

## Climate Change Vulnerability Index Report

*Rubus arcticus* ssp. *acaulis* (Nagoonberry)

Date: 28 February 2020

Assessor: Walter Fertig, WA Natural Heritage Program

Geographic Area: Washington

Heritage Rank: G5T5/S1

Index Result: Moderately Vulnerable

Confidence: Very High

### Climate Change Vulnerability Index Scores

<b>Section A</b>	<b>Severity</b>	<b>Scope (% of range)</b>
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	100
	-0.074 to -0.096	0
	-0.051 to -0.073	0
	-0.028 to -0.050	0
	>-0.028	0
<b>Section B</b>		<b>Effect on Vulnerability</b>
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
<b>Section C</b>		
1. Dispersal and movements		Neutral
2ai Change in historical thermal niche		Somewhat Increase
2aii. Change in physiological thermal niche		Somewhat Increase
2bi. Changes in historical hydrological niche		Neutral
2bii. Changes in physiological hydrological niche		Somewhat 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		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		Unknown
5b. Genetic bottlenecks		Unknown
5c. Reproductive system		Somewhat Increase

6. Phenological response to changing seasonal and precipitation dynamics	Neutral
<b>Section D</b>	
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 occurrences of *Rubus arcticus* ssp. *acaulis* in Washington (100%) occur in areas with a projected temperature increase of 3.9-4.4° F (Figure 1).

