Climate Change Vulnerability Index Report

*Chrysolepis chrysophylla* var. *chrysophylla* (Golden chinquapin)

Date: 30 January 2020

Assessor: Walter Fertig, WA Natural Heritage Program

Geographic Area: Washington    Heritage Rank: G5T5/S2

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 | 35 |
| | <3.9° F (2.2°C) warmer | 65 |
| 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** | | **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 | | Increase |
| 2aii. Change in physiological thermal niche | | Neutral |
| 2bi. Changes in historical hydrological niche | | Neutral |
| 2bii. Changes in physiological hydrological niche | | Neutral |
| 2c. Dependence on specific disturbance regime | | Somewhat Increase |
| 2d. Dependence on ice or snow-covered habitats | | Neutral |
| 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 | | Somewhat Increase |
| 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 | | Somewhat Increase |

| | |
|---|---|
| 5b. Genetic bottlenecks | Neutral |
| 5c. Reproductive system | Neutral |
| 6. Phenological response to changing seasonal and precipitation dynamics | Neutral |
| **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: Six of the 17 known occurrences of *Chrysolepis chrysophylla* var. *chrysophylla* in Washington (35%) occur in areas with a projected temperature increase of

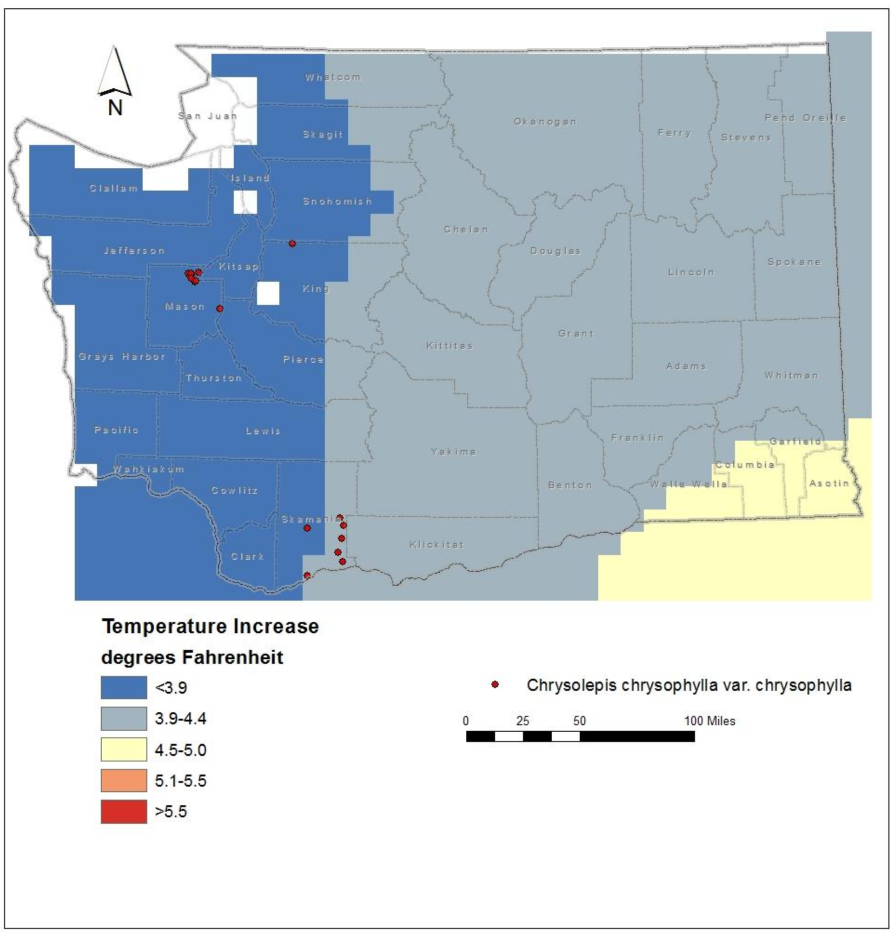


Figure 1. Exposure of *Chrysolepis chrysophylla* var. *chrysophylla* occurrences in Washington to projected local temperature change. Base map layers from www.natureserve.org/ccvi

3.9-4.4° F (Figure 1). The other 11 occurrences (65%) are from areas with a predicted temperature increase of <3.9° F.

