Climate Change Vulnerability Index Report

Navarretia tagetina (Marigold pincushion-plant)

Date: 18 February 2020

Assessor: Walter Fertig, WA Natural Heritage Program

Geographic Area: Washington Heritage Rank: G5/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	0
	-0.074 to - 0.096	0
	-0.051 to - 0.073	0
	-0.028 to -0.050	100
	>-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		Somewhat Increase
2aii. Change in physiological thermal niche		Neutral/Somewhat Increase
2bi. Changes in historical hydrological niche		Neutral
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	Somewhat Increase
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 *Navarretia tagetina* in Washington (100%) occur in areas with a projected temperature increase of 3.9-4.4˚ F (Figure 1).

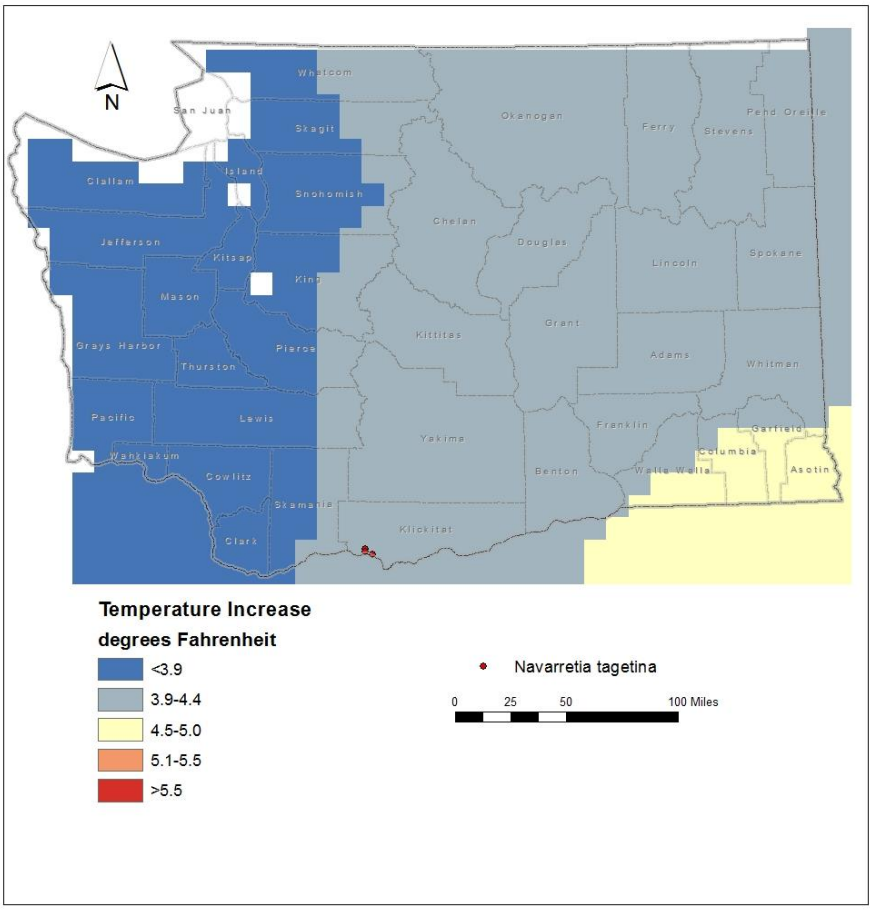

Figure 1. Exposure of *Navarretia tagetina* occurrences in Washington to projected local temperature change. Base map layers from www.natureserve.org/ccvi

A2. Hamon AET:PET Moisture Metric: All three of the occurrences of *Navarretia tagetina* (100%) 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 -0.028 to -0.050 (Figure 2).

