TULALIP TRIBES
TREATY RIGHTS
& GOVERNMENT
AFFAIRS

Big Huckleberry | swədaʔx̌

Big huckleberry (*Vaccinium membranaceum*; hereafter 'huckleberry'), also known as thinleaf, mountain, or black huckleberry, occurs throughout subalpine regions of the Pacific Northwest. In the Washington Cascades, huckleberry is found in dry subalpine zones and often grows with beargrass. It is a dominant species in both fir and hemlock forests in the western Cascades, and occurs in the understory of Pacific silver fir, noble fir, mountain hemlock, Douglas-fir, western white pine and western redcedar (Simonin 2000). Huckleberry is *c*urrently found from ~3,000 ft. to the higher elevations of the Cascades Range.

Prior to European settlement, Native peoples west of the Cascades used fire as a tool to improve huckleberry habitat by removing conifers encroaching on meadows. Huckleberry is typically able to survive low to moderate severity fires and is adapted to resprout from rhizomes after low to moderately severe fires (Simonin 2000). Current forest practices in the Pacific Northwest, including fire suppression policies and localized declines in logging coinciding with the designation of late successional reserves, are likely connected to the declining area of suitable huckleberry habitat and declines in huckleberry productivity (Nelson 2015).

Future changes in climate may present numerous challenges for huckleberry. Climate change may lead to shifts in the distribution of huckleberry habitat across western North America. Climate change may also result in shifts in huckleberry phenology[1], as well as changes in huckleberry productivity.

We conducted a synthesis of peer-reviewed and gray literature (i.e., reports, previous syntheses, etc.) exploring climate impacts on huckleberry. Below, we describe key

[1] The timing of seasonal activities of plants and animals (e.g., flowering or fruiting; Walther et al. 2002).

findings from these studies and their implications for future huckleberry distribution, phenology and productivity within the geography of the Treaty of Point Elliott.

Climate-driven changes in huckleberry distribution

Several studies have investigated potential future changes in huckleberry distributions that may be relevant to potential impacts within the geography of the Treaty of Point Elliott.

- **Proctor et al. (2017)** monitored 300 huckleberry patches visited by grizzly bears over a two-year period in southeast British Columbia. They developed a predictive huckleberry patch model that found that snow was a dominant predictor of huckleberry occurrence, indicating that deep snowpack is favorable for huckleberry habitat. Snowpack is projected to decline substantially within the Tulalip Tribes' area of interest: by the end of the century, April 1st snow water equivalent[2] within the geography of the Treaty of Point Elliott is projected to decline by 37% and 59% under a low (RCP 4.5) and high (RCP 8.5) greenhouse gas scenario, respectively, relative to 1971-2000 (Tribal Climate Tool; Figure 1). This suggests that habitat suitability for huckleberry may decline across the Tribes' Treaty Area.

- **Roberts et al. (2014)** used presence-absence data from over 7,000 plots in the southern Canadian Rocky Mountains of Alberta and British Columbia along with climatic niche models[3] to project habitat changes in 17 of the most common grizzly bear food resources, including black huckleberry. By the 2080s, huckleberry habitat is projected to expand considerably, increasing in projected area by 84% and 112%, under a low (B1) and high (A2) greenhouse gas scenario, respectfully, relative to 1961-1990 (Figure 2).

- **Prevéy et al. (2020)** used climatic niche models to examine how projected changes in climate will alter the predicted range of big huckleberry across coastal western North America (southern CA north through British Columbia and east to central Montana). Results suggested that while habitat suitability for big huckleberry will decrease between 5-40% at lower elevations and lower latitudes, higher elevations (>10,000 ft.) and more northerly latitudes (above 56° N) are expected to become areas of more suitable habitat (Figure 3 and Figure 4). The results of this modeling effort are consistent with those reported in British Columbia and Alberta, Canada (Roberts et al. 2014; Lamb et al. 2017).

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[2] Amount of water contained in the snowpack on April 1st.