A2. Hamon AET:PET Moisture Metric: All Washington occurrences of *Chrysolepis chrysophylla* var. *chrysophylla* 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).

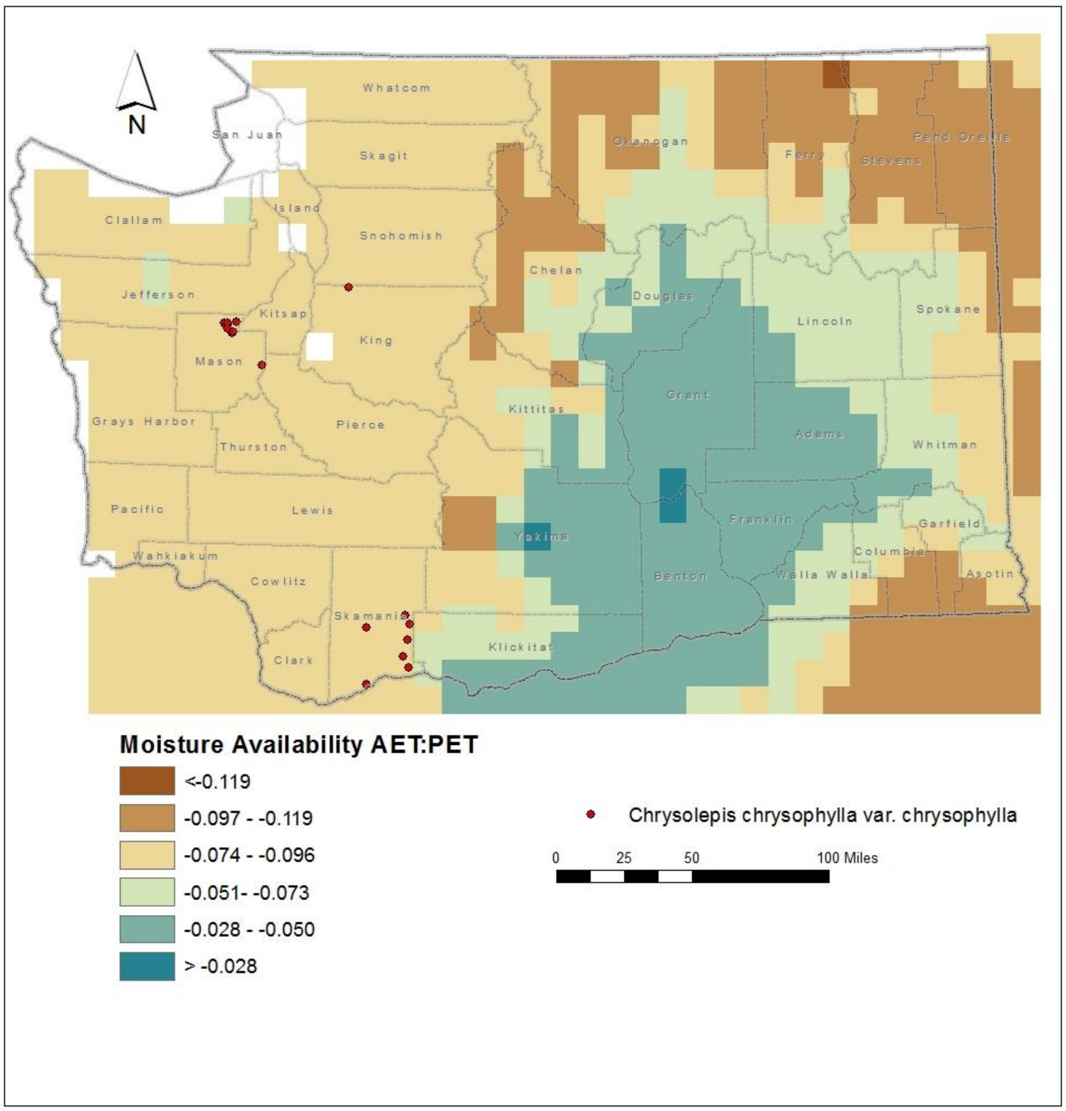


Figure 2. Exposure of *Chrysolepis chrysophylla* var. *chrysophylla* occurrences in Washington to projected moisture availability (based on ratio of actual to predicted evapotranspiration). Base map layers from www.natureserve.org/ccvi

