

Climate Change Vulnerability Index Report

Penstemon wilcoxii (Wilcox's beardtongue)

Date: 24 February 2020

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	12.5
	3.9-4.4° F (2.2-2.4°C) warmer	75
	<3.9° F (2.2°C) warmer	12.5
2. Hamon AET:PET moisture	< -0.119	0
	-0.097 to -0.119	25
	-0.074 to -0.096	50
	-0.051 to -0.073	25
	-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
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
2aii. Change in physiological thermal niche		Somewhat Increase
2bi. Changes in historical hydrological niche		Somewhat Increase/Neutral
2bii. Changes in physiological hydrological niche		Somewhat Increase/Neutral
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		Neutral
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: Six of the eight occurrences of *Penstemon wilcoxii* in Washington (75%) occur in areas with a projected temperature increase of 3.9-4.4° F (Figure 1). One population (12.5%) occurs in an area with a predicted temperature increase of <3.9° F and one historical occurrence (12.5%) is from an area with a predicted temperature increase of 4.5-5.0° F.

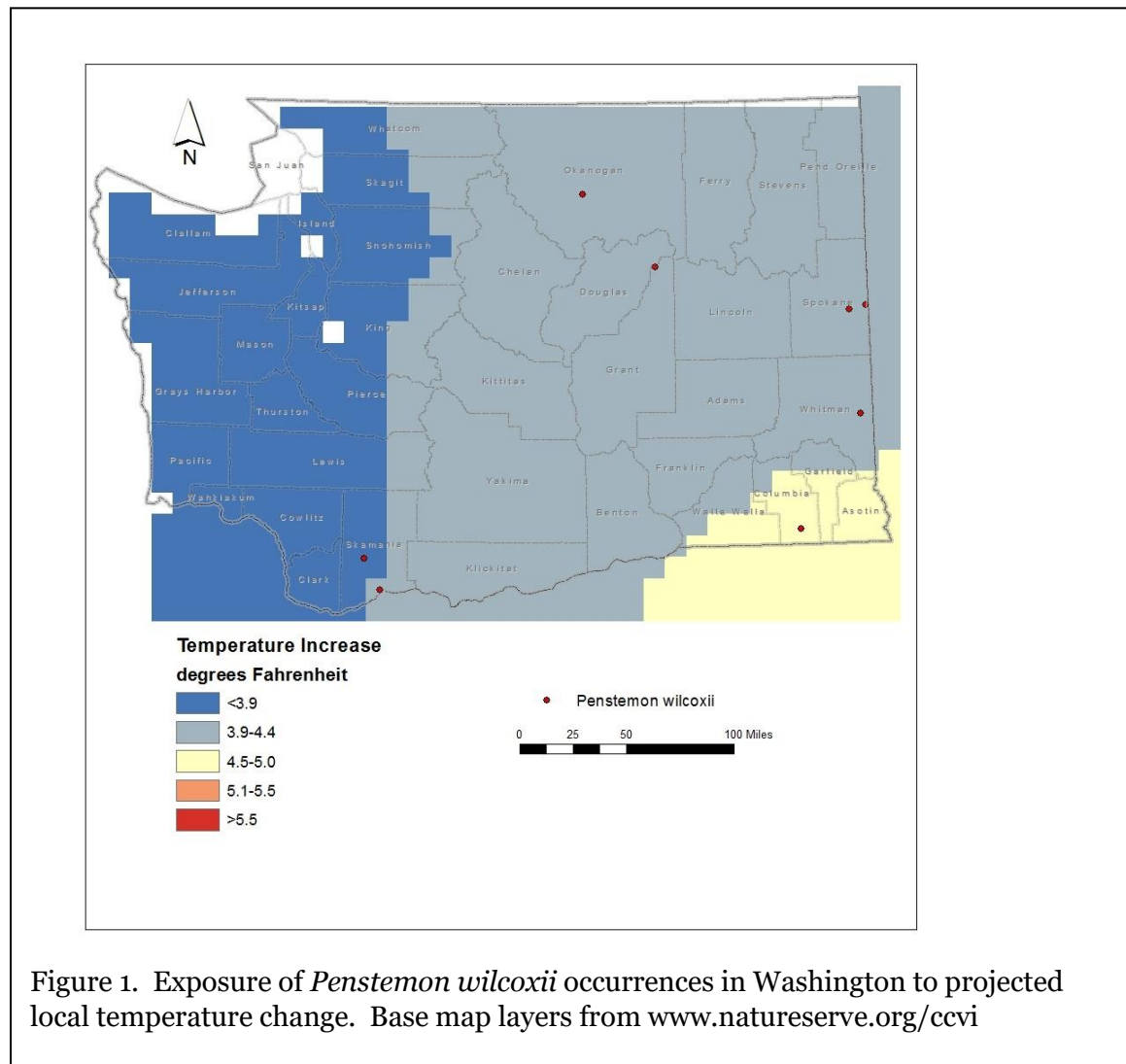


Figure 1. Exposure of *Penstemon wilcoxii* occurrences in Washington to projected local temperature change. Base map layers from www.natureserve.org/ccvi

