Climate Change Vulnerability Index Report

Dactylorhiza viridis (Long-bract frog orchid)

Date: 20 October 2021 Synonym: *Coeloglossum viride* var. *virescens*

Assessor: Walter Fertig, WA Natural Heritage Program

Geographic Area: Washington Heritage Rank: G5/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	100
	<3.9° F (2.2°C) warmer	0
2. Hamon AET:PET moisture	< -0.119	0
	-0.097 to -0.119	85.7
	-0.074 to -0.096	14.3
	-0.051 to -0.073	0
	-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		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		Increase
2c. Dependence on specific disturbance regime		Somewhat Increase
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		Unknown
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		Somewhat Increase
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	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 seven of the extant and historical occurrences of *Dactylorhiza viridis* in Washington (100%) occur in areas with a projected temperature increase of 3.9-4.4˚ F (Figure 1).

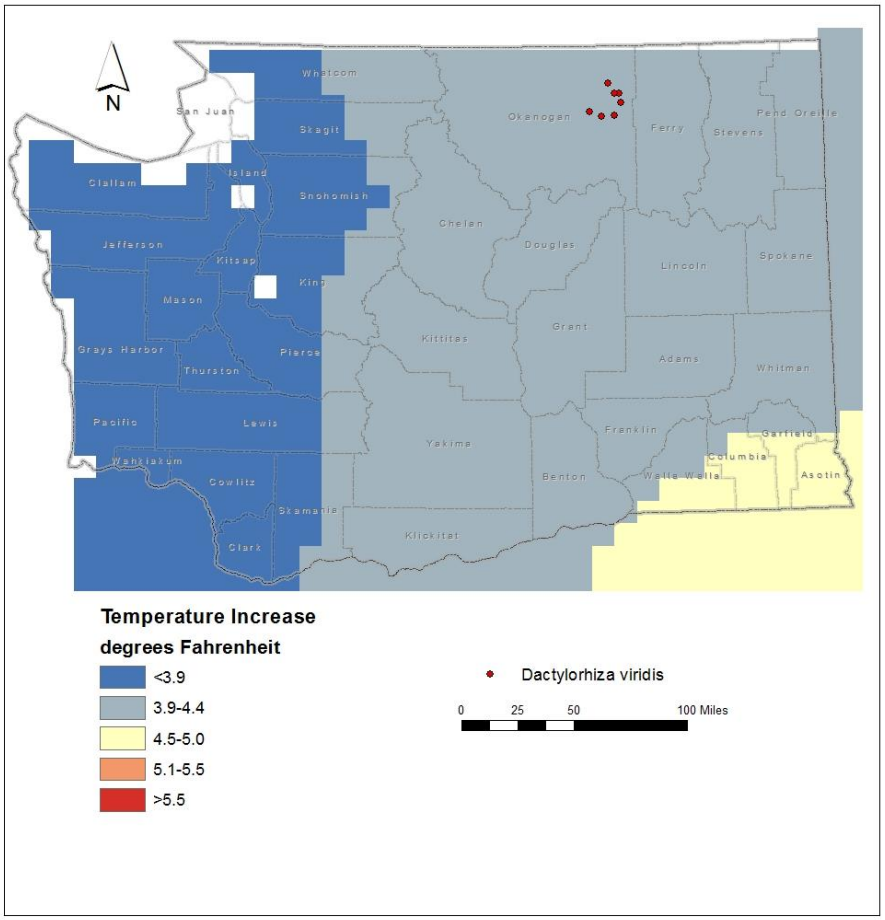

Figure 1. Exposure of *Dactylorhiza viridis* occurrences in Washington to projected local temperature change. Base map layers from www.natureserve.org/ccvi

A2. Hamon AET:PET Moisture Metric: Six of the 7 occurrences (85.7%) of *Dactylorhiza viridis* 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 -0.097 to -0.119 (Figure 2). One other population (14.3%) is from an area with projected decrease of -0.074 to -0.096.