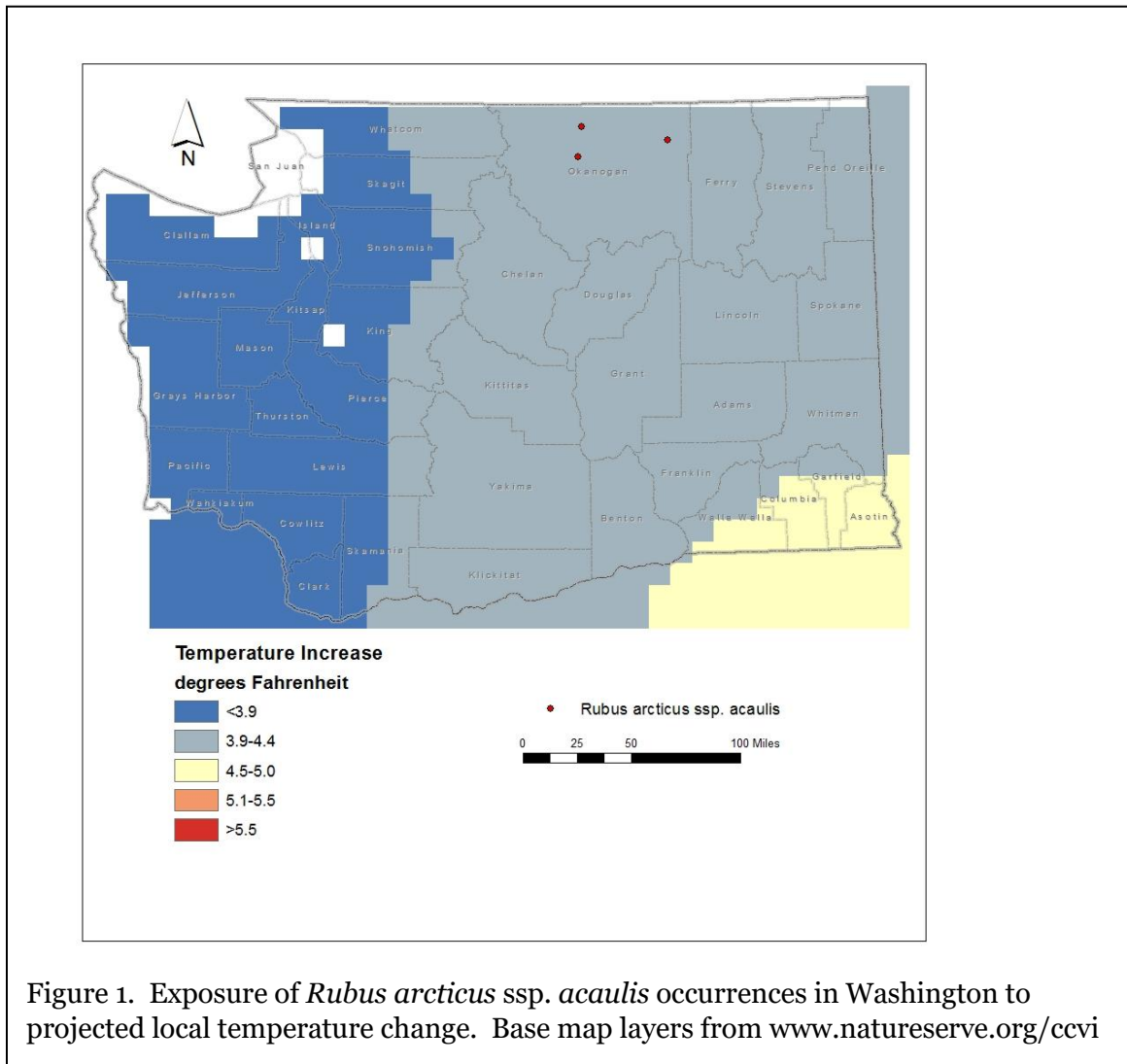


Figure 1. Exposure of *Rubus arcticus* ssp. *acaulis* occurrences in Washington to projected local temperature change. Base map layers from [www.natureserve.org/ccvi](http://www.natureserve.org/ccvi)

A2. Hamon AET:PET Moisture Metric: All three of the Washington occurrences of *Rubus arcticus* ssp. *acaulis* (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 -0.097 to -0.119 (Figure 2).