A2. Hamon AET:PET Moisture Metric: Four of the eight Washington occurrences of *Penstemon wilcoxii* (50%) 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). Two occurrences (25%) are found in areas with a projected decrease in moisture of -0.097 to -0.119 and two others (25%) are from areas with a projected decrease of -0.051 to -0.073.

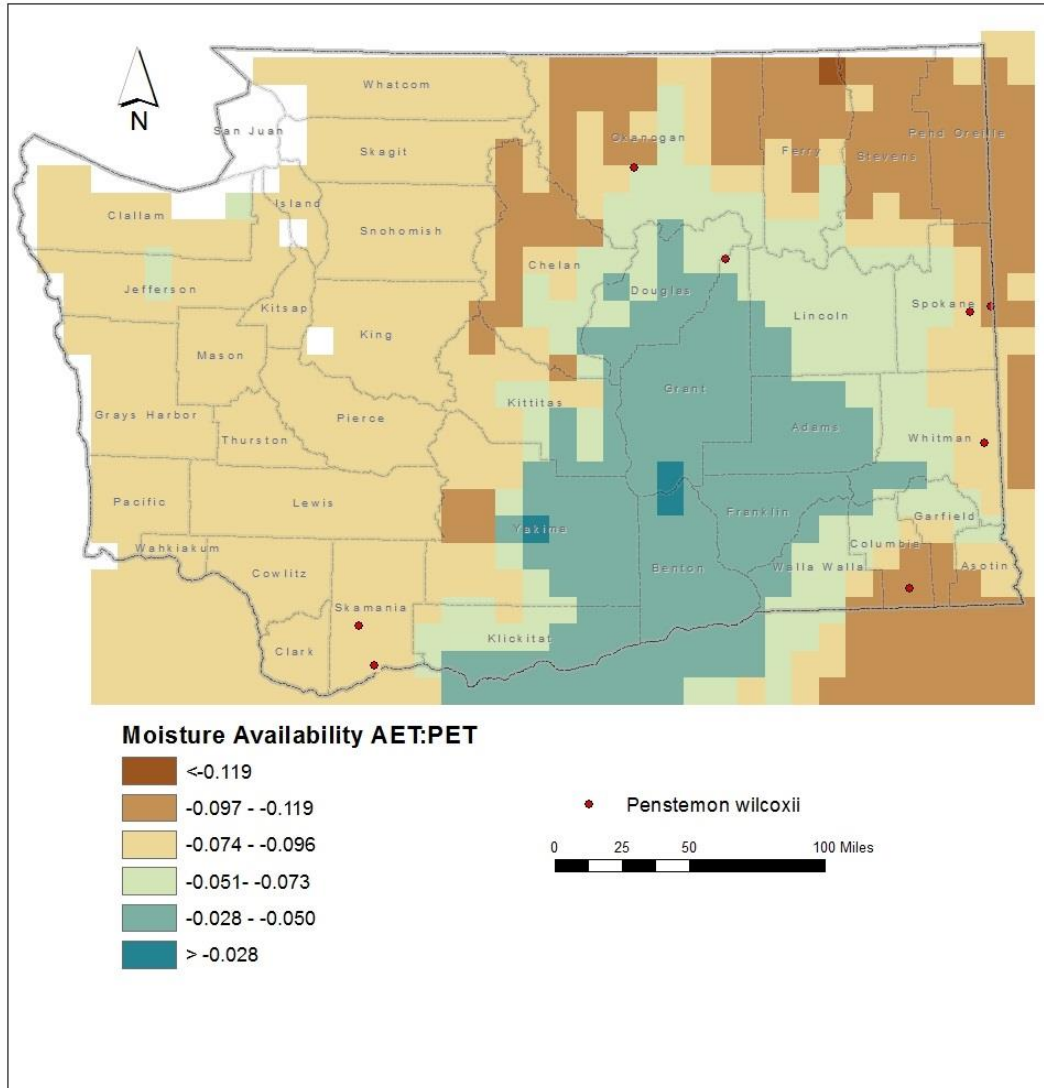


Figure 2. Exposure of *Penstemon wilcoxii* occurrences in Washington to projected moisture availability (based on ratio of actual to predicted evapotranspiration). Base map layers from www.natureserve.org/ccvi

Section B. Indirect Exposure to Climate Change

B1. Exposure to sea level rise: Neutral.

