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## Hindcasting Climatic Water Balance Scenarios in the Clearwater Refugium

**Bridget Guildner**

The Clearwater-Nez Perce Forest functioned as a refuge for a variety of herbaceous and amphibian species through the Last Glacial Maximum (Gavin 2009, Brunsfeld et al. 2007, Brunsfeld and Sullivan 2005). This refugium has been suggested as a possible explanation for the disjunct ranges of inland wetbelt tree species such as Western redcedar (*Thuja plicata*) and mountain hemlock (*Tsuga mertensiana*): while these species may have migrated from the coast following warming, they could also have persisted in glacial refugia, or areas where the local climate decoupled from glacial regional climate enough to allow survival (Gavin 2009, Bjork 2010). Answering this question requires combining multiple lines of evidence, including reconstructing glacial climate and potential historical species distributions.

Evaluating the plausibility of refugia used by tree species requires examination of the bioclimatic factors that drive tree establishment and survival: water availability and temperature. Based solely on minimum temperatures, hindcasted climate scenarios suggest that tree seedling establishment and survival would have been unlikely in the Clearwater region (Gavin et al. 2014). However, focusing solely on minimum temperatures ignores the potential importance of water as a limiting factor; the water balance has been demonstrated to be a key driver in other reconstructions of glacial refugia (de LaFontaine et al. 2014), and water availability could have been sufficient to support trees in the valley bottoms of the Clearwater.

To examine climatic water balance in the Clearwater refugium since the Last Glacial Maximum for these key inland wetbelt tree species, I used a simple water balance model (Stephenson 1990, Dobrowski et al. 2013) with monthly temperature, relative humidity, precipitation, wind, and soil data as inputs. The model accounts for evaporative demand and soil storage and snowmelt dynamics. Fine-scale climate inputs for this model will be obtained from TopoWX (Oyler et al. 2014) and PRISM (Daly et al. 1994).

To hindcast the climatic water balance at 6,000 years ago (6kya) and 17,000 years ago (17kya), I used broad-scale global climate model reconstructions for those periods from the Paleoclimate Model Intercomparison Project (PMIP) (Braconnot et al. 2007) and compared those climate reconstructions to current climate conditions to generate a set of climate anomalies for

each time period. Anomalies were applied to current-day fine-scale climate inputs to generate plausible climate scenarios at 6kya and the LGM. These hindcasted climate scenarios were used as inputs to the water balance model to generate a range of possible water balance scenarios at 6kya and 17kya. Finally, I compared the water balance scenarios against juvenile niche models built from Forest Inventory Analysis plot data to determine whether conditions could have allowed the survival and establishment of western redcedar and mountain hemlock seedlings at 6kya and LGM. Work is in progress, and preliminary results will be presented.

This analysis will provide evidence about the historical biogeographical conditions that led to the disjunct ranges of key inland wetbelt trees, but may also shed light on important drivers of future climate change refugia.

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