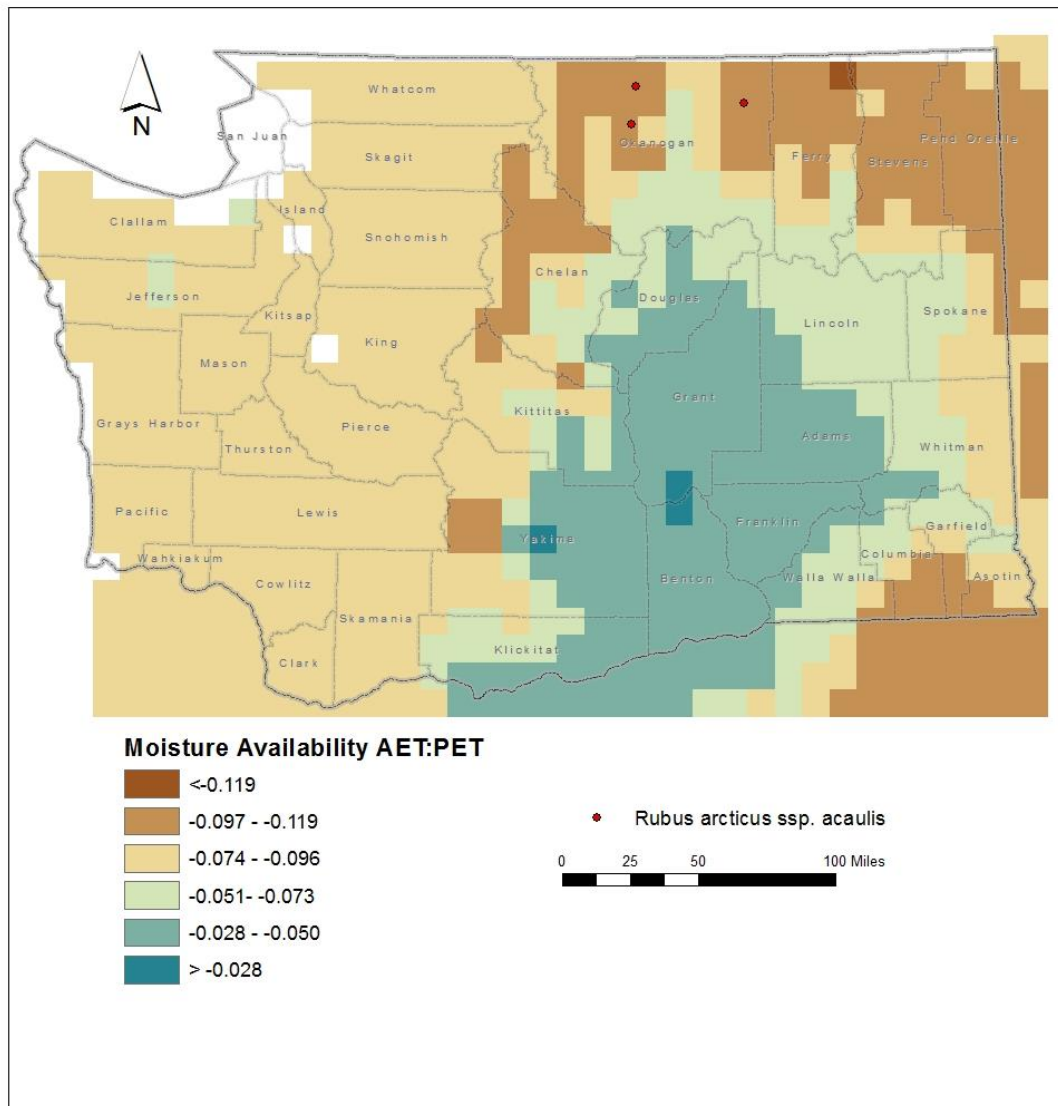


Figure 2. Exposure of *Rubus arcticus* ssp. *acaulis* occurrences in Washington to projected moisture availability (based on ratio of actual to predicted evapotranspiration). Base map layers from [www.natureserve.org/ccvi](http://www.natureserve.org/ccvi)

## **Section B. Indirect Exposure to Climate Change**

B1. Exposure to sea level rise: Neutral.

Washington occurrences of *Rubus arcticus* ssp. *acaulis* are found at 3550-5950 feet (1080-1815 m) and would not be inundated by projected sea level rise.

B2a. Natural barriers: Somewhat Increase.

In Washington, *Rubus arcticus* ssp. *acaulis* is found in forested Engelmann spruce wetlands and *Sphagnum*-dominated fens (Camp and Gamon 2011). These habitats are components of the Rocky Mountain Subalpine-Montane Riparian Woodland and Rocky Mountain Subalpine-Montane Fen ecological systems (Rocchio and Crawford 2015). Individual populations are small and separated by 23-64 km (14-40 miles) of mostly unsuitable habitat that would act as a barrier to gene flow.

B2b. Anthropogenic barriers: Neutral.

The range of *Rubus arcticus* ssp. *acaulis* in Washington is probably more constrained by natural conditions than human ones.

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

## **Section C: Sensitive and Adaptive Capacity**

C1. Dispersal and movements: Neutral.

*Rubus arcticus* ssp. *acaulis* produces edible, aggregate fruits comprised of 20-30 fleshy, 1-seeded drupelets that are readily consumed by humans, rodents, birds, and other wildlife. Seeds can be dispersed short to long distances and the small seeds excreted in feces.

C2ai. Historical thermal niche: Somewhat Increase.

Figure 3 depicts the distribution of *Rubus arcticus* ssp. *acaulis* in Washington relative to mean seasonal temperature variation for the period from 1951-2006 (“historical thermal niche”). Two of the three known occurrences (66.7%) 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 risk from climate change. The third population (33.3% of the state occurrences) is historical and from an area with average (57.1-77°F/31.8-43.0°C) temperature variation in the same period and is considered at neutral vulnerability to climate change.