[3] Climatic niche models use correlations between climate variables (e.g., temperature and precipitation) and species occurrence data to define the climate niche for a species and project it into the future.

Climate-driven shifts in huckleberry phenology

Prevéy et al. (2019) developed phenological models to predict how huckleberry flowering and fruiting dates may shift in response to climate change. The authors used 97 flowering observations and 908 fruiting observations from 1980-2017 that were gathered from different sources. The phenological models were tested by evaluating their ability to predict contemporary timing (i.e., year 2000) of huckleberry flowering and fruiting. These models predict that both flowering and fruiting dates will advance across coastal western North America in the future, with more drastic advances in northerly latitudes and higher elevations. Across the study area by the 2080s, huckleberry flowering dates are projected to advance an average of 21 days (range: 11-31 days) under a low (RCP 4.5) greenhouse gas scenario and an average of 35 days (range: 23-50 days) under a high (RCP 8.5) greenhouse gas scenario (Figure 5). Fruiting is projected to advance 23 days on average (range: 13-37 days) under a low greenhouse gas scenario and 36 days (range: 25-52 days) under a high scenario.[4] While flowering dates are projected to advance throughout the 21st century, the risk of late frost events is not expected to change, suggesting that the vulnerability of frost damage will increase as flowering dates advance. Frost can damage flowers and lead to years with no fruit crop (Prevéy et al. 2019; Richardson et al. 2018).

Climate impacts on huckleberry productivity

Absence of long-term monitoring datasets and historical huckleberry surveys limits conclusions on how observed climate has historically affected huckleberry productivity. It is known that huckleberry productivity is often influenced by local weather (as opposed to longer-term climate) and varies year-to-year.[5] Due to the high interannual variability of huckleberry productivity, several decades of data are needed to identify longer-term trends. However, at least one study has attempted to predict changes in huckleberry productivity in the Northwest.

- **Holden et al. (2012)** used predictive empirical models to analyze relationships between climate metrics (e.g., temperature and precipitation) and huckleberry productivity in northern Idaho and western Montana between 1989-2010. This study found that huckleberry productivity during this 21-year period was strongly dependent on temperature, specifically July temperature range. Huckleberry productivity was greatest in years with cool springs with high July diurnal temperature ranges (i.e., days with warm daytime temperatures and cooler

[4] The phenology model used in this study does not account for abiotic factors that can influence flowering and fruiting dates including: the timing of snowmelt, photoperiod, or the chilling temperatures required for fruit production.

[5] However, huckleberry abundance or percent cover is more stable year-to-year and is influenced less by meteorological factors (Minore and Dubrasich 1978).

nights)[6]. While temperature is known to directly affect plant growth, more analysis is needed to identify the mechanisms responsible for the observed correlation. A negative correlation between spring temperatures and huckleberry productivity was also observed. Years with warmer springs were associated with lower huckleberry productivity. Spring temperatures are projected to increase in the Puget Sound. By the 2080s, spring temperatures in the Puget Sound are projected to increase by 5.3°F and 7.9°F under a low (RCP 4.5) and high (RCP 8.5) greenhouse gas scenario, relative to 1970-1999 (Mauger et al. 2015). While these results suggest that warming spring temperatures may negatively affect future huckleberry productivity, the authors state that further model development is necessary to estimate how climate change will affect huckleberry productivity.

