Labrador Tea | qʷəlut

Labrador tea (*Rhododendron groenlandicum*), also known as bog Labrador tea or rusty Labrador tea, is a widespread, slow-growing evergreen shrub, typically found west of the Cascades in swamps and bogs at low- to mid-elevations. Feather mosses are frequently found in the understory. Labrador tea produces a large number of small, wind-dispersed seeds (>50 seeds per flower), suggesting it is able to generate a significant seed crop most years (Gucker 2006).

Future changes in climate may present challenges for Labrador tea. Warming air temperatures, earlier snowmelt, declining soil moisture and lower water levels in wetlands and bogs could reduce habitat suitability for the Labrador tea.

We conducted a synthesis of peer-reviewed and gray literature (i.e., reports, previous syntheses, etc.) exploring climate impacts on Labrador tea. Below, we describe key findings from these studies and their implications for Labrador tea distribution, phenology and productivity within the geography of the Treaty of Point Elliott.

Climate-driven Changes To Labrador Tea Distribution

A range of approaches has been developed to model potential changes in the spatial distributions of vegetation communities under future climate scenarios. Below, we describe key findings from available studies predicting future changes in Labrador tea distribution within the geography of the Treaty of Point Elliott. These studies rely on two primary approaches for predicting future changes in vegetation communities: wetland hydrologic models and climatic niche models.

I. Wetland Hydrologic Models

- **Lee et al. (2015)** developed regression models to investigate how projected climate change will affect wetland soil moisture and wetland water levels throughout the Pacific Northwest. Bogs, the primary habitat type of Labrador tea, are a type of wetland that remains moist/wet year-round. The ECHAM5 general circulation model was used with the A1B (moderate) emissions scenario to generate wetland hydrologic projections for the 2040s and 2080s. Results suggest that climate change will cause hydrologic changes in wetlands throughout the Pacific Northwest. For example, perennial wetlands (i.e., wetlands that do not dry out except during extreme droughts) are projected to transition to wetlands that dry out in late summer or fall in low precipitation years, or in some cases may transition to wetlands that dry out very quickly following seasonal rains or spring snowpack melt. Wetlands or bogs located in mixed-rain-and-snow watersheds and snow-dominant watersheds will be most vulnerable to climate-driven hydrological shifts because snowmelt in the spring and summer is the primary water source during these months. Additionally, snowpack throughout the Tulalip Tribe's treaty area is projected to decline throughout the 21st century under a high emissions scenario (Figures 1-2), which would limit the total amount of meltwater available in the late spring and summer. Furthermore, soil moisture is projected to decline throughout the Point Elliott Treaty Area by the end of the century under a high emissions scenario (Figure 3). These projected climate-driven hydrological shifts will reduce water availability for wetlands and likely result in shifts in the distribution of wetlands throughout the region. These changing hydrologic conditions are likely to negatively affect Labrador tea habitat suitability.

II. Climatic Niche Models

Climatic niche models, also known as bioclimatic envelope models, define the climatic conditions within a species' current distribution and then predict where those conditions are expected to occur in the future. This approach is appealingly straightforward yet makes several simplifying assumptions (e.g., that climatic conditions alone determine a species' distribution and that species will be able to disperse to areas of future climatic suitability) that demand caution in interpreting results.

- **Gallego-Sala and Prentice (2013)** used the global bioclimatic model, "PeatStash", to evaluate how climate change is projected to affect the extent and distribution of the blanket peat biome in the 21st century. The blanket peat bog is a very unique biome that can be found along the Pacific coast of Alaska and is often dominated by *Sphagnum* and `bryophytes, along with other species including Labrador tea. The occurrence of the biome is dependent on a permanently high water table and cool summer temperatures, as many *Sphagnum* species within the biome are sensitive to temperature greater than 15°C. PeatStash was run with three bioclimatic variables: (1) climatic moisture index, which is represented as a ratio between annual precipitation and mean annual potential evapotranspiration, and was selected because the biome requires sufficient moisture throughout the year; (2) mean annual temperature (specifically, areas with a mean annual temperature greater than -1°C), which was selected because this biome is not associated with permafrost; and (3) mean temperature of the warmest month, which was selected because high summer temperatures can damage *Sphagnum.* The model was run for the 2080s (2070-2099) under the A1B (moderate) emissions scenario for eight global climate models. Results from the model predict that the blanket bog biome along the western coast of North America is projected to decline by more than 50% (Figure 4). The primary driver of the projected decline in the blanket bog biome is warming temperatures, which affect the biome directly via hotter summer months and indirectly via reduced moisture availability.