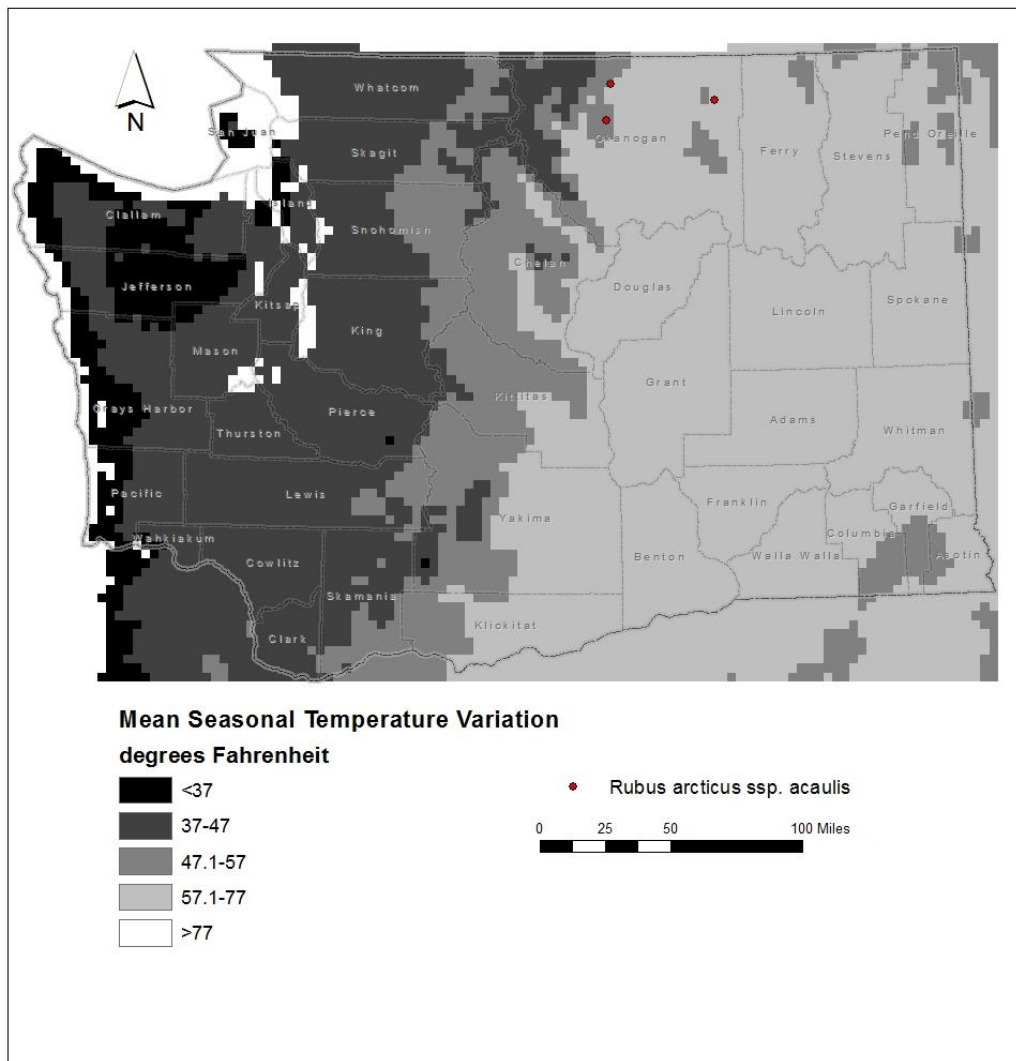


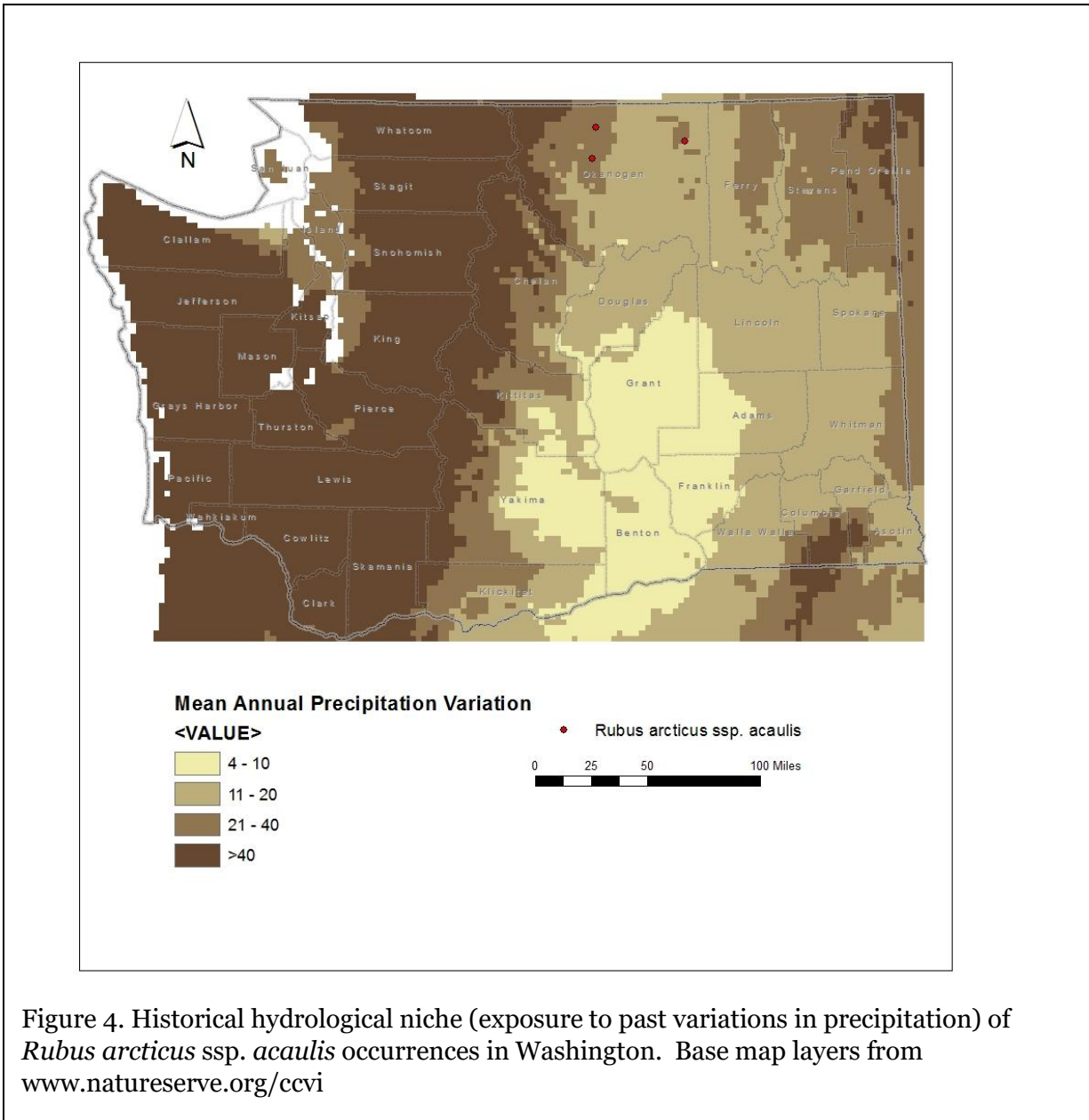
Figure 3. Historical thermal niche (exposure to past temperature variations) of *Rubus arcticus ssp. acaulis* occurrences in Washington. Base map layers from [www.natureserve.org/cvvi](http://www.natureserve.org/cvvi)

C2aii. Physiological thermal niche: Somewhat Increase.

The swamp forest and *Sphagnum*-dominated fen sites occupied by *Rubus arcticus ssp. acaulis* are associated with cold air drainage or partial shade during the growing season and would have somewhat increased vulnerability to climate change.

C2bi. Historical hydrological niche: Neutral.

All three of the populations of *Rubus arcticus* ssp. *acaulis* in Washington (100%) are found in areas that have experienced average or greater than 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 from climate change.



C2bii. Physiological hydrological niche: Somewhat Increase.

In Washington, *Rubus arcticus* ssp. *acaulis* is restricted to forested wetland and *Sphagnum*-dominated fen habitats. Forested wetlands are especially sensitive to changes in moisture levels related to precipitation, snowmelt, and drought (Rocchio and Ramm-Granberg 2017). Fen

habitats are more dependent on groundwater discharge and less susceptible to climate change, at least in the short term (Rocchio and Ramm-Granberg 2017). Long-term, fen sites are vulnerable to displacement by moist to dry meadow species as water tables become lowered due to reduced snowmelt, increased drought, and changes in the amount or timing of precipitation.