Washington occurrences of *Penstemon wilcoxii* are found at 200-4200 feet (60-1280 m) and would not be inundated by projected sea level rise.

B2a. Natural barriers: Neutral.

In Washington, *Penstemon wilcoxii* is found mostly on moist, shady, rocky sites or cliffs in conifer forests dominated by Douglas-fir or Ponderosa pine or shrublands (Camp and Gamon 2011, WNHP records). This habitat is most similar to the Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest ecological system (Rocchio and Crawford 2015). Individual populations occupy small areas and are separated from each other by 13-320 km (7.5-200 miles). The habitat is not specialized, and populations are widely scattered, suggesting that the species may be under-sampled or is rare for reasons besides lack of habitat (such as over-collection or hybridization with other species; Fertig and Kleinknecht 2020). Based on available information, this factor is scored as neutral.

B2b. Anthropogenic barriers: Neutral.

The range of *Penstemon wilcoxii* in Washington is scattered over much of the state in a variety of ecological settings in the Blue Mountains, Columbia Plateau, Okanogan Mountains, and West Cascades. Whether anthropogenic impacts create a significant barrier for dispersal of this species is not well documented.

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

Section C: Sensitive and Adaptive Capacity

C1. Dispersal and movements: Somewhat Increase.

Penstemon wilcoxii produces many-seeded dry capsule fruits that split open at maturity to release the seeds passively by gravity or wind. Average dispersal distances are probably relatively short, however (100-1000 meters).

C2ai. Historical thermal niche: Neutral.

Figure 3 depicts the distribution of *Penstemon wilcoxii* in Washington relative to mean seasonal temperature variation for the period from 1951-2006 (“historical thermal niche”). Five of the eight known occurrences (62.5%) 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 (Young et al. 2016). Two occurrences (25%) have experienced slightly lower than average (47.1-57° F/26.3-31.8° C) temperature variation and would be at somewhat increased vulnerability. One population (12.5%) has experienced small temperature variation (37-47° F/20.8-26.3° C) during the last 50 years and is considered at increased vulnerability to climate change.