Synthesis & Key Conclusions

- Projected reductions in soil moisture and water availability suggest that Labrador tea is likely to be negatively affected by future hydrologic changes in the Northwest.
- For Labrador tea growing in swamps and bogs at mid-elevations, projected declines in winter snowpack and advances in spring snowpack melt are likely to negatively affect Labrador tea due to reductions in moisture availability during dry summer months.

Opportunities and Considerations for Applying Results

- *Supporting Climate Adaptation:* While results of available spatial models are too coarse to be used to identify specific swamps or bogs to prioritize for adaptation actions supporting Labrador tea, they are nonetheless useful for understanding how and where (more generally) the species may be affected by changing climatic conditions. For example, model results suggest that management actions aimed at maintaining the hydroperiod and water supply for bogs and wetlands where Labrador tea is found may help support populations under drier future conditions.
- *Identify future research needs*: Limitations of existing models suggest that future research is needed to create higher resolution spatial models of projected changes in climatic variables relevant to Labrador tea, or, preferably, climatic niche models or mechanistic models that predict future areas of Labrador tea suitable habitat within the area of interest. Such models would be useful in identifying and prioritizing specific bogs and swamps for active management, restoration and protection of Labrador tea.
- *Integration with local knowledge:* Application of results will be most effective if combined with the local knowledge and expertise of Tribal scientists and

knowledge keepers. For example, knowledge of the location of Labrador tea populations in swamps or bogs that may be more resilient to climate change due to micro-climatic conditions that may help maintain hydroperiod could be used to prioritize those habitats for protection or restoration.

References:

Dieleman, C.M., Branfireun, B.A., McLaughlin, J.W., Lindo, Z. 2015. Climate change drives a shift in peatland ecosystem plant community: Implications for ecosystem function and stability. *Global Change Biology* 21, 388-395. doi: 10.1111/gcb.12643

Gallego-Sala, A., Colin Prentice, I. 2013. Blanket peat biome endangered by climate change. *Nature Clim Change* **3,** 152–155. doi:10.1038/nclimate1672

Gucker, Corey L. 2006. *Ledum groenlandicum*. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: https://www.fs.fed.us/database/feis/plants/shrub/ledgro/all.html [2020, January 5].

Lee S-Y, Ryan ME, Hamlet AF, Palen WJ, Lawler JJ, Halabisky M. 2015. Projecting the Hydrologic Impacts of Climate Change on Montane Wetlands. PLoS ONE 10(9): e0136385. doi:10.1371/journal.pone.0136385

Appendix A. Figures and Tables.