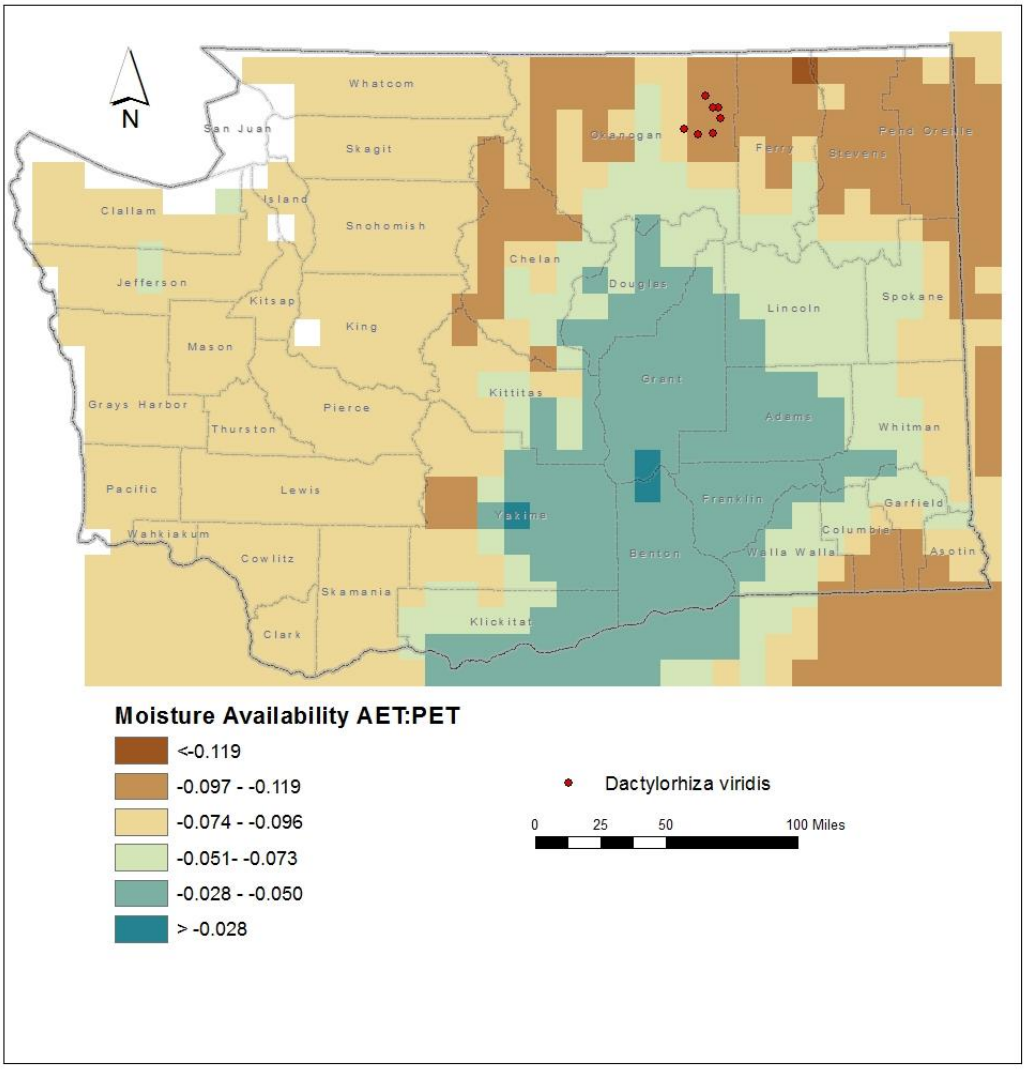

Figure 2. Exposure of *Dactylorhiza viridis* occurrences in Washington to projected moisture availability (based on ratio of actual to predicted evapotranspiration). Base map layers from www.natureserve.org/ccvi

Section B. Indirect Exposure to Climate Change

B1. Exposure to sea level rise: Neutral.
Washington occurrences of *Dactylorhiza viridis* are found at 3840-4400 feet (1170-1340 m) and would not be inundated by projected sea level rise.

B2a. Natural barriers: Somewhat Increase.
In Washington, *Dactylorhiza viridis* is found mostly in seasonally moist depressions or midslopes in recently thinned or burned Douglas-fir (*Pseudotsuga menziesii*) forests with aspen (*Populus tremuloides*), reedgrass (*Calamagrostis*), and snowberry (*Symphoricarpos*) (Camp and Gamon 2011, Washington Natural Heritage Program 2021). This habitat is part of the Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest ecological system (Rocchio and Crawford 2015). The entire range of this species in Washington is contained within an area of 15 square miles, with individual occurrences isolated by 2-6.5 miles (3.5-10 km). Populations are separated by broad valleys and areas of dense forest which may impede dispersal.

B2b. Anthropogenic barriers: Neutral.
The forested habitat of *Dactylorhiza viridis* in northern Washington is located on low elevation National Forest lands actively managed for timber production and interspersed with private lands used for livestock, farming, and forestry. This human footprint may reduce long-distance dispersal, but is less significant at the local scale than natural topographic barriers.