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

B1. Exposure to sea level rise: Neutral.
Washington occurrences of *Chrysolepis chrysophylla* var. *chrysophylla* are found at 50-3600 ft (15-1100 m) and would not be inundated by projected sea level rise.

B2a. Natural barriers: Neutral.
In Washington, *Chrysolepis chrysophylla* var. *chrysophylla* occurs mostly in second growth Douglas-fir/mixed hardwood forests on droughty soils. It is found in two main areas of the state: the Olympic Peninsula/Hood Canal area in Mason County and the vicinity of Mount Adams in Skamania County (Kruckeberg 1980). Reports from King and Kitsap counties are recent human introductions. Populations from the Olympic Peninsula are found in the North Pacific Dry Douglas-fir Forest and Woodland ecological system, while those from the Mount Adams area are from the North Pacific Maritime Dry-Mesic Douglas-fir-Western Hemlock Forest ecological system (Rocchio and Crawford 2015). Kruckeberg (1980) noted few apparent physical, environmental, or climatic barriers to explain the disjunct populations in Mason County, though chance long-distance dispersal or periodic cold snaps/disease may account for its present isolated distribution.

B2b. Anthropogenic barriers: Neutral.
Extant occurrences of *Chrysolepis chrysophylla* var. *chrysophylla* in Washington are embedded within a matrix of paved and unpaved roads and areas that have been recently logged and second growth forest. The species is dispersal limited, but this is discussed separately.

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

**Section C: Sensitive and Adaptive Capacity**

C1. Dispersal and movements: Somewhat Increase.
Golden chinquapin produces 1-3 large, hard-shelled, one-seeded nuts surrounded by a spiny involucre. These fruits are dispersed passively by gravity or by seed predators, such as squirrels and pigeons (McKee 1990, Salstrom 1992).

C2ai. Historical thermal niche: Increase.
Figure 3 depicts the distribution of *Chrysolepis chrysophylla* var. *chrysophylla* in Washington relative to mean seasonal temperature variation for the period from 1951-2006 ("historical thermal niche"). Five of the 17 known occurrences in the state (29%) 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. These populations have somewhat increased vulnerability under projected climate change (Young et al. 2016). The remaining 12 occurrences (71%) are found in areas that have experienced small (37-47˚F/20.8-26.3˚C) temperature variation in the same historic time period and are at increased vulnerability to climate change. Since the majority of Washington populations are in the latter group, this factor is scored "Increase" for the full species.