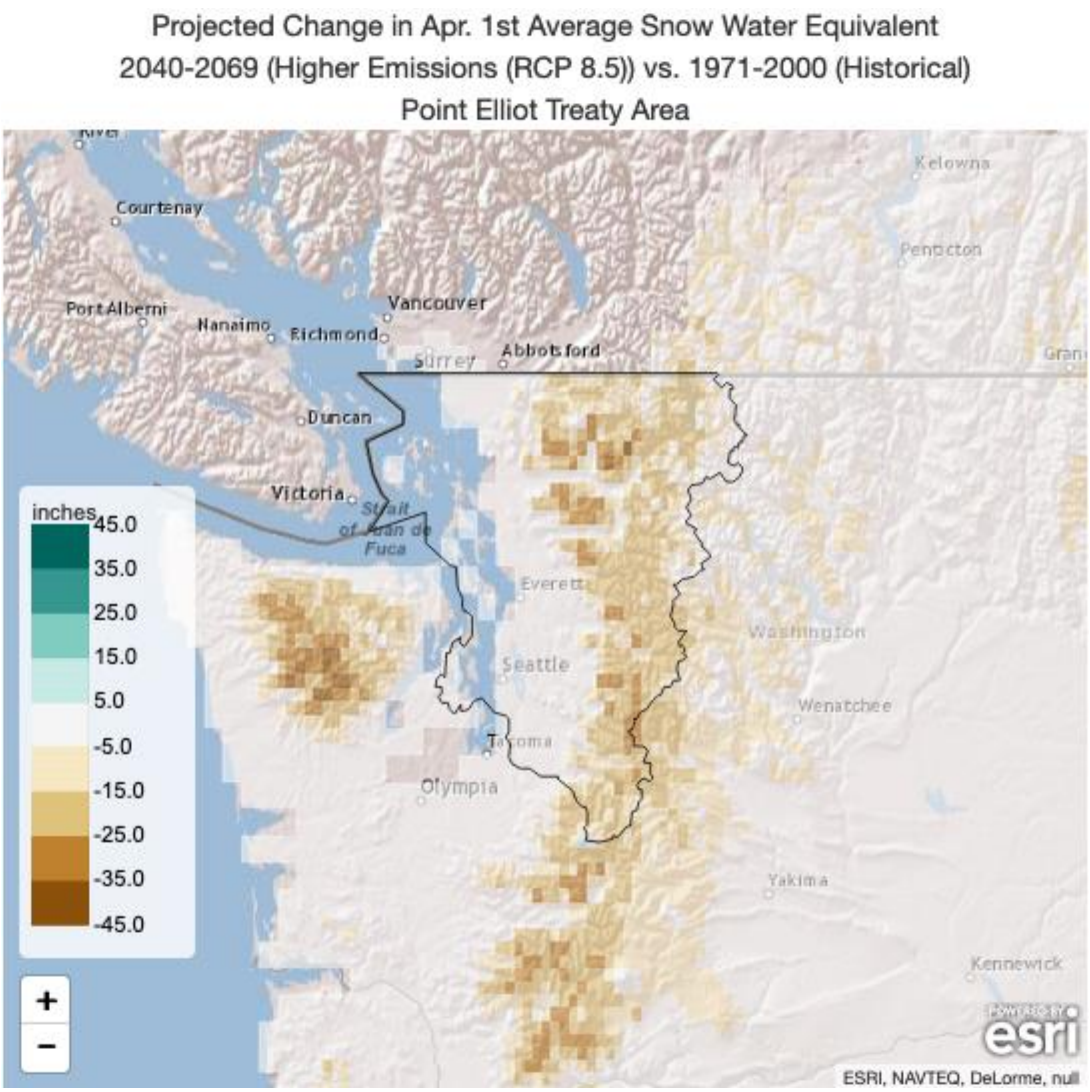

Figure 1. Projected change in Apr. 1 average snow water equivalent for the 2050s (2040-2069) over the Point Elliott Treaty Area under a high (RCP 8.5) greenhouse gas scenario, relative to 1971-2000. Figure from the Tribal Climate Tool.

