Climate Change Vulnerability Index Report

Ranunculus californicus (California buttercup)

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Geographic Area: Washington Heritage Rank: G5/S1

Index Result: Moderately 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	100
	-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		Somewhat Increase
2a. Distribution relative to natural barriers		Somewhat Increase
2b. Distribution relative to anthropogenic barriers		Neutral/Somewhat Increase
3. Impacts from climate change mitigation		Somewhat Increase
Section C: Sensitivity and Adaptive Capacity		
1. Dispersal and movements		Somewhat Increase
2ai Change in historical thermal niche		Greatly Increase
2aii. Change in physiological thermal niche		Neutral
2bi. Changes in historical hydrological niche		Neutral
2bii. Changes in physiological hydrological niche		Somewhat Increase
2c. Dependence on specific disturbance regime		Neutral/Somewhat Increase
2d. Dependence on ice or snow-covered habitats		Neutral
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		Somewhat Increase

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 four of the confirmed occurrences of *Ranunculus californicus* in Washington (100%) are found in areas with a projected temperature increase of <3.9˚ F (Figure 1). At least 5 other island populations have been reported (Dunwiddie, no date), but each of

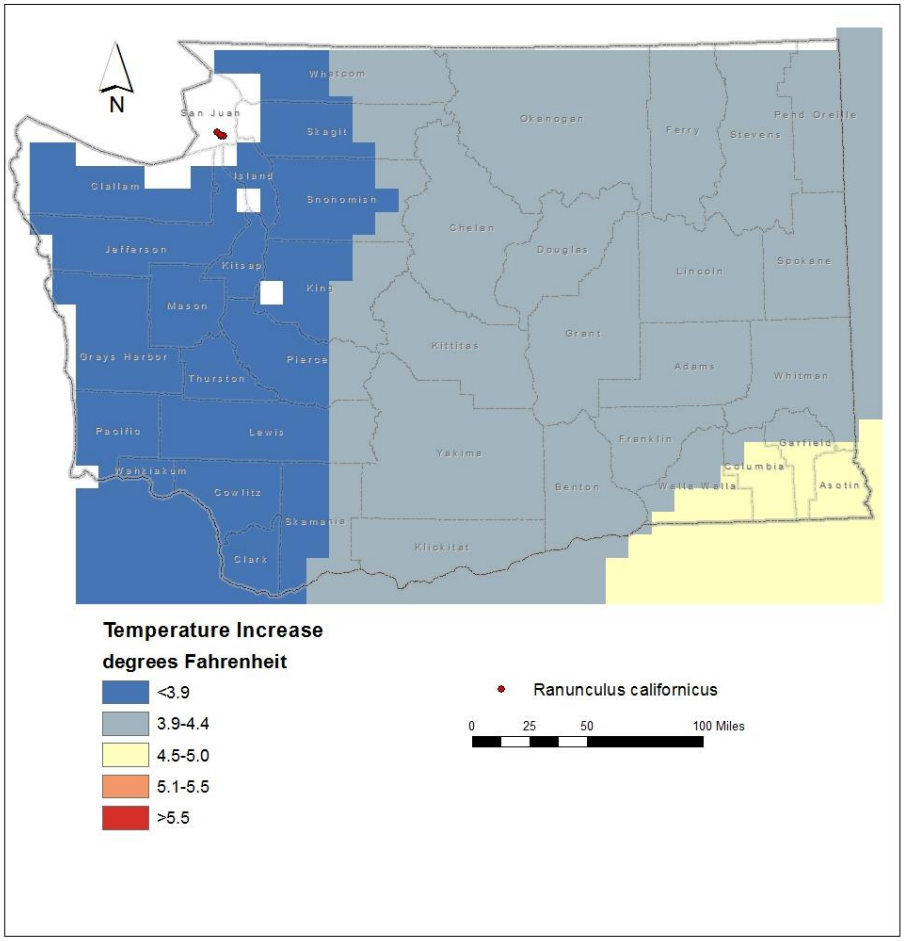

Figure 1. Exposure of *Ranunculus californicus* occurrences in Washington to projected local temperature change. Base map layers from www.natureserve.org/ccvi

these consists of hybrids between *R. californicus* and *R. occidentalis* and are excluded from this analysis. All of the Washington occurrences (including hybrids) are from the same small geographic area and have similar ecological conditions, and so leaving out hybrid populations will not alter the results of this assessment.