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

Section C: Sensitive and Adaptive Capacity

C1. Dispersal and movements: Neutral.
Dactylorhiza viridis produces 1400-2300 tiny seeds per pod (Tatarenko et al. 2020). These are released passively by dehiscence of the dried fruit capsule, with seeds spreading primarily by wind. Dispersal distances vary from a few meters to potentially long distances (over 1 km). Germination success beyond local populations is probably quite low if mycorrhizal fungi symbionts are not available in the soil (Tatarenko et al 2020).

C2ai. Historical thermal niche: Neutral.
Figure 3 depicts the distribution of *Dactylorhiza viridis* in Washington relative to mean seasonal temperature variation for the period from 1951-2006 ("historical thermal niche"). Six of the 7 known occurrences in the state (85.7%) are found in areas that have experienced average (57.1-77˚F/31.8-4.0˚C) temperature variation during the past 50 years and are considered at neutral vulnerability to climate change (Young et al. 2016). One other population (14.3%) is from an area with slightly lower than average (47.1-57˚F/26.3-31.8˚C) temperature variation over the same period and is considered at somewhat increased vulnerability to climate change (Young et al. 2016).

C2aii. Physiological thermal niche: Somewhat Increase.
In Washington, *Dactylorhiza viridis* occurs in low-lying areas and midslopes of partially open conifer forests that are in cold air drainages that create somewhat cooler microhabitat conditions. These areas could be impacted by increased temperatures or reduction of forest