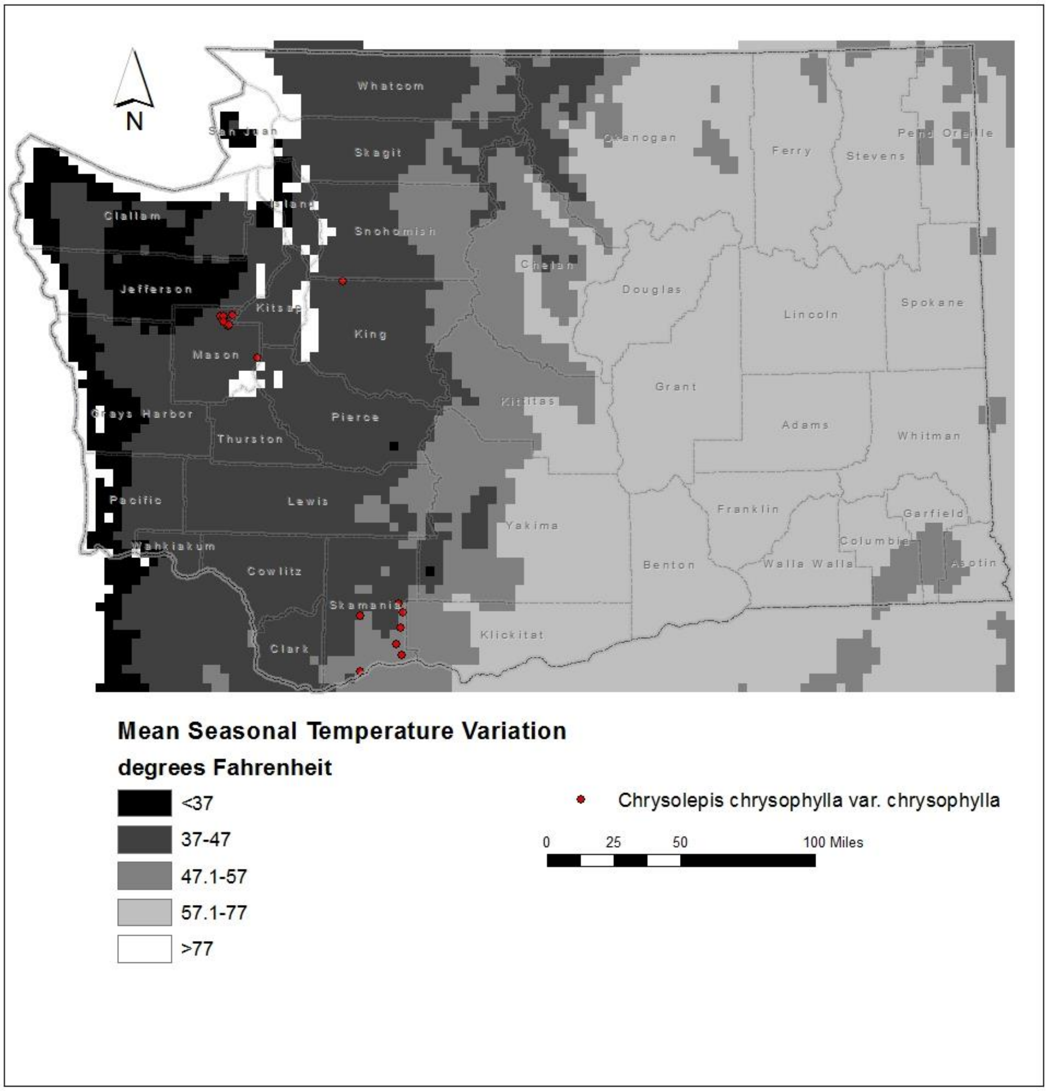


Figure 3. Historical thermal niche (exposure to past temperature variations) of *Chrysolepis chrysophylla* var. *chrysophylla* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2aii. Physiological thermal niche: Neutral.
The low-elevation tree ecotype of *Chrysolepis chrysophylla* var. *chrysophylla* found in Washington is not dependent on cool environments like the high-elevation shrub ecotypes of the Oregon Cascades (McKee 1990).

C2bi. Historical hydrological niche: Neutral.
All of the known populations of *Chrysolepis chrysophylla* var. *chrysophylla* in Washington are found in areas that have experienced average or greater than average (>20 inches/508 mm)

precipitation variation in the past 50 years. According to Young et al. (2016), these occurrences are Neutral in terms of risk from climate change.

