are separated by 5-37 km (3-23 miles) and occupy small areas of habitat within a matrix of unsuitable sagebrush steppe and scablands that create a barrier to dispersal.

The range of *Thelypodium sagittatum* ssp. *sagittatum* in Washington is embedded within a matrix of natural and agricultural lands. The species is probably more isolated by natural barriers than anthropogenic ones.

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

Section C: Sensitive and Adaptive Capacity

C1. Dispersal and movements: Somewhat Increase.
*Thelypodium sagittatum* ssp. *sagittatum* produces numerous, many-seeded siliques per inflorescence. The fruits open along two sutures at maturity to passively release the small, unornamented seeds for dispersal by gravity, water, or wind. Seeds are mostly shed close to their parent, but may be able to travel 100-1000 m.

Figure 3 depicts the distribution of *Thelypodium sagittatum* ssp. *sagittatum* in Washington relative to mean seasonal temperature variation for the period from 1951-2006 (“historical thermal niche”). All five of the extant and historical 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 from climate change.
C2aii. Physiological thermal niche: Neutral. The shallow, alkali wetlands inhabited by *Thelypodium sagittatum ssp. sagittatum* in the Columbia Plateau of eastern Washington are not associated with cold air drainage in the growing season and not vulnerable to projected temperature increases due to climate change.

Figure 3. Historical thermal niche (exposure to past temperature variations) of *Thelypodium sagittatum ssp. sagittatum* occurrences in Washington. Base map layers from www.natureserve.org/ccvi
C2bi. Historical hydrological niche: Somewhat Increase.
Four of the five populations of *Thelypodium sagittatum* ssp. *sagittatum* in Washington (80%) 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 areas are at somewhat increased vulnerability from climate change. One other occurrence is found in an area with small (4-10 inches/100-254 mm) precipitation variation in the same period and is considered at increased risk from climate change.

Figure 4. Historical hydrological niche (exposure to past variations in precipitation) of *Thelypodium sagittatum* ssp. *sagittatum* occurrences in Washington. Base map layers from www.natureserve.org/ccvi
Physiological hydrological niche: Increase.

In Washington, *Thelypodium sagittatum ssp. sagittatum* is found in shallow alkali depressions and other marshy meadows over basalt. These wetland areas are probably supported by rainfall, rather than groundwater. Such sites are vulnerable to changes in timing and amount of precipitation, increasing temperatures, and summer drought (Rocchio and Ramm-Granberg 2017). Marsh and pothole wetland systems are likely to convert to wet meadow communities under prolonged climate change.

Dependence on a specific disturbance regime: Neutral.

*Thelypodium sagittatum ssp. sagittatum* occurs in shallow depressions in basalt bedrock with vernal alkali wetlands surrounded by sagebrush or bunchgrass vegetation on deeper soils. The wetland communities are maintained by precipitation, seasonal drought, and soil depth and chemistry, more so than disturbances, such as fire.

Dependence on ice or snow-cover habitats: Neutral.

The range of *Thelypodium sagittatum ssp. sagittatum* in the Columbia Plateau in Washington has low snowfall. Drifting or late-melting snow is a supplemental source of moisture along with spring and winter rainfall.

Restricted to uncommon landscape/geological features: Somewhat Increase.

In Washington, *Thelypodium sagittatum ssp. sagittatum* is strongly associated with shallow depressions in basalt with thin clay soil. While basalt is widespread across central and eastern Washington (and not limiting), the depressions and thin, alkali soil layers required by this species may be relatively uncommon.

Dependence on other species to generate required habitat: Neutral

The alkali marshy meadow habitat of *Thelypodium sagittatum ssp. sagittatum* is probably maintained primarily by natural abiotic processes.

Dietary versatility: Not applicable for plants

Pollinator versatility: Neutral.

Like other members of the Brassicaceae, *Thelypodium sagittatum ssp. sagittatum* is adapted for pollination by numerous, unspecialized (generalist) species of insects such as moths, butterflies, bees, and flies. It is unlikely to be pollinator limited.

Dependence on other species for propagule dispersal: Neutral.

Seed dispersal in *Thelypodium sagittatum ssp. sagittatum* is entirely passive, with the small seeds spreading by wind, water, or gravity.

Sensitivity to pathogens or natural enemies: Somewhat Increase.

Impacts from pathogens are not known. This species may be threatened by livestock grazing (Camp and Gamon 2011).

Sensitivity to competition from native or non-native species: Somewhat Increase.

*Thelypodium sagittatum ssp. sagittatum* could be vulnerable to competition from other native or introduced plant species if its specialized vernal alkali marsh habitat became converted to wet
meadow vegetation due to changes in the timing or amount of precipitation (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 genetic variability for this species.

C5b. Genetic bottlenecks: Unknown.

C5c. Reproductive System: Neutral

*Thelypodium sagittatum* ssp. *sagittatum* is pollinated by a variety of insects and is likely to be an outcrosser. Genetic diversity is probably average.


Based on flowering dates from specimens in the Consortium of Pacific Northwest herbaria website, 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 changes in the distribution of this species in Washington has been observed in recent years.

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