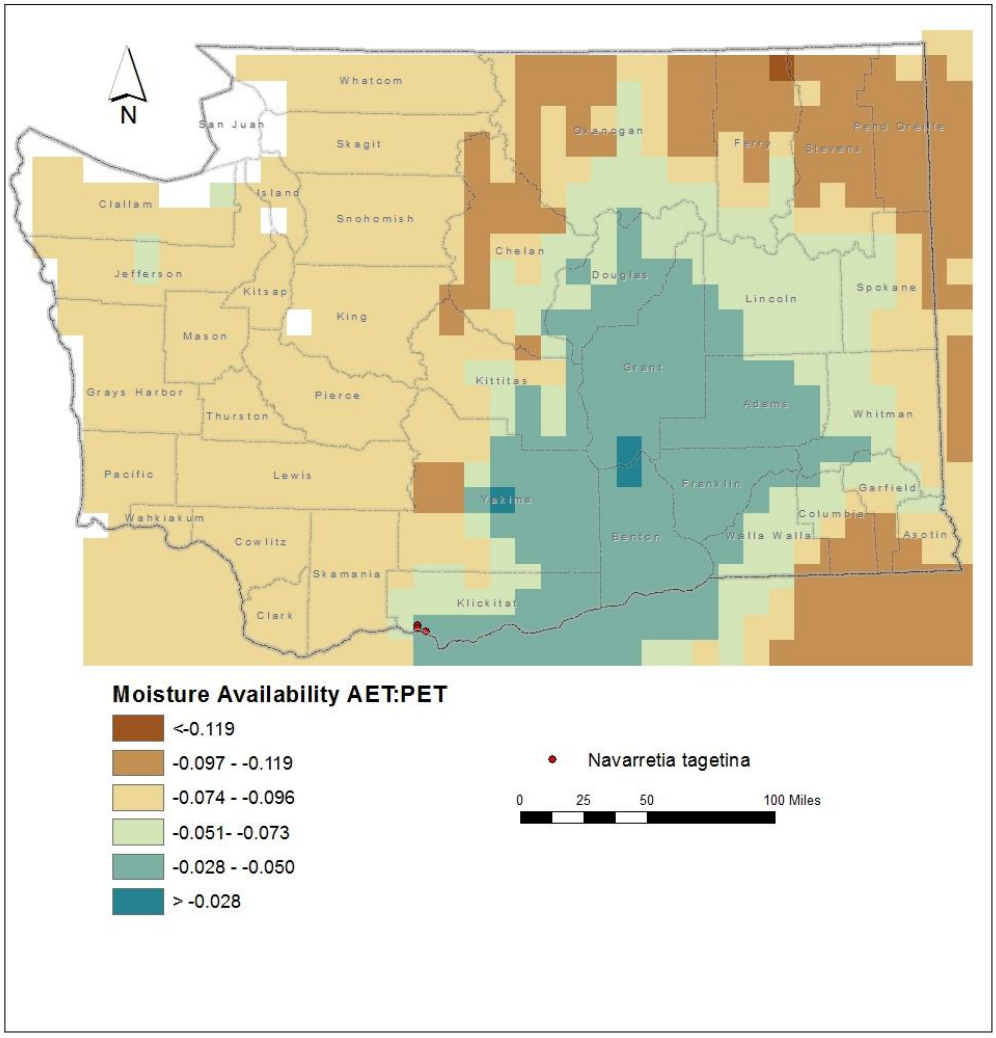

Figure 2. Exposure of *Navarretia tagetina* occurrences in Washington to projected moisture availability (based on ratio of actual to predicted evapotranspiration). Base map layers from www.natureserve.org/ccvi

Section B. Indirect Exposure to Climate Change

B1. Exposure to sea level rise: Neutral.
Washington occurrences of *Navarretia tagetina* are found at 250-450 feet (75-140 m) and would not be inundated by projected sea level rise.

B2a. Natural barriers: Somewhat Increase.
In Washington, *Navarretia tagetina* is found in shallow vernal pools and stony washes in basalt scablands within grasslands or along the forest-grassland ecotone (Camp and Gamon 2011, WNHP records). These areas are characterized by shallow standing water or saturated soils in the spring, but are dry in summer (Alverson and Sheehan 1986). This habitat is part of the Modoc Basalt Flow Vernal Pool ecological system (Rocchio and Crawford 2015). All of the known occurrences (2 historic and 1 extant) are located within 5.4 km (3.5 miles) of each other in the Columbia River Gorge. These sites are embedded within a matrix of unsuitable habitat.