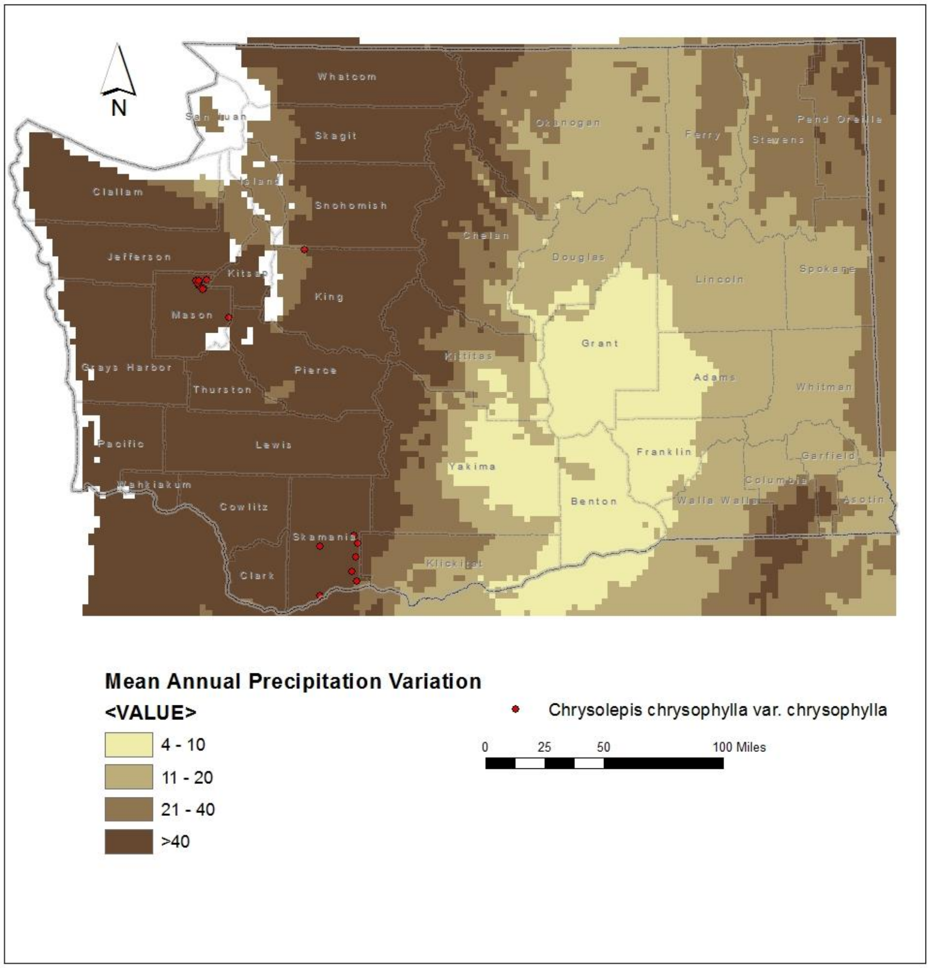


Figure 4. Historical hydrological niche (exposure to past variations in precipitation) of *Chrysolepis chrysophylla* var. *chrysophylla* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2bii. Physiological hydrological niche: Neutral.
This species is not dependent on a specific aquatic or wetland habitat or a seasonal hydrologic regime.

C2c. Dependence on a specific disturbance regime: Somewhat Increase.
Seedling Golden chinquapins are somewhat shade intolerant and have better establishment success in sites without a dense understory (McKee 1990). Most populations in Washington are found at forest edges or in second growth forests, suggesting that it may be partly dependent on periodic disturbances (such as fire, wind-throw, or cutting) to create open conditions for

seedling establishment (McKee 1990). Projected climate change could result in increased drought and higher fire frequency and increased susceptibility to wind-throw in dry Douglas-fir forests (Rocchio and Ramm-Granberg 2017). Mature plants are able to re-sprout prolifically. McKee (1990) considered the tree-form of Golden chinquapin (the phase found in Washington) to be less shade tolerant than the shrub phase of Oregon and California, but to be intermediate in shade tolerance relative to other trees of the Northwest.

C2d. Dependence on ice or snow-cover habitats: Neutral.
The Hood Canal populations occur at low elevations where ice and snow is not significant (relative to rainfall). Populations in the Mt. Adams area may be more dependent on winter precipitation, and could be considered to have somewhat increased vulnerability.

C3. Restricted to uncommon landscape/geological features: Neutral
Washington populations occur on flats or convex slopes on relatively infertile or droughty pumice, ash, or sandy soils (Salstrom 1992).

C4a. Dependence on other species to generate required habitat: Neutral
The second growth forest habitats occupied by Golden chinquapin are maintained by natural climatic phenomena (and enhanced by humans), but are largely not influenced by other animal species.