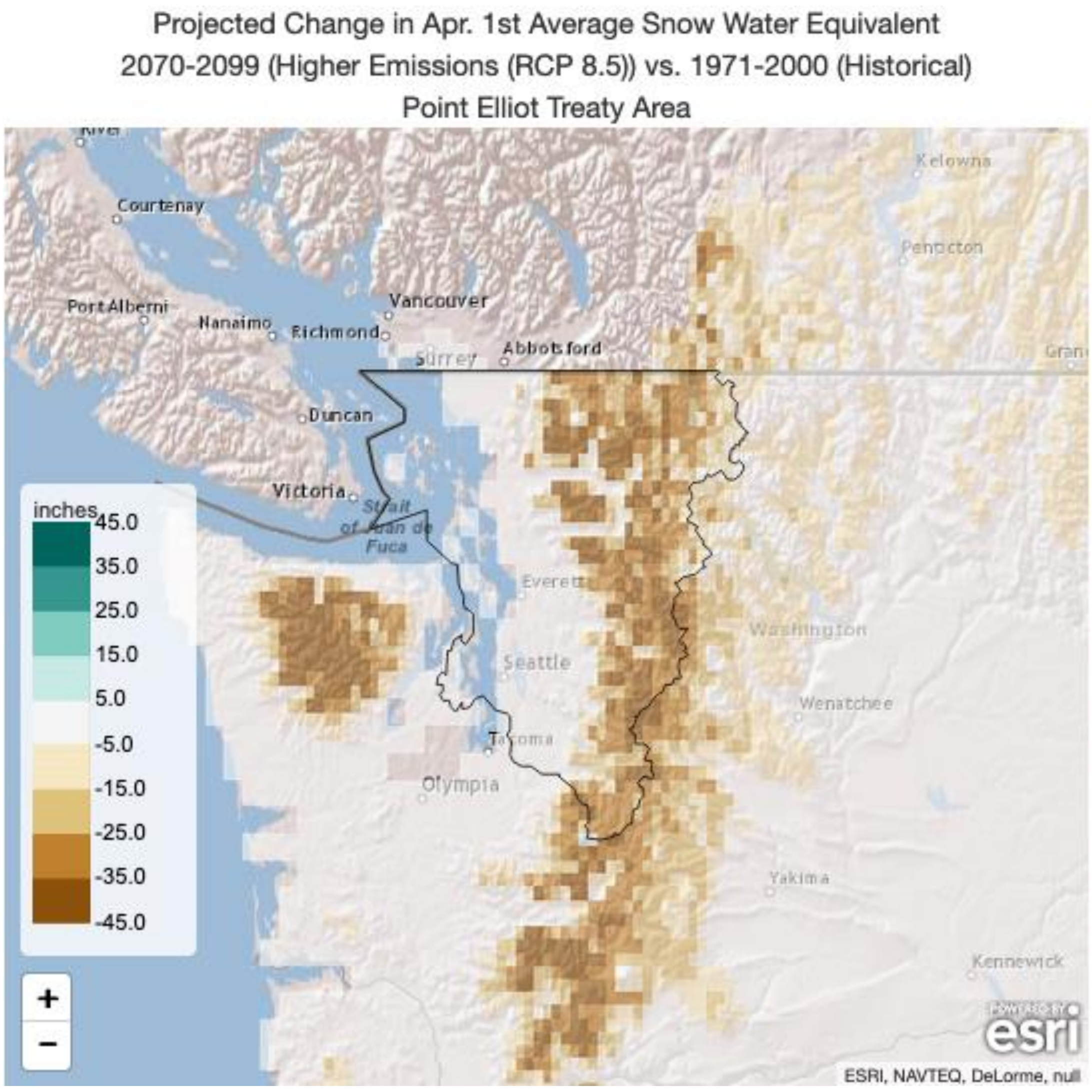

Figure 2. Projected change in Apr. 1 average snow water equivalent for the 2080s (2070-2099) over the Point Elliott Treaty Area under a high (RCP 8.5) greenhouse gas scenario, relative to 1971-2000. Figure from the Tribal Climate Tool.