B2b. Anthropogenic barriers: Neutral.
The range of *Navarretia tagetina* is naturally fragmented. Human impacts in southern 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.
Navarretia tagetina has indehiscent capsule fruits with numerous small seeds. After heavy rains, fibers on the seed surface uptake moisture to swell and break the fruit wall, allowing the seeds to be released (Spencer and Rieseberg 1998). *Navarretia* seeds become mucilaginous when wetted and can be transported long distances (or at least to other ephemeral wetlands) by waterfowl. Although average travel distances may be relatively short, the species is capable of dispersal of at least 1 km.

C2ai. Historical thermal niche: Somewhat Increase.
Figure 3 depicts the distribution of *Navarretia tagetina* in Washington relative to mean seasonal temperature variation for the period from 1951-2006 ("historical thermal niche"). All three of the known occurrences (100%) 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.

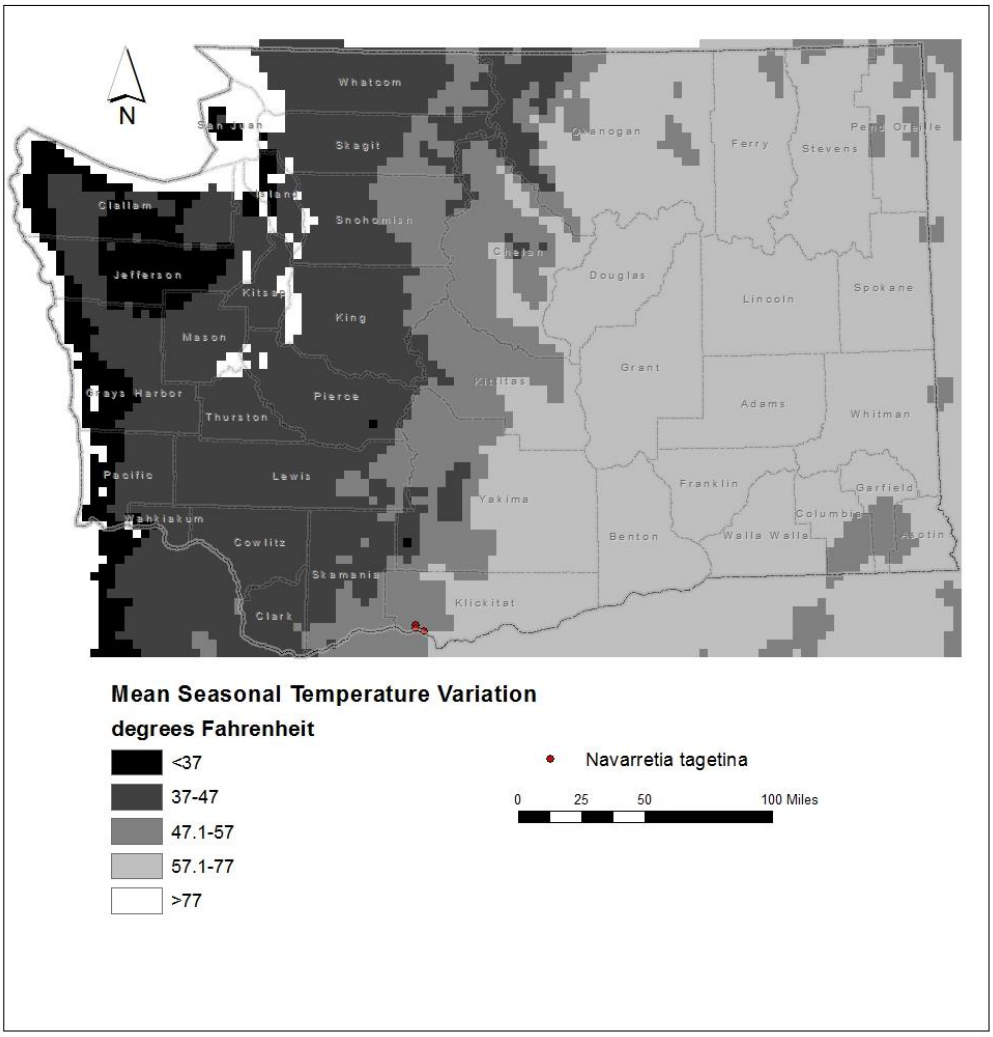

Figure 3. Historical thermal niche (exposure to past temperature variations) of *Navarretia tagetina* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2aii. Physiological thermal niche: Neutral/Somewhat Increase.
The ephemeral wetland and vernal pool habitat of *Navarretia tagetina* is not associated with cold air drainage during the growing season. These shallow wetlands would be vulnerable to long-term persistent drought (Rocchio and Ramm-Granberg 2017).