Survey Results from Mt. Baker-Snoqualmie N.F Big Huckleberry Harvester Study
In 2012, Tulalip Natural Resources staff and Mt. Baker-Snoqualmie National Forest staff developed an exploratory study to evaluate the recreational harvest of huckleberry in Mt. Baker-Snoqualmie National Forest. 225 participants completed the survey and 24 in-depth interviews were conducted with recreational harvesters survey participants who were willing to provide additional information. A subset of these in-depth interviews touched on the implications of natural climate variation and climate change on huckleberry harvest. Interview finding highlights include:

- Interviewees note that over the past decade, the rate of conifer encroachment has increased in huckleberry patches, specifically in upper elevation habitats within the Mt. Baker Snoqualmie National Forest. The interviewees speculate that this observed shift is due to warmer air temperatures, earlier snowpack melt, and wetter winters, which benefit conifer germination. Additionally, one of the interviewees noted that the earlier spring snowmelt may expose the huckleberries to late spring freeze events -- a statement that has been corroborated by the literature (Prevéy et al. 2019; Richardson et al. 2018). Survey participants stressed the importance of disturbance events (e.g., selectively logging, prescribed burning) to mitigate or slow conifer encroachment.
- Interviewees also note that plant-pollinator interactions may be affected by climate change. If flowering and fruiting times are advancing with earlier spring snowmelt and warmer spring temperatures, there may be a mismatch between huckleberry and the pollinators if the bees are not actively pollinating earlier in the season.

[6] The diurnal temperature range is the difference between the daily maximum and daily minimum temperature.

Synthesis & Key Conclusions

- Climate change is projected to reduce habitat suitability for huckleberry in the Northwest, and is likely to cause areas of huckleberry habitat to contract across the geography of the Treaty of Point Elliott. Specifically, huckleberry distributions may shift to higher elevations, where more suitable climatic conditions may be available under future scenarios.
- Models also predict that huckleberry flowering and fruiting will advance in timing by the end of the 21st century, moving earlier in the year. Vulnerability of frost damage will likely increase as flowering dates advance, which may damage huckleberry flowers and result in years with no fruit crop.
- Warming spring temperatures may negatively affect future huckleberry productivity, but additional research is needed in this area.

Opportunities and Considerations for Applying Results

- Results from the Prevey et al. (2020) study, which project changes in huckleberry habitat suitability and berry phenology across the Northwest, can be used for planning, management, and restoration efforts of huckleberry across the region. Anticipating these projected changes provides an opportunity to shift natural resource management strategies and policies. Results could be used by natural resource managers to determine priorities for competing projects, and identify (generally) where new areas may be suitable for huckleberry patches.
- Future work should evaluate how the projected shifts in habitat suitability and phenology of big huckleberry could have cascading impacts to pollinators, animals, and human communities -- who all rely on huckleberries for different resources.
- Application of results will be most effective if combined with the local knowledge of Tribal scientists and knowledge keepers. For example, knowledge of the location of huckleberry habitat that may be more resilient to climate change due to being located in higher elevations with cooler temperatures could be used to prioritize those habitats for protection or restoration.
- Reduce existing stressors. Because climate change is one of many stressors affecting natural systems, reducing non-climate stressors (e.g., invasive species, habitat loss, overharvesting) can help to increase resilience to climate change. Although the benefits of reducing non-climate stressors are generally well established, the degree to which reducing non-climate stresses increases system resilience may depend on the specific nature of the climate impact(s).
- To understand how specific changes may be occurring across the Treaty of Point Elliot area, monitoring - of phenological shifts in flowering and fruiting timing, possible resulting mismatches between huckleberry flowering and pollinator presence, and possible conifer encroachment into huckleberry patches - may be particularly useful for informing future decisions.

- Managing big huckleberry in a changing climate management approach will require some active strategies such removing trees that are encroaching into huckleberry habitat and using prescribed fire to kill encroaching thin-barked trees and encourage the development of new, more rigorous sprouts from huckleberry rhizomes.