A2. Hamon AET:PET Moisture Metric: The four occurrences of *Ranunculus californicus* in Washington (100%) 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).

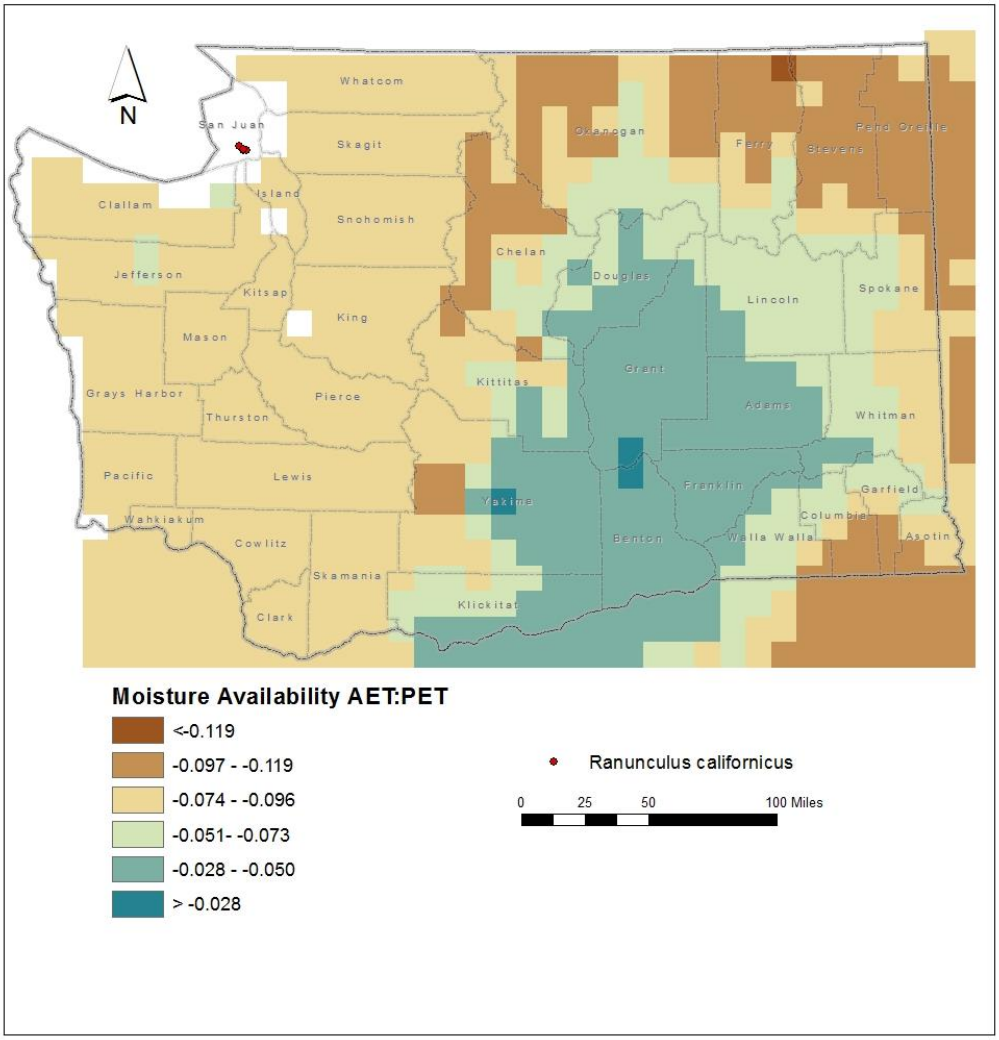

Figure 2. Exposure of *Ranunculus californicus* occurrences in Washington to projected moisture availability (based on ratio of actual to predicted evapotranspiration). Base map layers from www.natureserve.org/ccvi

Section B. Indirect Exposure to Climate Change

B1. Exposure to sea level rise: Somewhat Increase.
The Washington occurrences of *Ranunculus californicus* are found at 10-30 feet (3-9 m) and within 0.5 miles (0.8 km) of the Pacific Ocean on low-lying islands in the Salish Sea. Sea level is projected to rise by 0.5-2 m in the current century (Young et al. 2016). While existing populations are high enough to escape sea level rise, they are low enough to experience additional storm surges or intrusions of salt water due to climate change.