C2bi. Historical hydrological niche: Neutral.
All three of the populations of *Navarretia tagetina* in Washington (100%) are found in areas that have experienced 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.

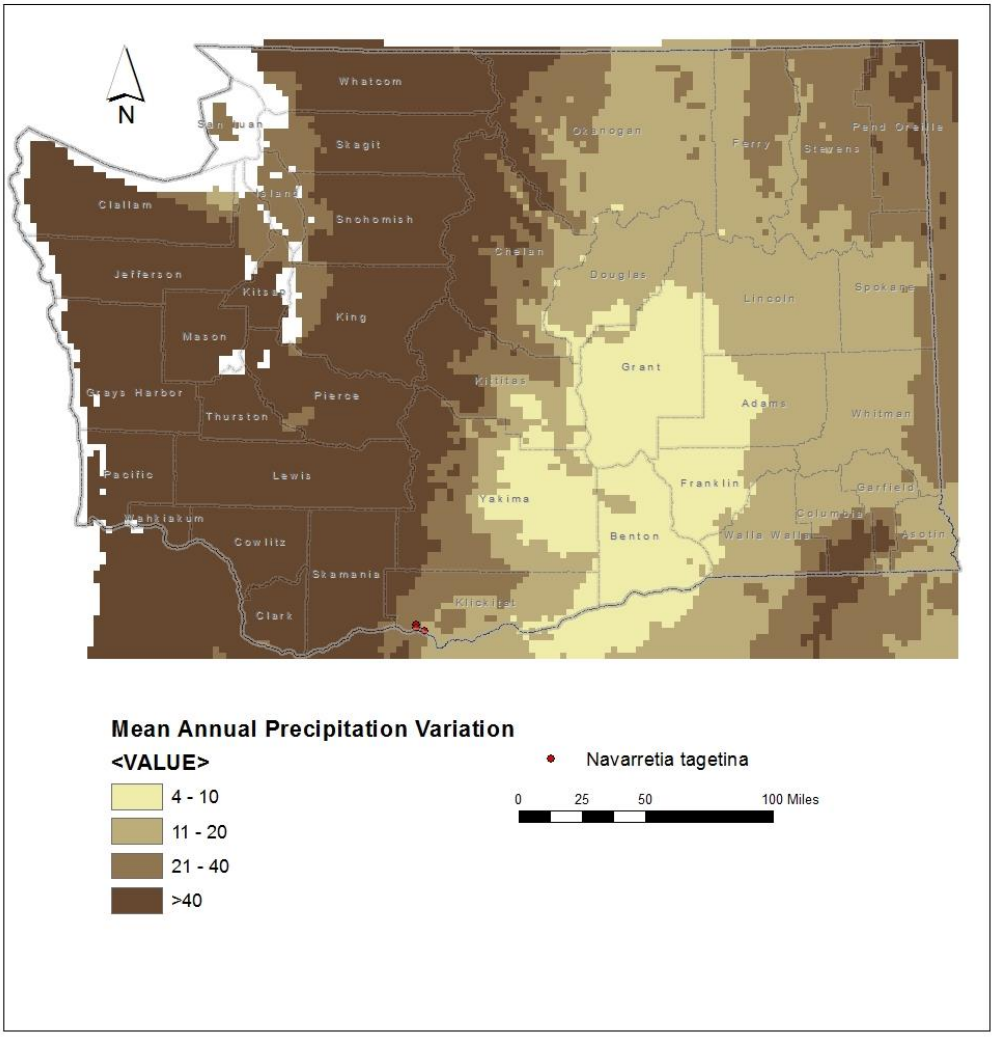

Figure 4. Historical hydrological niche (exposure to past variations in precipitation) of *Navarretia tagetina* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