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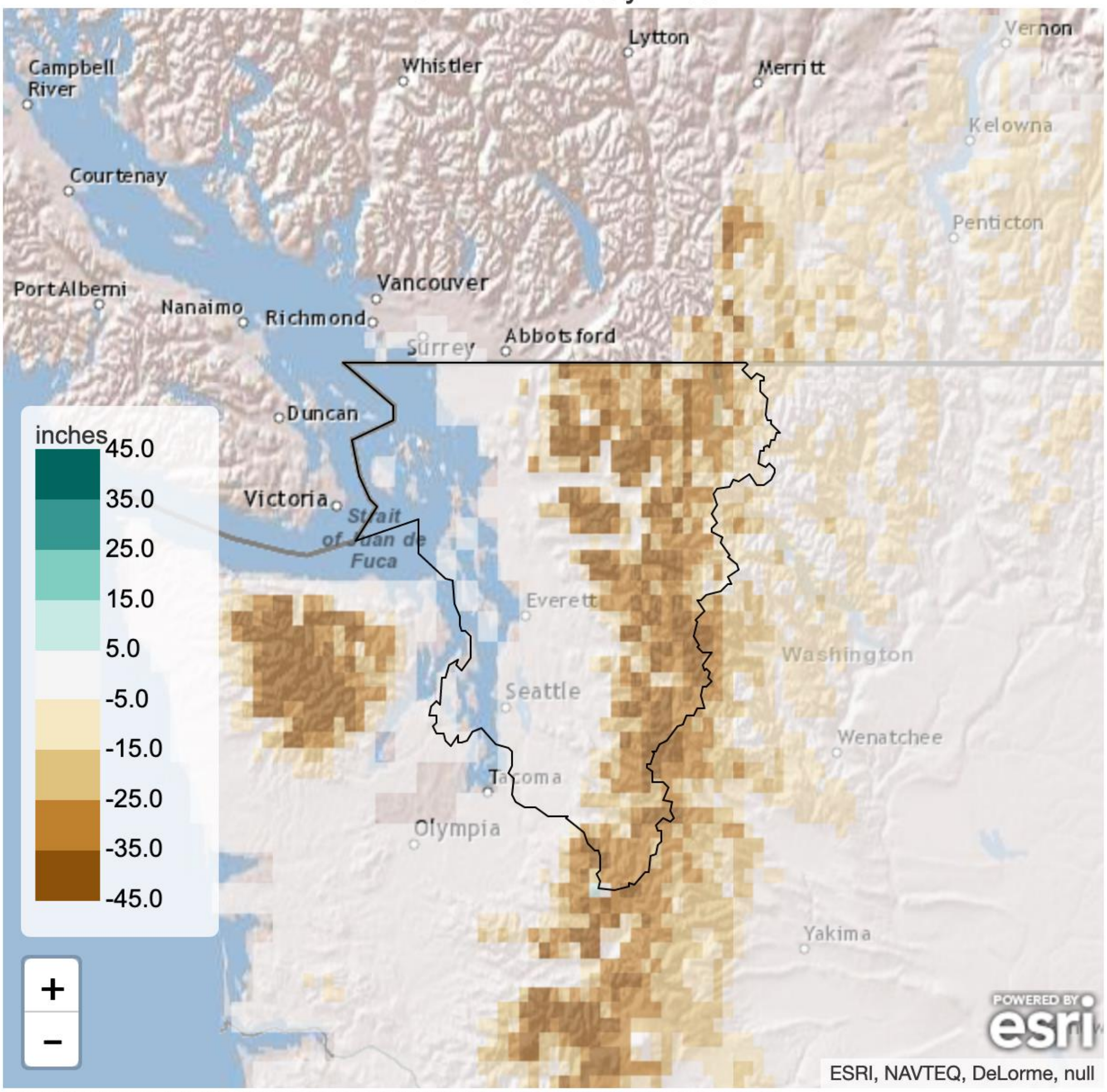
Appendix A. Figures and Tables

Projected Change in Apr. 1st Average Snow Water Equivalent
2070-2099 (Higher Emissions (RCP 8.5)) vs. 1971-2000 (Historical)
Point Elliot Treaty Area



Tribal Climate Tool, NW Climate Toolbox, Data: VIC-MACAv2-LIVNEH, RCP 8.5, 10-Model Mean

Figure 1. Projected change in Apr. 1st average snow water equivalent for the 2080s (2070-2099) over the Point Elliott Treaty Area under a high (RCP 8.5) greenhouse gas scenario, relative to 1971-2000. Figure from the Tribal Climate Tool.