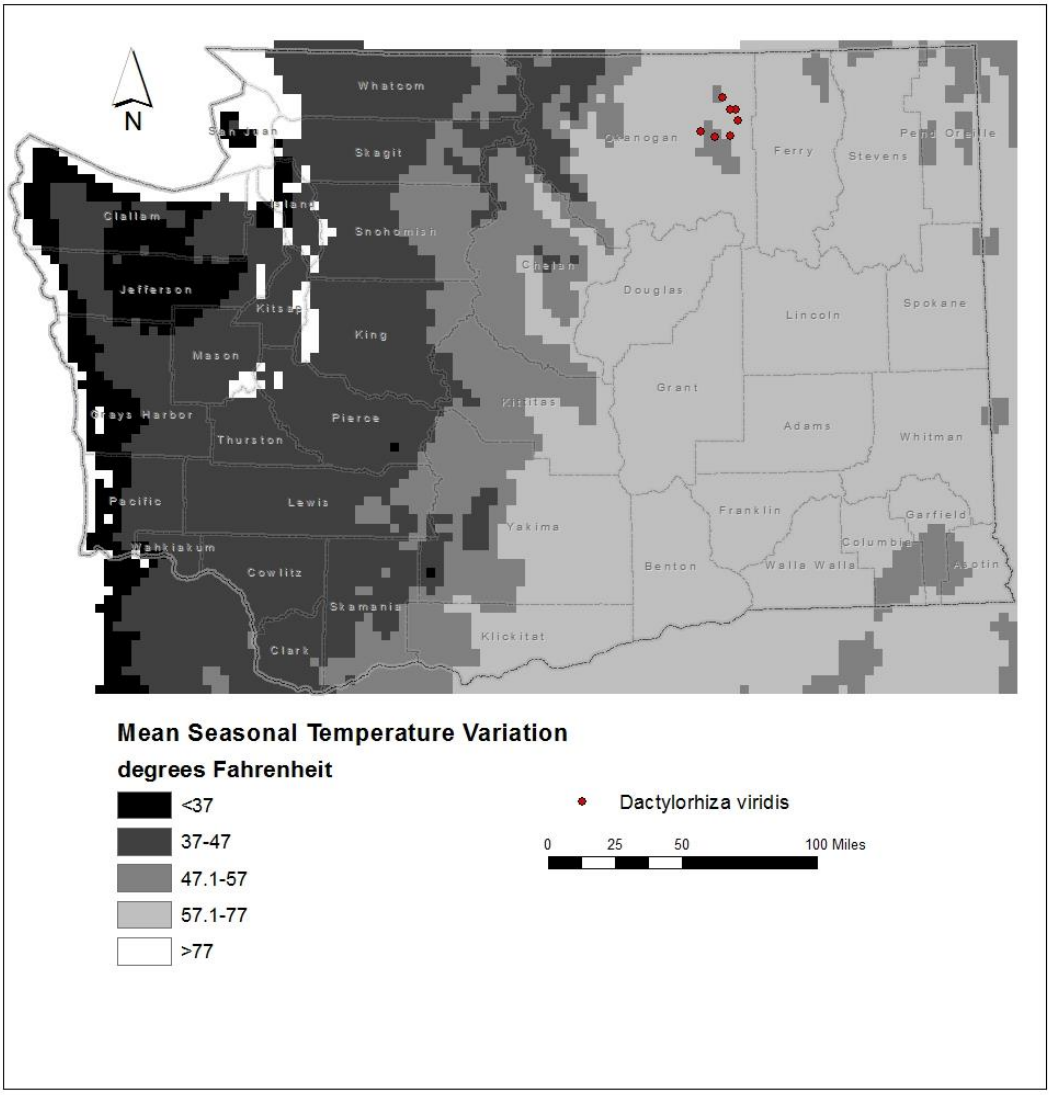

Figure 3. Historical thermal niche (exposure to past temperature variations) of *Dactylorhiza viridis* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

cover from increased wildfire expected from future climate change (Rocchio and Ramm-Granberg 2017).

C2bi. Historical hydrological niche: Somewhat Increase.
Four of the seven populations of *Dactylorhiza viridis* in Washington (57.1%) 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

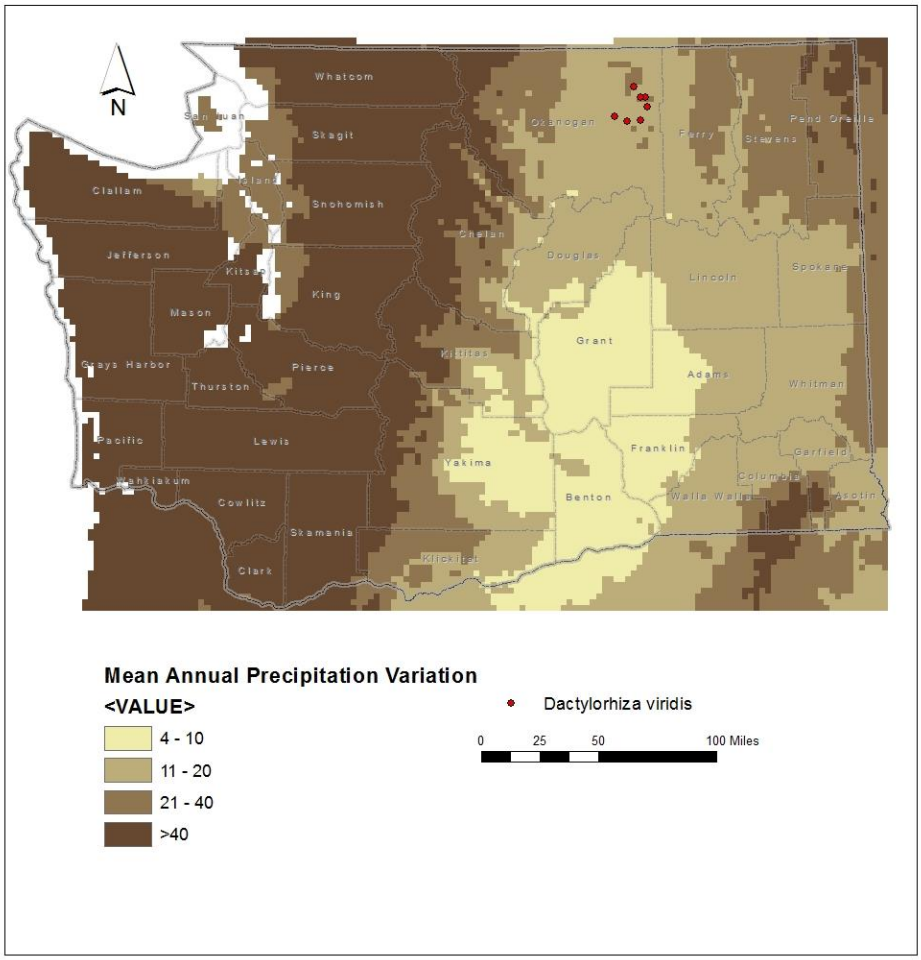

Figure 4. Historical hydrological niche (exposure to past variations in precipitation) of *Dactylorhiza viridis* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

at slightly increased vulnerability to climate change. Three other populations (42.9%) are from areas with average variation in precipitation (20-40 inches/508-1116 mm) over the same period and are at neutral vulnerability.