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

C2c. Dependence on a specific disturbance regime: Neutral.
Navarretia tagetina is not dependent on periodic disturbances to maintain its scabland vernal pool habitat. The species could, however, be detrimentally affected by increased summer temperatures, drought, or decreased snowpack that might favor conversion of this habitat to sparsely vegetated scablands, or make it more susceptible to competition from invasive annual weeds (Rocchio and Ramm-Granberg 2017).

C2d. Dependence on ice or snow-cover habitats: Somewhat Increase.
Reduced snowpack or changes in snow melt are a threat to many scabland vernal pool communities in the Columbia Plateau Columbia River Gorge (Rocchio and Ramm-Granberg 2017). Increased drought would favor transition to sparsely vegetated scabland communities.

C3. Restricted to uncommon landscape/geological features: Increase.
Navarretia tagetina is restricted to shallow depressions in Miocene basalt beds that are deep enough to be flooded in winter and early spring, but shallow enough to become dry in late spring or summer. Although basalt outcrops are widespread in the Columbia River Gorge, sites with the specific microsite qualities required by this species are much less common.

C4a. Dependence on other species to generate required habitat: Neutral
The vernal wetland habitat occupied by *Navarretia tagetina* is maintained by natural abiotic processes and geologic conditions, rather than by interactions with other species.

C4b. Dietary versatility: Not applicable for plants

C4c. Pollinator versatility: Neutral.
Navarretia tagetina is presumed to be pollinated by small insects (Alverson and Sheehan 1986). Other *Navarretia* species from vernal pools are predominantly selfers, but *N. tagetina* is capable of outcrossing (Spencer and Rieseberg 1998).

C4d. Dependence on other species for propagule dispersal: Neutral.
The mucilaginous seeds of *Navarretia tagetina* are probably dispersed by sticking to the feet or feathers of waterfowl. It is probably not limited by the number of potential seed vector species.

C4e. Sensitivity to pathogens or natural enemies: Neutral.
Impacts from pathogens are not known. Whether this species is grazed by livestock is poorly known (Alverson and Sheehan 1986), but given its low stature and spiny foliage, it may not be widely consumed.

C4f. Sensitivity to competition from native or non-native species: Somewhat Increase.
Navarretia tagetina could be sensitive to competition from other plant species (especially non-native invasive annuals) if its specialized wetland habitat became completely dried out 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.
Spencer and Rieseberg (1998) used pollen to ovule ratios to infer that *Navarretia tagetina* is probably a facultative selfer but also capable of outcrossing. This would suggest that genetic variation between populations should be somewhat less than within isolated occurrences maintained by selfing. No genetic data are available on actual variability within or between populations in Washington.

C5b. Genetic bottlenecks: Unknown.

C5c. Reproductive System: Neutral
Navarretia tagetina probably has average genetic diversity across populations due to its ability to outcross as well as self-pollinate. Washington populations are located at the northern edge of the species range and may have less genetic diversity than occurrences from Oregon or California due to founder effects or genetic drift (Alverson and Sheehan 1986)

C6. Phenological response to changing seasonal and precipitation dynamics: Somewhat Increase.
Based on herbarium records from the Consortium of Pacific Northwest herbaria website, *Navarretia tagetina* populations in Washington appear to be flowering slightly later in the past 30 years (June 7-July 24) than in the 1920s when the species was first documented in the state (May 12-27).

Section D: Documented or Modeled Response to Climate Change

D1. Documented response to recent climate change: Neutral.
Significant changes in the distribution of *Navarretia tagetina* have not been documented. Although two of the three known occurrences in Washington are historical, they are from the same general location as the extant population. Their disappearance could be an artifact of incomplete surveys (both are from private lands) or a consequence of development.

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

Alverson, E. and M. Sheehan. 1986. Status report on *Navarretia tagetina*. Washington Natural Heritage Program, WA Department of Natural Resources, Olympia, WA.

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