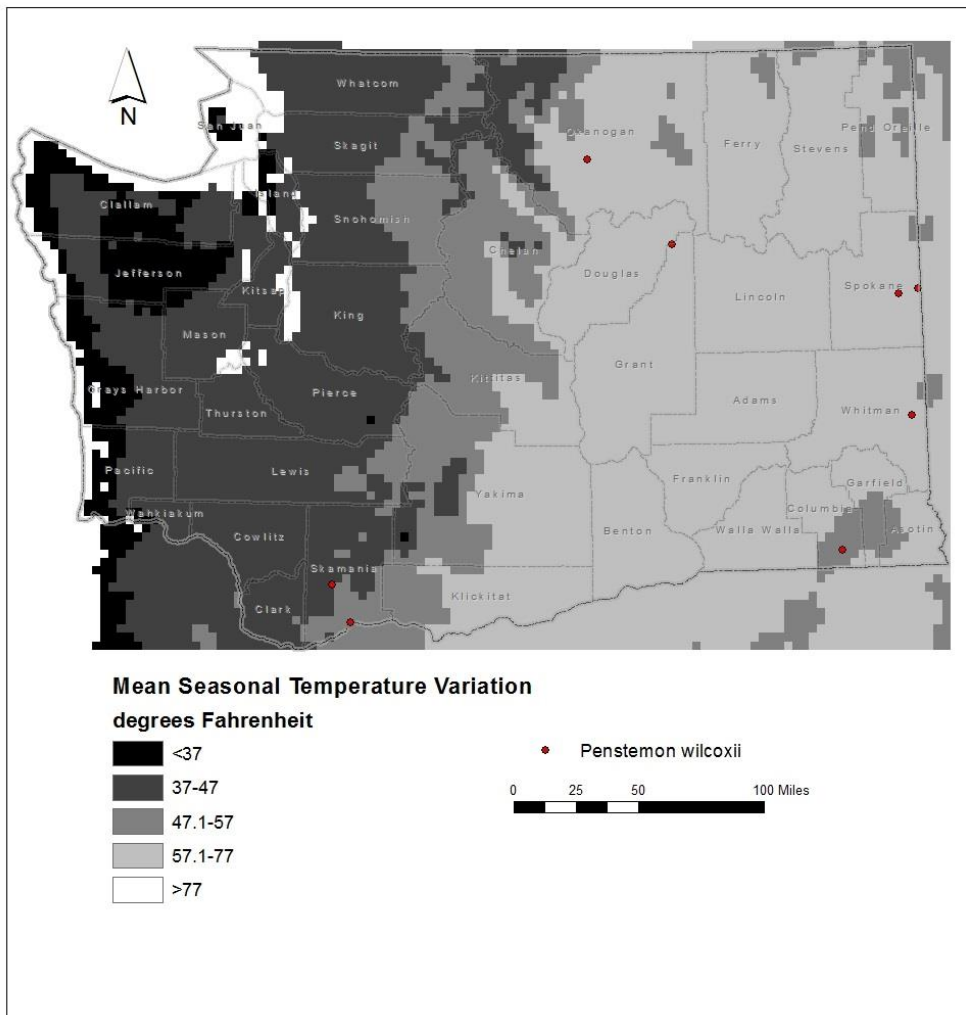


Figure 3. Historical thermal niche (exposure to past temperature variations) of *Penstemon wilcoxii* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2aii. Physiological thermal niche: Somewhat Increase.

The microsites within the montane conifer forest habitat occupied by *Penstemon wilcoxii* are often associated with cool, shaded conditions during the growing season and would have somewhat increased vulnerability to climate change.

C2bi. Historical hydrological niche: Somewhat Increase/Neutral.

Three of the eight populations of *Penstemon wilcoxii* in Washington (37.5%) 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 occurrences are at somewhat increased vulnerability from climate change. Five occurrences (62.5%) have experienced average or greater than average (>20 inches/508 mm) precipitation variation and are at neutral vulnerability from climate change.