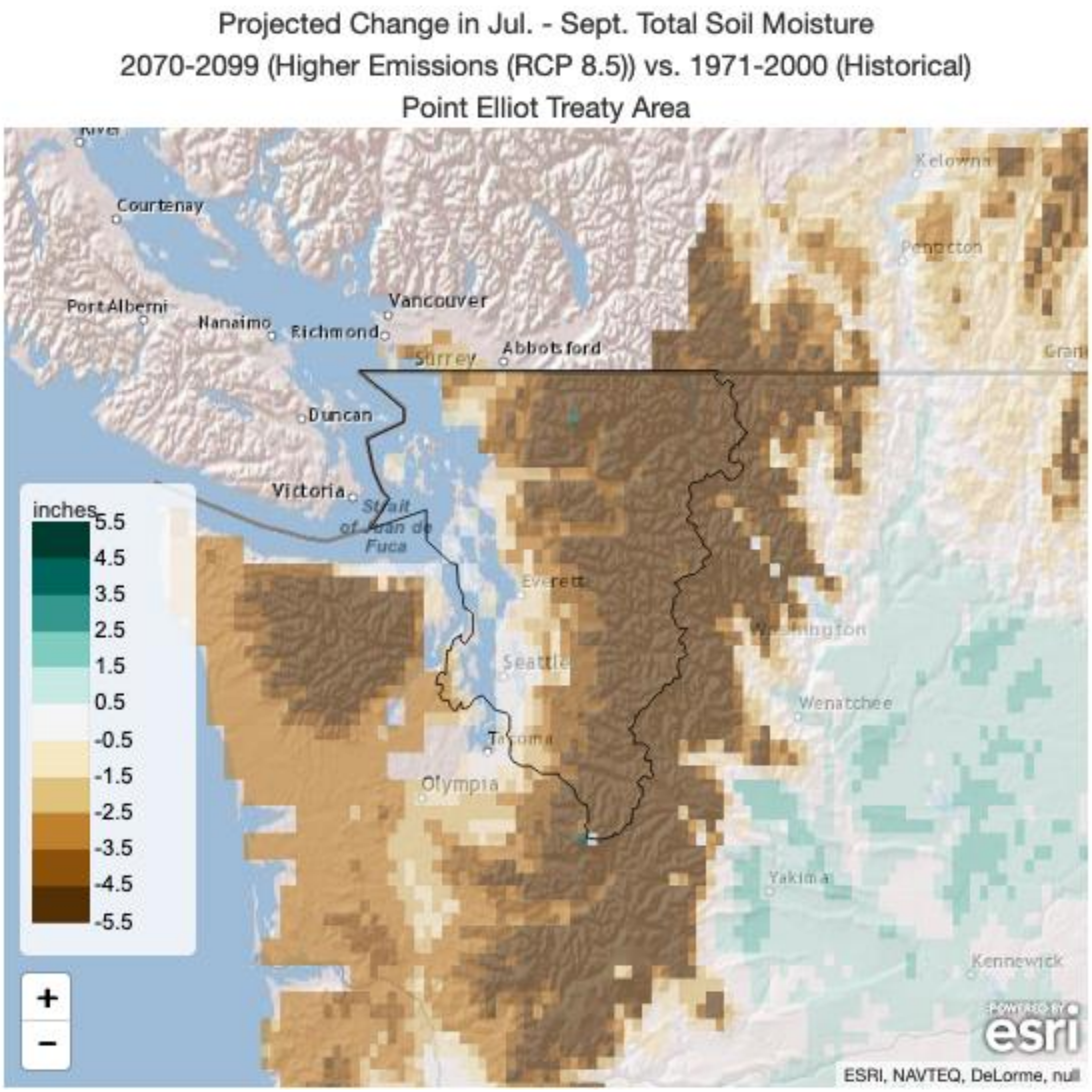

Figure 3. Projected change in July-September soil moisture for the 2080s (2070-2099) over the Point Elliott Treaty Area under a high (RCP 8.5) greenhouse gas scenario, relative to 1971-2000. Figure from the Tribal Climate Tool.

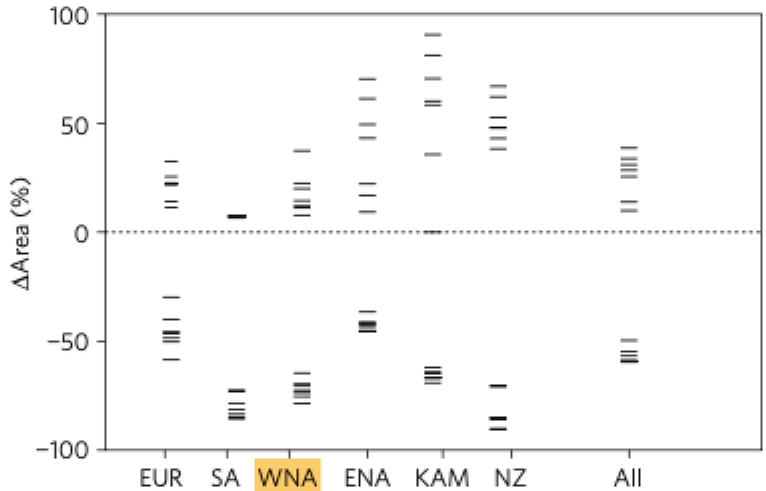

Figure 4. Projected changes in blanket bog potential area for the 2080s for Europe (EUR); South America (SA); western coast of North America (WNA); eastern coast of North America (ENA); Kamchatka, Hokkaido and the Bering Strait (KAM); New Zealand's South Island and Tasmania (NZ), from Gallego-Sala and Prentice (2013). These regions have a range of different surface areas; changes are shown as percentages of present area.

Appendix B. Conceptual Model of Climate Impacts on Labrador Tea

We created a conceptual model that summarizes the ecological and climatic drivers of Labrador tea 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 Labrador tea.

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 Labrador tea in western Washington.

Conceptual Model of Climate Impacts on Labrador Tea | qʷəlut