C4b. Dietary versatility: Not applicable for plants

C4c. Pollinator versatility: Neutral.
*Chrysolepis chrysophylla* var. *chrysophylla* is predominantly wind-pollinated, though it can be pollinated by honeybees (McKee 1990).

C4d. Dependence on other species for propagule dispersal: Somewhat Increase.
Dispersal of *Chrysolepis* seeds is dependent on squirrels and pigeons (Salstrom 1992).

C4e. Sensitivity to pathogens or natural enemies: Somewhat Increase.
This species is vulnerable to heart-rot fungi (*Phellinus igniarius*) that can become established following scarring by wind-throw, large game animals, or mountain beaver (Salstrom 1992). Kruckeberg (1980) reported that populations in the Hood Canal area were partially defoliated and infected by ascomycete fungi (*Venturia* or *Didymella*). Several insect pests have been reported to reduce seed production or affect foliar cover in northern California (McKee 1990). McDonald (2008) suggests that establishment of this species by seed may be relatively uncommon due to high rates of seed predation by squirrels, insects, and birds.

C4f. Sensitivity to competition from native or non-native species: Somewhat Increase.
In droughty sites, Golden chinquapin may out-compete other forest species. In late seral conditions, it is susceptible to competition and poor recruitment. Some disturbance (wind-throw, fire, thinning) appears to be beneficial in maintaining populations (McKee 1990). These disturbances are likely to increase in dry Douglas-fir forest habitats under projected climate change (Rocchio and Ramm-Granberg 2017).

C4g. Forms part of an interspecific interaction not covered above: Somewhat Increase.
*Chrysolepis chrysophylla* is the only host for the rare golden hairstreak butterfly (*Habrodais grunus heri*) (Pyle 1989).

C5a. Measured genetic variation: Somewhat Increase.
Rangewide, *Chrysolepis chrysophylla* exhibits regional patterns of genetic divergence between northern and southern populations and between high elevation and lower elevation occurrences (Willyard et al. 2020 in press). The disjunct Olympic Peninsula/Hood Canal populations from Washington are also genetically distinct from other populations in the state and from those in Oregon and California. Willyard et al. (2020 in press) also note some minor morphological differences in the NW Washington populations and suggest that these plants may warrant taxonomic recognition. The genetic variability among different populations of Golden chinquapin is more similar to that found between species in the Fagaceae. Rangewide (and in the Mount Adams area of Washington), genetic diversity is relatively high and the vulnerability of the species is neutral. Lower genetic diversity and lower heterozygosity in the Olympic Peninsula/Hood Canal populations, however, suggest that these plants are at somewhat increased risk than the species as a whole (Willyard et al. 2020 in press). Because of the conservation significance of the disjunct Hood Canal populations, the statewide score is given as Somewhat Increase.

C5b. Genetic bottlenecks: Neutral (according to Young et al. 2016, this is not scored if C5a is not unknown).
The genetic distinctiveness of the Olympic Peninsula/Hood Canal populations may be due to founder effects if the population arose by long distance dispersal of one or a few individuals representing a small subset of the genetic variability of the full species. Conversely, it might also be due to long-term inbreeding depression if these populations were once connected with other breeding populations but are now isolated due to contraction of its range.

C5c. Reproductive System: Neutral.
*Chrysolepis chrysophylla* is a monoecious outcrosser and predominantly pollinated by wind. This reproductive system should promote more genetic homogenization across its range, except for instances (like the populations in the Olympic Peninsula/Hood Canal) that are reproductively isolated.

C6. Phenological response to changing seasonal and precipitation dynamics: Neutral.
Changes in flowering or fruiting time for *Chrysolepis chrysophylla* in Washington have not been observed.

**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 40 years since Kruckeberg (1980) published his paper on the distribution of *Chrysolepis chrysophylla* in Washington. Case et al. (2015) ranked the climate sensitivity of this species as moderate (score of 44) in their assessment of 195 northwestern bird, mammal, amphibian, reptile, and vascular plant species.

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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