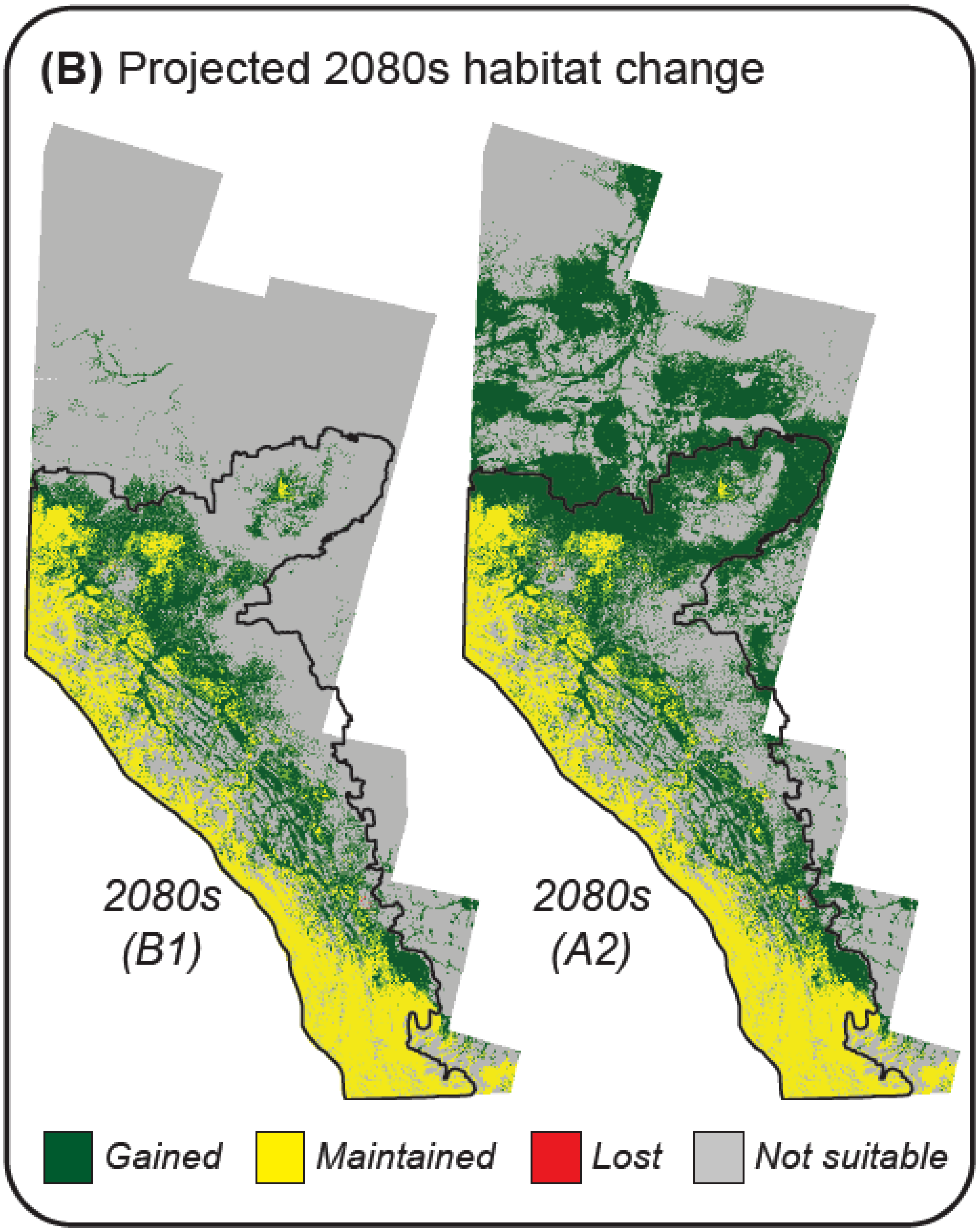


Figure 2. Roberts et al. (2014). Map of projected changes in black huckleberry habitat, showing range gained (absent in 1961-1990 but present in future), range lost (present in 1961-1990 but absent in future), range maintained (present in 1961-1990 and present in future), and not suitable range (absent in 1961-1990 and absent in future). Results for the 2080s are shown for two greenhouse gas scenarios (B1 and A2). Figure from Roberts et al. 2014.