B2a. Natural barriers: Somewhat Increase.
In Washington, *Ranunculus californicus* is found mostly on coastal bluffs and dry grasslands on small islets (Camp and Gamon 2011). These sites conform to the North Pacific Hypermaritime Shrub and Herbaceous Headland and Willamette Valley Upland Prairie and Savanna ecological systems (Rocchio and Crawford 2015). Individual occurrences are isolated by distances of 0.6-1.6 miles (0.8-2.6 km) and occur on separate islands. Dispersal to other islands or the mainland is limited due to expanses of inhospitable ocean habitat.

B2b. Anthropogenic barriers: Neutral/Somewhat Increase.
The small islets inhabited by *Ranunculus californicus* in Washington are naturally isolated, but have a small human footprint. Anthropogenic barriers from roads, farms, and homesites, are more pervasive on the larger islands of the San Juan chain and on the mainland. Whether this species occurred more widely in the San Juan Islands or the coast of the Puget Sound in the past is not known, and some authors have suggested the Washington populations may have been introduced* (Whittemore 1997). At present, human-influenced barriers are minor (neutral) within occupied habitat, but could significantly constrain migration to new sites in the future (somewhat increase).

B3. Predicted impacts of land use changes from climate change mitigation: Somewhat Increase.
The island bluff habitat of *Ranunculus californicus* could be vulnerable to impacts from construction of sea walls or other structures to protect shoreline homes.

Section C: Sensitive and Adaptive Capacity

C1. Dispersal and movements: Somewhat Increase.
Ranunculus californicus produces clusters of flattened, one-seeded achenes. Each fruit has a short, stout beak that can catch on the fur or feathers of animals. Dispersal by birds could

**Ranunculus californicus* was first reported in the San Juan Islands in 1978, prompting Whittemore (1997) to suggest the populations must be recently established (through human introduction), since early collectors missed the species. Whittemore further suggested that introductions were the result of "maritime trade between Victoria and San Francisco" which also resulted in other California coastal species being translocated. COSEWIC (2008) and Dunwiddie no date) cite five facts in considering *R. californicus* to be native in Washington and British Columbia: (1) the islands inhabited by *R. californicus* were poorly botanized until recently; (2) these islands are not along major trade routes and retain relatively undisturbed habitats; (3) this species is not otherwise known from weedy sites at major ports; (4) a suite of native, coastal disjunct species is found in the San Juan Islands; and (5) the islands are actually not that isolated from the nearest occurrences of *R. californicus* on islands in the Columbia River in Oregon. The British Columbia and Washington state natural heritage programs recognize *R. californicus* as native and a species of concern.

potentially spread fruits well over 1 km from the parent plant. Due to the isolation of the San Juan Islands, however, dispersal to the mainland is probably rare and unpredictable.

C2ai. Historical thermal niche: Greatly Increase.
Figure 3 depicts the distribution of *Ranunculus californicus* in Washington relative to mean seasonal temperature variation for the period from 1951-2006 ("historical thermal niche"). All four occurrences (100%) are found in coastal areas that have experienced very small temperature variation (<37˚F/20.8˚C) during the past 50 years and are considered to be at greatly increased vulnerability to climate change (Young et al. 2016).