C2bii. Physiological hydrological niche: Increase.
This species is dependent on seasonally moist conditions during the growing season that are enhanced by local snow deposition and adequate spring and summer precipitation. Reductions in the amount or timing of precipitation and warmer temperatures are likely to increase drought, insect outbreaks, and stand-replacing wildfires that could result in changes from Douglas-fir forests to shrublands or dry meadows (Rocchio and Ramm-Granberg 2017).

C2c. Dependence on a specific disturbance regime: Somewhat Increase.
Dactylorhiza viridis populations in Washington occur in small depression and slopes in openings in Douglas-fir forests. These openings may be maintained naturally through periodic, low-intensity wildfire. Recent management actions to thin forests or do controlled burns for silviculture may mimic these natural disturbances. Future climate change in these communities is likely to result in drier and hotter conditions that might promote larger scale, stand-replacing wildfires (Rocchio and Ramm-Granberg) that would be detrimental to *D. viridis*.

C2d. Dependence on ice or snow-cover habitats: Somewhat Increase.
The populations of *Dactylorhiza viridis* in Washington are found in lower elevation montane forested areas on the east side of the Cascades that receive moderate amounts of winter snow accumulation. Snow deposition in depressions and lee slopes may be important for ensuring adequate moisture in microhabitats occupied by *D. viridis*. Reduction in the amount of snowfall or in the timing of its melting due to climate change (Rocchio and Ramm-Granberg 2017) could be detrimental to this species.

C3. Restricted to uncommon landscape/geological features: Neutral.
In Washington, *Dactylorhiza viridis* is known only from depressions and mountain slopes of Pleistocene Continental glacial drift. This geologic layer is found widely in the Okanogan Plateau.

C4a. Dependence on other species to generate required habitat: Neutral
The habitat of *Dactylorhiza viridis* is maintained primarily by natural, abiotic processes and not by other species.

C4b. Dietary versatility: Not applicable for plants

C4c. Pollinator versatility: Unknown.
The specific pollinators of *Dactylorhiza viridis* in Washington are not known. In Europe, this species is pollinated by beetles, bees, and wasps (Tatarenko et al. 2020) and by ants in alpine habitats (Claessens and Seifert 2017). *D. viridis* is unusual among orchids in taking 20 to 30 minutes to successfully bend the pollen-bearing pollinium structure of their flowers and adhere the sticky pollen mass to a pollinator (other orchids typically complete this in a matter of seconds) (Claessens and Seifert 2017).

C4d. Dependence on other species for propagule dispersal: Neutral.
The seeds of *Dactylorhiza viridis* are minute and readily wind dispersed.

C4e. Sensitivity to pathogens or natural enemies: Somewhat Increase.
Impacts from pathogens are not known. *Dactylorhiza viridis* is palatable and the species could be susceptible to grazing (Camp and Gamon 2011).

C4f. Sensitivity to competition from native or non-native species: Somewhat Increase.
Populations of *Dactylorhiza viridis* in England are believed to be declining due to competition for space and nutrients from other plant species in open meadow habitats (Fay 2015). Under projected climate change, increasing temperatures and drier conditions could increase the frequency of wildfire and convert forest sites occupied by this species to dry meadows (Rocchio and Ramm-Granberg 2017).

C4g. Forms part of an interspecific interaction not covered above: Somewhat Increase.
Successful germination of *Dactylorhiza viridis* seed is dependent on the presence of specific mycorrhizal fungi species in the soil (Tatarenko et al. 2020).

C5a. Measured genetic variation: Unknown.
Research on the genetic variability of *Dactylorhiza viridis* in Washington has not been conducted. In Eurasia, genetic variation in this species is high across the continent (Pillon et al. 2006). Being at the southern edge of its range in North America, Washington populations might be expected to have lower overall genetic variability due to inbreeding or founder effects.

C5b. Genetic bottlenecks: Unknown.
Not known.

C5c. Reproductive System: Neutral.
Dactylorhiza viridis is an obligate outcrosser and is probably not limited by pollinators or dispersal, so is presumed to have at least average genetic variation.

C6. Phenological response to changing seasonal and precipitation dynamics: Neutral.
The flowering period for *Dactylorhiza viridis* has not changed in recent years.

Section D: Documented or Modeled Response to Climate Change

D1. Documented response to recent climate change: Neutral.
No major changes have been detected in the distribution of *Dactylorhiza viridis* in Washington since it was first discovered in the state in 1998.

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

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