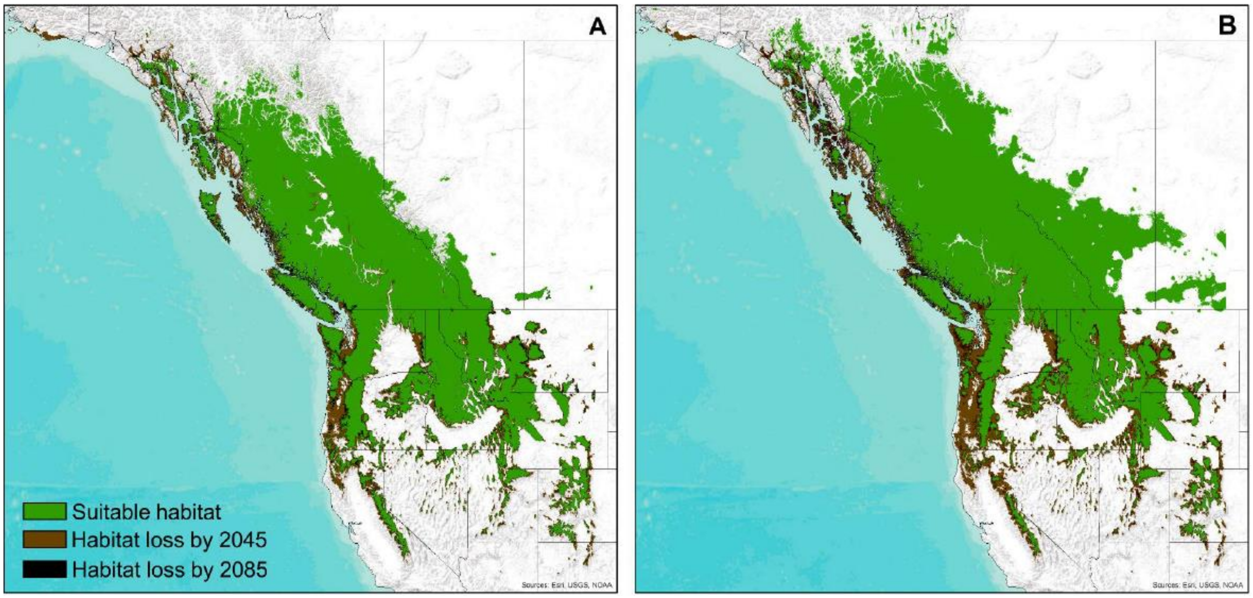


Figure 3. Prevéy et al. (in review). Predicted change in spatial distributions of black huckleberry by the end of the 21st century for the (A) RCP 4.5 and (B) RCP 8.5 greenhouse gas scenario. Figure from Prevéy et al. (in review).