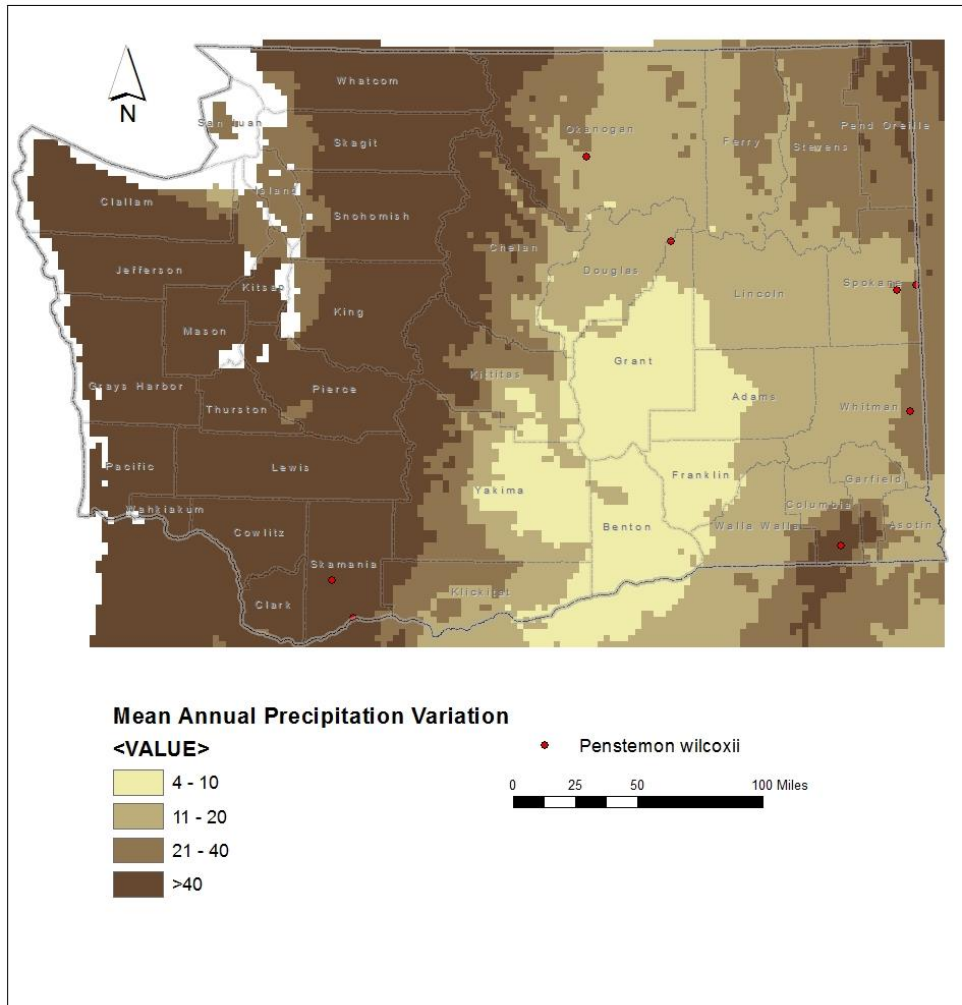


Figure 4. Historical hydrological niche (exposure to past variations in precipitation) of *Penstemon wilcoxii* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2bii. Physiological hydrological niche: Somewhat Increase/Neutral.

Penstemon wilcoxii is not a wetland obligate or dependent on a seasonal hydrologic regime. Its dry-mesic montane mixed conifer forest habitat is vulnerable to drought, wildfire, and insect outbreaks due to increased temperature, and reduced snowpack (Rocchio and Ramm-Granberg 2017).

C2c. Dependence on a specific disturbance regime: Neutral.

Penstemon wilcoxii is not dependent on periodic disturbances to maintain its montane rocky forest habitat. The species could, however, be detrimentally affected by loss of forest canopy due to wildfire, or long-term drought associated with potential climate change (Rocchio and Ramm-Granberg 2017).

C2d. Dependence on ice or snow-cover habitats: Somewhat Increase.

At least five of the populations of *Penstemon wilcoxii* in Washington (and all but one of the extant ones) occur in montane areas with at least moderate accumulations of snow. These populations could be adversely affected by reduction in snow cover or changes in the timing of snow melt due to projected climate change (Rocchio and Ram-Granberg 2017).

C3. Restricted to uncommon landscape/geological features: Neutral.

Penstemon wilcoxii is found on a variety of geologic substrates, including basalt, gneiss, and glacial deposits, none of which are uncommon in the state.

C4a. Dependence on other species to generate required habitat: Neutral

The habitat occupied by *Penstemon wilcoxii* is maintained primarily by natural abiotic processes.

C4b. Dietary versatility: Not applicable for plants

C4c. Pollinator versatility: Neutral.

Blue or bluish-purple flowered species of *Penstemon* are predominantly pollinated by bees. The size of the *Penstemon* flower and position of the sterile staminode is often correlated with the size of the bee species best suited to receive and deposit pollen. *P. wilcoxii* has intermediate sized flowers and should be adapted to pollination by a large number of medium-sized bees.

C4d. Dependence on other species for propagule dispersal: Neutral.

Seed dispersal in *Penstemon* is passive, with small seeds spreading by gravity or high winds once the dry fruit capsule is ripe and splits open. The genus is not dependent on animals for dispersal.

C4e. Sensitivity to pathogens or natural enemies: Neutral.

Impacts from pathogens are not known. This species may be edible to livestock, ungulates, rodents, and insect grazers, but whether herbivory limits its distribution is not known.

C4f. Sensitivity to competition from native or non-native species: Somewhat Increase.

Rocky microsites occupied by *Penstemon wilcoxii* may not be especially vulnerable to competition from other native or introduced plant species. Changes to forest and shrub cover due to long-term drought or wildfire could make these sites more vulnerable to competition from more xeric-adapted species (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: Neutral.

Broderick (2010) assessed the genetic variability of 104 of the 270 *Penstemon* taxa in North America and found that *P. wilcoxii* had the highest variation among samples of any species studied. This variation may be evidence of on-going differentiation of populations into subspecies (Broderick 2010).

C5b. Genetic bottlenecks: Unknown.

C5c. Reproductive System: Neutral

Penstemon wilcoxii produces showy flowers that are pollinated by bees and is an outcrosser.

C6. Phenological response to changing seasonal and precipitation dynamics: Neutral.

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: Somewhat Increase.

Three occurrences in the Columbia Plateau and Blue Mountains are historical and possibly extirpated, suggesting a potential contraction of the species range in the past 40 years. Whether this is due to climate change or other factors is poorly known.

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

Broderick, S.R. 2010. An examination of the DNA content, taxonomy and phylogeny of *Penstemon* (Plantaginaceae). Master's Thesis, Department of Plant and Wildlife Sciences, Brigham Young University, Provo, UT. 51 pp.

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