By Tongli Wang, PhD

Projecting Future Climatic Habitats for Red Alder Under Climate Change in British Columbia

Red alder grows along the entire coast of British Columbia in humid to superhumid climates. The main limits to its growth are low winter temperatures and lack of precipitation during the growing season. We think that the geographical range of suitable climate for red alder, also known as its bioclimate envelope, will expand in BC as the climate changes.

We developed projections of alder ranges with a niche-based bioclimate envelope model (BEM). To develop a bioclimate envelope model, we needed the following things:

1. Species present-absent data (where the trees grow and where they don't) to represent the realized climatic niche of the species.
2. High-resolution climate data that reflect the detail climate conditions where the species is present or absent.
3. A powerful modelling approach that can effectively capture the relationship between the species occurrence and climate variables.

Species Present-Absent Data

In developing the BEM for red alder, species-range-wide present-absent data were collected from the ecological plot data from BC Ministry of Minister of Forests, Lands and Natural Resource Operations (through Dr. Elizabeth Campbell) and the Forest Inventory and Analysis (FIA) data from the United States. In total, we collected present/absent data for tree species from over 35,000 plots.

High-Resolution Climate Data

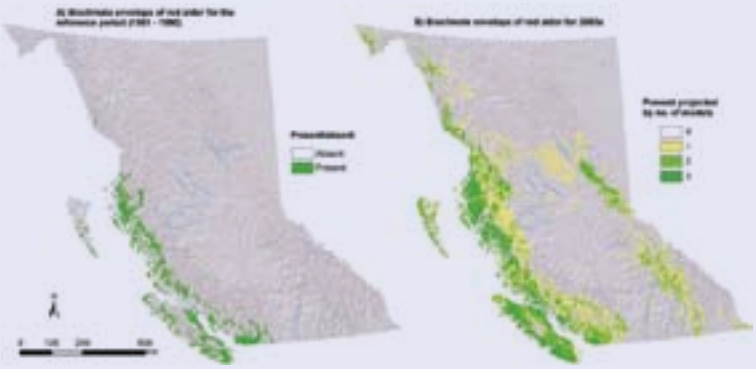
High-resolution climate variables were generated using ClimateWNA (previously ClimateBC) (Wang et al. in press). ClimateWNA provides scale-free climate data for 85 climate variables. Climate variable include things such as growing degree-day, frost-free period, and extreme minimum temperature, etc.

ClimateWNA also generates historical and future climate data in the same model and provides easy access to over 20,000 climate surfaces. The climate variables for 1961-1990 normal period were used to develop the bioclimate envelop model, while the climate data for future periods (2080s) were used to project the future geographic distributions of the bioclimate envelope for this species.

For projecting the bioclimate envelopes for future periods, we chose three climate change scenarios from the IPCC Forth Assessments recommended by Spittlehouse and Murdock (Spittlehouse and Murdock 2010), including the CGCM3 A2 run4, HadCM3 B1 run1 and HadGEM1 A1B run1.

A Powerful Modelling Approach

Random Forests (Breiman 2001), a machine-learning ensemble classifier and one of the most powerful modeling methods, was used to capture the species-climate relationships and to develop the bioclimate envelope model. The mismatch rate estimated with an independent out-of-bag dataset was only 8.5%, suggesting that the bioclimate envelope representing the realized climatic niche of red alder (Figure 1A) can be accurately predicted by the Random Forest model using climate variables as predictors.



After the model was built, we used the three selected climate change scenarios to project bioclimate envelopes for 2080s. In order to have a general view about the climate change impact, projections for the three climate change scenarios are integrated into a single map (Figure 1B). We found that the bioclimate envelope for red alder would substantially expand northward along the coast and towards the Interior—although the range of the expansion varies among climate change scenarios. In any case, the area suitable for planting red alder in British Columbia may increase substantially in the future due to climate change.

In terms of range expansion for red alder, our projections agree with Hamann and Wang's (2006) projections in general. However, our new projections show more range expansion into the Interior. The BEM developed in the previous study was based on the Biogeoclimatic Ecosystem Classifications (BEC) using discriminant statistical analysis method and the projections were based on a mid-road climate change scenario (CGCM2 A2x) from IPCC Third Assessments. We expect that projections based on the new BEM built using Random Forest with the plot data, together with the three climate change scenarios from IPCC Fourth Assessments will provide more reliable projections.

However, uncertainties about the future climate remain a challenge in both projecting future changes and applications of these projections in forest resource management. We are in process of applying a consensus projecting method to generate consensus maps for BC ecosystems and forest tree species through integration of multiple projections based on a large number of climate change scenarios.

Tongli Wang, PhD, is a forest geneticist and Associate Director at the Centre for Forest Conservation Genetics at the Department of Forest Sciences, University of British Columbia. He received his Masters and Doctoral degrees at the University of Helsinki, Finland in 1992 and 1996.

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