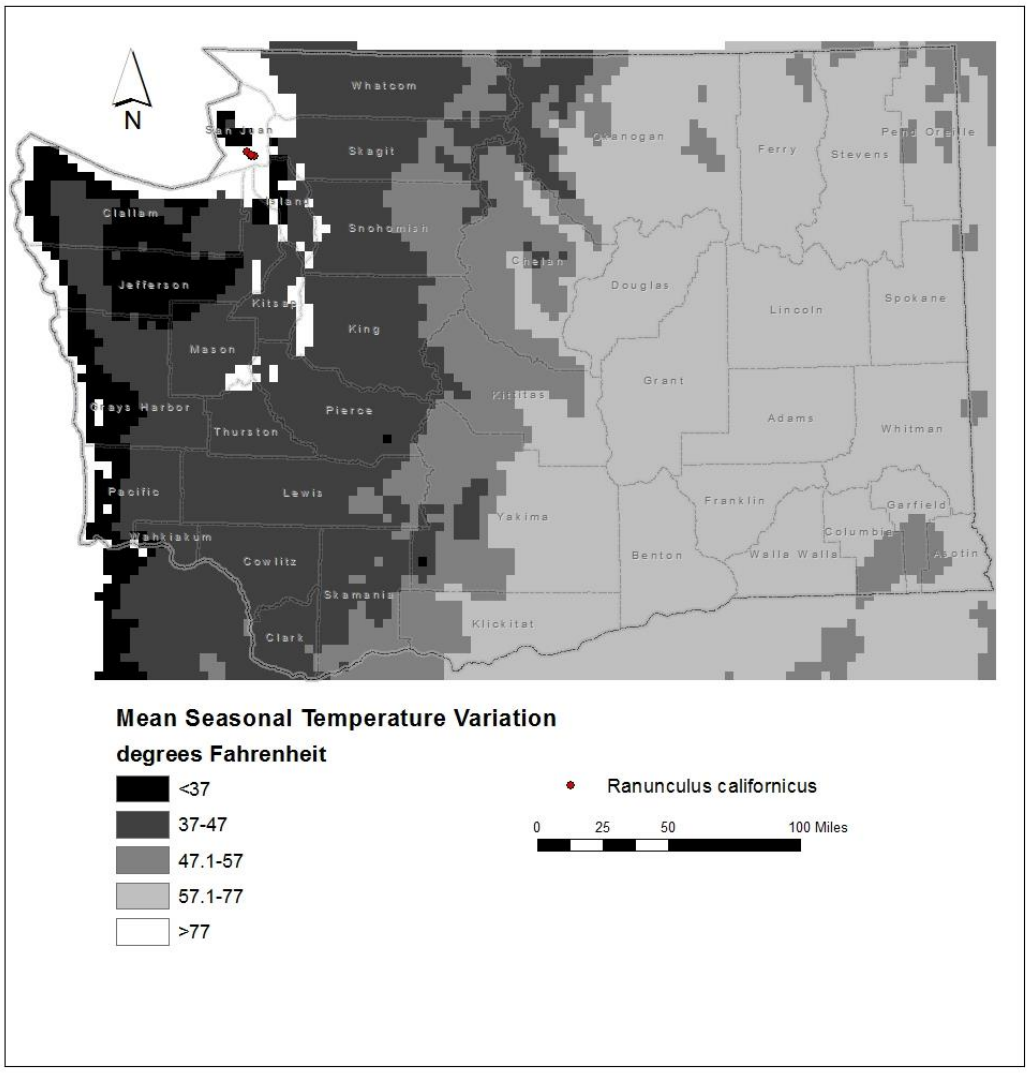

Figure 3. Historical thermal niche (exposure to past temperature variations) of *Ranunculus californicus* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2aii. Physiological thermal niche: Neutral.
The San Juan Islands in Washington and Canada have milder temperatures than nearby inland locations due to the moderating effect of the ocean as a heat sink and warm off-shore currents (COSEWIC 2008). This condition has a neutral impact on climate change vulnerability.

C2bi. Historical hydrological niche: Neutral.
The four occurrences of *Ranunculus californicus* in Washington (100%) have experienced average (21-40 inches/533-1016 mm) precipitation variation in the past 50 years (Figure 4). According to Young et al. (2016), all of these populations are at neutral vulnerability to climate change.