C2c. Dependence on a specific disturbance regime: Neutral.

*Rubus arcticus* ssp. *acaulis* is probably not dependent on periodic disturbances to maintain its forest wetland or *Sphagnum*-dominated fen habitat.

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

The populations of *Rubus arcticus* ssp. *acaulis* in Washington occur in areas of moderate to high accumulations of snow. Recharge of groundwater from melting snow is especially important for maintaining adequate moisture in fen wetlands. Populations could be vulnerable to reductions in the depth or changes in rate of melting of snowpack (Rocchio and Ramm-Granberg 2017).

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

The populations of *Rubus arcticus* ssp. *acaulis* in Washington occur on a variety of intrusive batholith, mixed metamorphic and igneous, and glacial till substrates that are relatively common in the mountains of the north-central portion of the state.

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

The habitat occupied by *Rubus arcticus* ssp. *acaulis* is maintained primarily by natural abiotic processes rather than by interactions with other species.

C4b. Dietary versatility: Not applicable for plants

C4c. Pollinator versatility: Neutral.

*Rubus arcticus* ssp. *acaulis* produces relatively large flowers that are pollinated by bumblebees and other bees (Ladyman 2006). Studies in Europe have shown that different genetic strains (genotypes) can occur within the same population. Fertilization and fruit production may depend on crosses between different genotypes due to gametophytic self-incompatibility (Tammisola 1988). Reduced fruit production in some populations, such as those in the Rocky Mountains of Colorado and Wyoming (Ladyman 2006; Fertig 2000) may be related to populations that are genetically incompatible (although still capable of spreading vegetatively) or triploid. Washington populations appear to be vigorous and capable of producing large amounts of flowers and fruits, so may not have the reproductive barriers found in the Rocky Mountains.

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

*Rubus arcticus* ssp. *acaulis* fruits are edible and can be potentially transported long distances by a variety of animal species. Dispersal, per se, is probably not a limiting factor, although finding new places with suitable habitat for germination is more problematic.

C4e. Sensitivity to pathogens or natural enemies: Neutral.

Ladyman (2006) reports that *Rubus arcticus* ssp. *acaulis* is potentially vulnerable to several virus diseases and from floral herbivory by thrips. Herbivory of stems and leaves is probably minor.

C4f. Sensitivity to competition from native or non-native species: Somewhat Increase. Shading by shrubs and taller vegetation is considered a threat to some European populations (Ladyman 2006). The wet forest and *Sphagnum*-dominated fen habitat could be vulnerable to competition from invasive species or displacement by native species adapted to drier conditions or adapted to fire under increased drought or reduced precipitation in the future (Rocchio and Ramm-Granberg).

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 the genetic diversity of *Rubus arcticus* ssp. *acaulis* in Washington. Studies in Finland found high levels of genetic diversity between population of *R. acaulis*, suggesting the importance of sexual reproduction within populations and limitations to gene flow between populations (Lindqvist-Kreuzer et al. 2003). The disjunct populations at the south edge of the species' range in western North America (such as Washington, Colorado, and Wyoming) suggest that genetic diversity may be low due to founder effects or inbreeding depression.

C5b. Genetic bottlenecks: Unknown.

C5c. Reproductive System: Somewhat Increase

*Rubus arcticus* ssp. *acaulis* produces large, unspecialized flowers that are pollinated by a variety of insects. Studies suggest that it can form self-incompatible clones and fruit production may be dependent on 2-3 different genetic clones being present in the same population for out-crossing. Genetic diversity is probably high for the species overall, but isolated populations in Washington would likely have lower diversity due to founder effects or inbreeding depression.

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 major 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.

The distribution of *Rubus arcticus* ssp. *acaulis* has probably not changed notably in the last 50 years. One population in Okanogan County is considered historical, but is from private lands and it appears no attempt has been made to relocate it.

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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