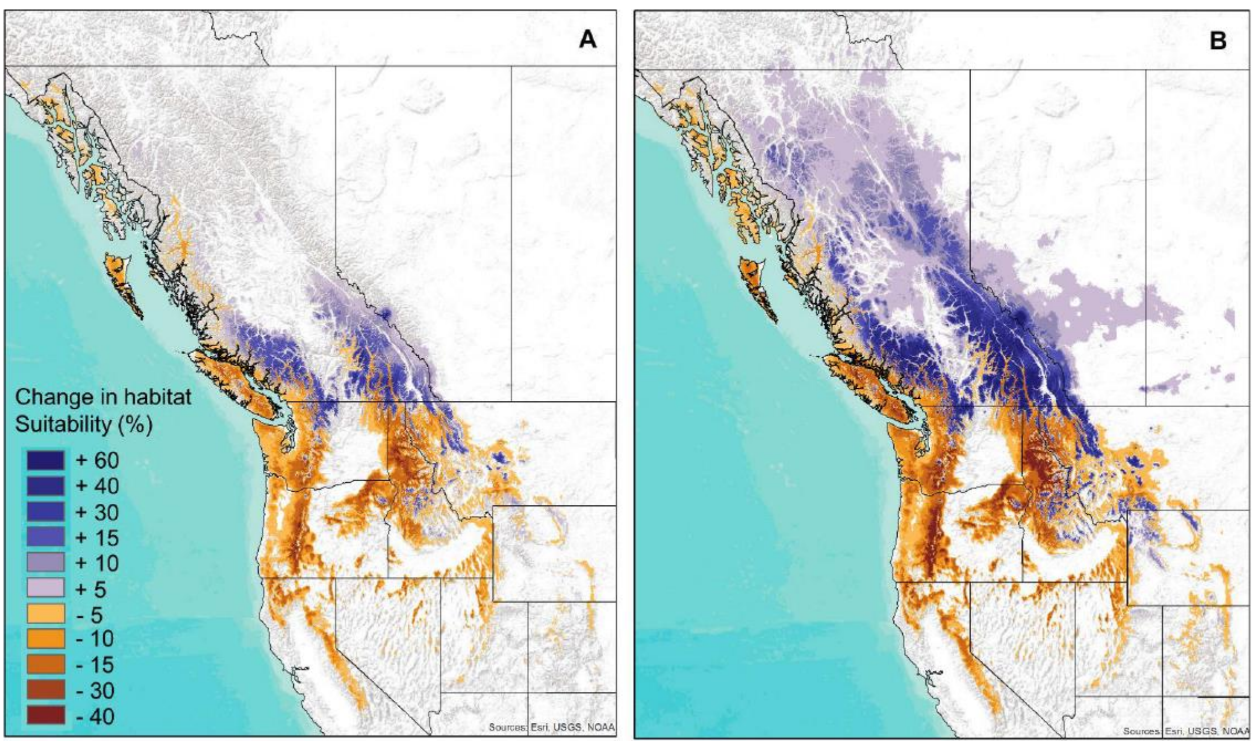


Figure 4. Prevéy et al. (in review). Predicted change in habitat suitability for black huckleberry by the end of the 21st century for the (A) RCP 4.5 and (B) RCP 8.5 greenhouse gas scenarios. Figure from Prevéy et al. (in review).