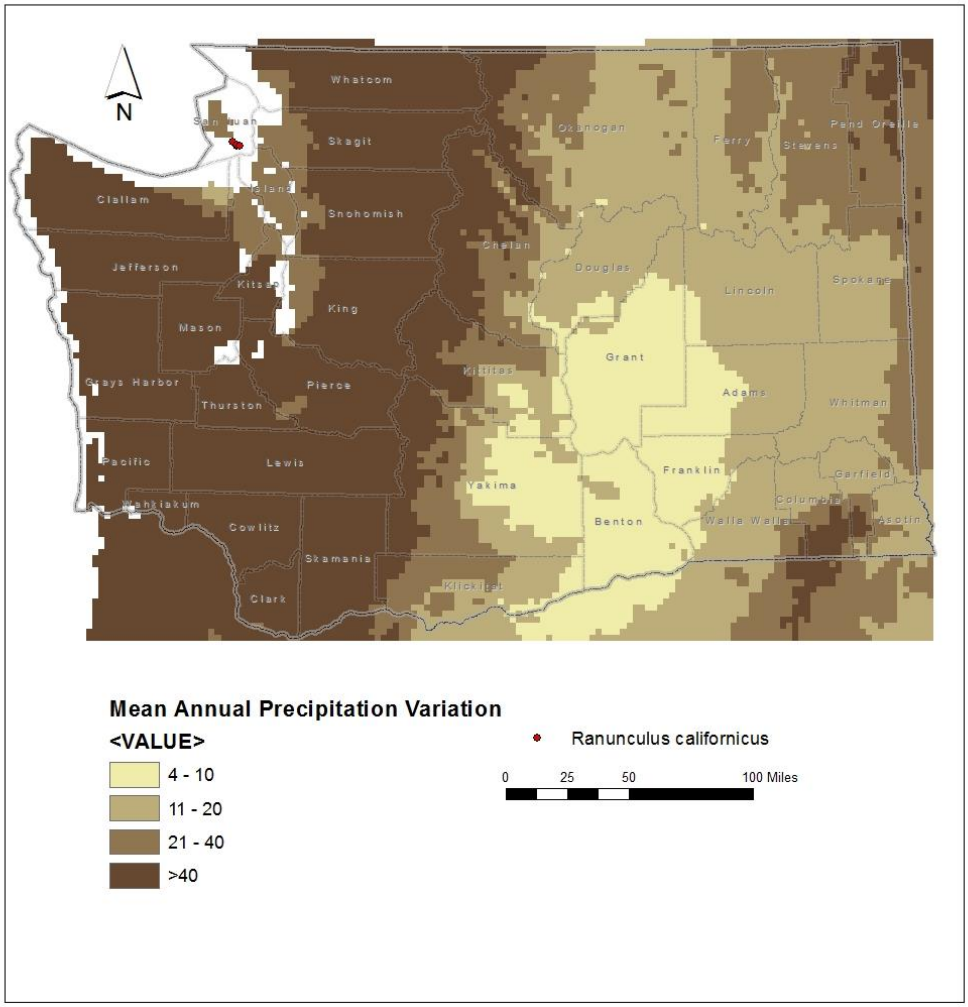

Figure 4. Historical hydrological niche (exposure to past variations in precipitation) of *Ranunculus californicus* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2bii. Physiological hydrological niche: Somewhat Increase.
Ranunculus californicus populations in the San Juan Islands depend on precipitation for moisture, as their habitat is not associated with springs or streams. Supplemental moisture comes from coastal fog in fall and winter (COSEWIC 2008). The proximity of populations to the coast makes them susceptible to saltwater intrusion during storm events or because of sea level rise (Rocchio and Ramm-Granberg 2017).

C2c. Dependence on a specific disturbance regime: Neutral/Somewhat Increase.
Ranunculus californicus populations in Washington are found on small, low-lying islands that are influenced by winter storms and erosion events. Drought conditions in summer may have been important historically for maintaining grassland communities with wildfire. Climate change may actually increase the frequency of winter storm surges and erosion that would maintain early seral conditions (Rocchio and Ramm-Granberg 2017).

C2d. Dependence on ice or snow-cover habitats: Neutral.
Snowfall is low over the range of *Ranunculus californicus* in Washington and a minimal component of its annual water budget.

C3. Restricted to uncommon landscape/geological features: Somewhat Increase.
In Washington, *Ranunculus californicus* is found on rocky slopes and bluffs of metamorphic sandstone and schist of the Cretaceous-Jurassic Constitution Formation (Washington Division of Geology and Earth Resources 2016). This marine sedimentary formation is restricted to portions of Orcas, San Juan, Shaw, and southern Lopez Islands and adjacent small islets in the San Juan archipelago (Logan 2003).

C4a. Dependence on other species to generate required habitat: Neutral.
The coastal meadow habitat of *Ranunculus californicus* is primarily maintained by abiotic factors, including exposure to drying winds, summer drought stress, and winter infiltration creating waterlogged soils in the spring that restricts encroachment of woody vegetation. Unlike mainland sites, herbivores are scarce on small islets in Canada, and do not appear to be significant in maintaining open habitats (COSEWIC 2008). Dunwiddie (no date) observed heavy deer browse on one islet in the Washington San Juans close to Lopez Island.

C4b. Dietary versatility: Not applicable for plants

C4c. Pollinator versatility: Unknown.
Ranunculus californicus is primarily pollinated by bees (COSEWIC 2008), but may also be pollinated by flies and thrips. Specific pollinators in Washington are not known.

C4d. Dependence on other species for propagule dispersal: Neutral.
The one-seeded achene fruits of *Ranunculus californicus* are flattened and have a short, curved beak at the tip. These fruits can be dispersed on the fur of mammals or feathers of birds. Dispersal within populations is not likely to be limiting. Long-distance dispersal (across the ocean to other islands or the mainland), however, may be limited to wide-ranging birds and is probably infrequent.

C4e. Sensitivity to pathogens or natural enemies: Neutral.
Impacts from pathogens are not known. Observations in Canada suggest little impact to this species from herbivory (COSEWIC 2008).

C4f. Sensitivity to competition from native or non-native species: Somewhat Increase.
Populations of *Ranunculus californicus* in Canada are threatened by competition from invasive plants (COSEWIC 2008). Canadian and Washington occurrences are also impacted by hybridization with the closely related *Ranunculus occidentalis*. Hybrids may have the floral traits of *R. californicus* (characterized by more than 5 narrow petals) and long fruit beaks found in typical *R. occidentalis* (Dunwiddie, no date). At least four islands in Washington consist of populations that are likely hybrids between the two species (Dunwiddie, no date).

C4g. Forms part of an interspecific interaction not covered above: Neutral.
Does not require an interspecific interaction.

C5a. Measured genetic variation: Unknown.
Ranunculus californicus is a diploid with a chromosome count of $2n = 28$. It is known to hybridize with *R. occidentalis*. Hybrids are morphologically intermediate between both parents and have reduced fertility, with only 50% of pollen viable and ovules producing seed (Brayshaw 1989). Genetic data are not available for *R. californicus* in Washington. Due to the isolation of island populations in Canada and western Washington, it is likely that genetic intermixing between these sites and others along the coast of Oregon and California is infrequent, and the original populations that reached these sites likely represented a small subset of the full genome of the species.

C5b. Genetic bottlenecks: Unknown.

C5c. Reproductive System: Somewhat Increase.
Ranunculus californicus is presumed to be an outcrosser, rather than self-pollinated. As noted in section C5a (above) genetic diversity is probably low in isolated Washington and Canadian populations due to founder effects and poor dispersal, but genetic studies have not been undertaken (Dunwiddie, no date). Hybridization with *R. occidentalis* is present in at least 5 Washington populations and possibly other mainland sites (COSEWIC 2008) and threatens to swamp out unique *californicus* genes.

C6. Phenological response to changing seasonal and precipitation dynamics: Neutral.
Based on herbarium records from the Consortium of Pacific Northwest herbaria website, no significant changes in the phenology of *Ranunculus californicus* have been detected over the past 20 years.

Section D: Documented or Modeled Response to Climate Change

D1. Documented response to recent climate change: Neutral.
Abundance data in Washington are difficult to interpret because of the presence of hybrids in several populations. Genetically pure *Ranunculus californicus* occurrences range in size from several hundred to several thousand individuals. Populations appear to be stable at present.

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

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