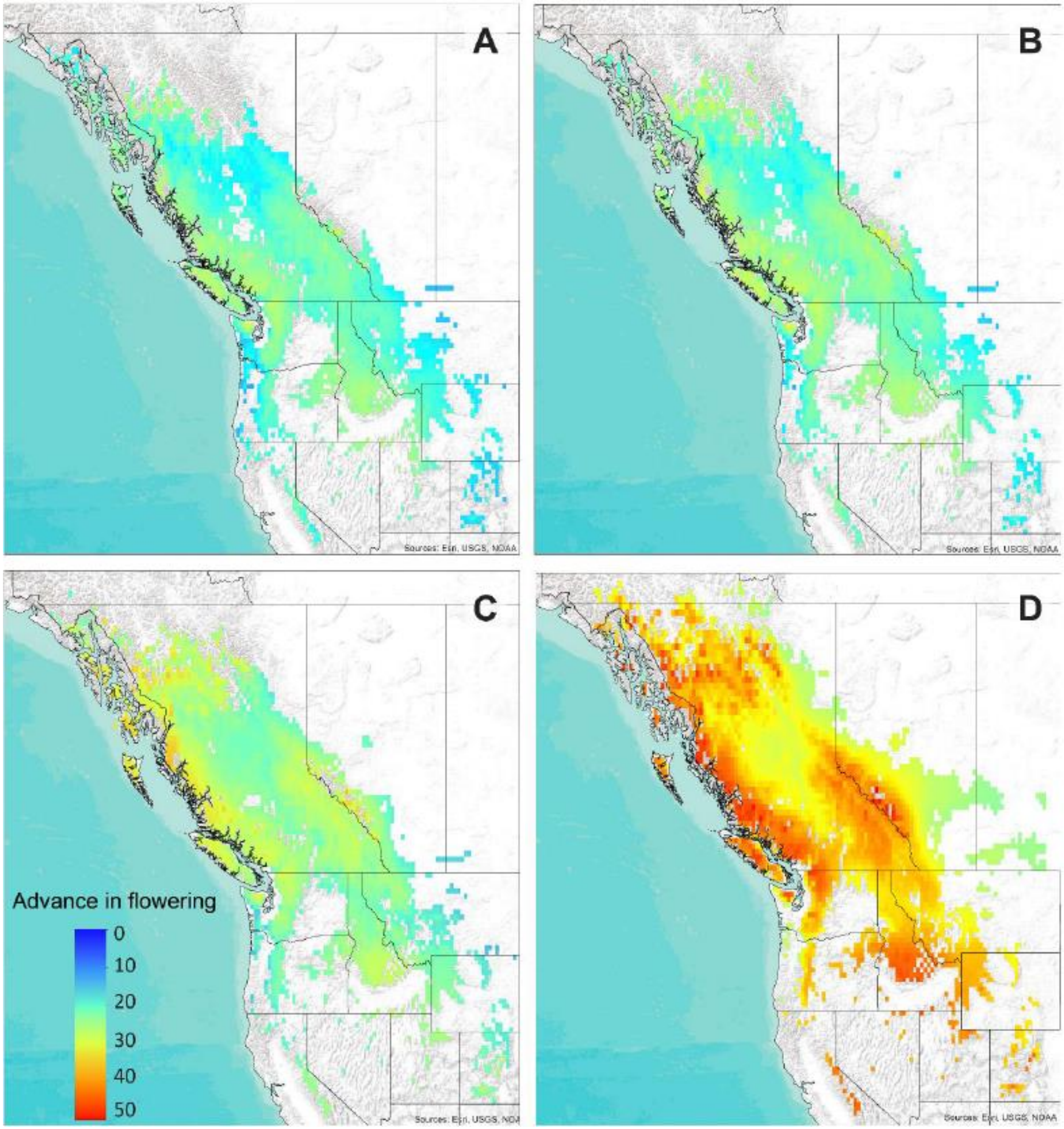


Figure 5. Prevéy et al. (in review). Thermal sum model projections for changes in the day of year of flowering for black huckleberry for two future time periods and climate scenarios: (A) mid-century and RCP 4.5 scenario, (B) end-of-century and RCP 4.5 scenario, (C) mid-century and RCP 8.5 scenario, and (D) end-of-century and RCP 8.5 scenario. Figure from Prevéy et al. (in review).

Appendix B. Conceptual Model of Climate Impacts on Big Huckleberry

We created a conceptual model that summarizes the ecological and climatic drivers of big huckleberry abundance in western Washington. This model can be used to identify intervention points where management action or traditional practices could help reduce climate risks to big huckleberry.

In the model, green arrows indicate a positive correlation between linked drivers or processes (i.e., as variable *x* increases variable *y* increases; orange arrows indicate a negative relationship between variables (i.e., as variable *x* increases, variable *y* decreases); and dashed gray arrows indicate the absence of a directional trend or an area where additional research is needed. Light red boxes are used to highlight human management activities (e.g., forest management or traditional practices) that directly or indirectly influence the abundance of big huckleberry in western Washington.

Conceptual Model of Climate Impacts on Big Huckleberry | swədaʔx̌