Spatial patterns of phenotypic variation in interior spruce and lodgepole pine

Katharina Liepe1; Andreas Hamann1; Sally Aitken2
1. Department of Renewable Resources, University of Alberta, Edmonton; 2. Department of Forest Sciences, University of British Columbia, Vancouver
contact: liepe@ualberta.ca

Introduction
In western Canada, both interior spruce (Picea glauca × Picea engelmannii) and lodgepole pine (Pinus contorta) are highly valued timber species that provide enough resources to support a strong forest industry. Subsequently to harvest 150 million seedlings are planted in British Columbia (BC) and Alberta1 (AB). However, changes in climate are impacting the environments to which populations are currently adapted, especially those at higher latitudes are expected to experience increases in temperature3. This could decrease forest productivity and threaten forest health; examples of this are already observed in large outbreaks and a spread of mountain pine beetle over the Rocky Mountains and into AB due to warmer winter temperatures2; the disease dothistroma needle blight causes defoliation and mortality due to warmer and wetter conditions in BC4, whereas lower precipitation causes spruce dieback in AB.

Project objective
This research investigates phenotypic variation to examine the relation of adaptive characteristics with climatic conditions and determine the spatial distribution of populations having similar phenotypes. The results will support the development of forest management strategies to match reforestation stock with predicted future environments.

Preliminary results
The MRT with continuous climate variables, exemplary shown for interior spruce (a), partitions the whole dataset into six groups. They can be identified from left to right as boreal plains with the lowest cold injury and therefore highest cold hardiness; montane AB; two groups including sub-boreal ecosystems and AB’s foothills; and finally the interior mountains and the interior valleys with best growth.

Using categorical ecovariants as predictor, interior spruce (b) split in 11 groups of similar phenotypic expression. The Rocky Mountains separate cold hardy populations (low injury) in the east from frost susceptible ones (high injury) in the west. Best growth was observed in the interior valleys. Montane areas (5,6,8) generally show a shorter growing season which leads to poor growth. Sub-boreal populations in BC show intermediate characteristics.

Lodgepole pine (c) mostly follows a similar trend in its phenotypic expression, however there is an unexpected variation with a group of extremly frost hardy and simultaneously good growing populations in Alberta’s dry mixed wood region. The small group of shore pine populations in coastal BC breaks buds really late, the entire growing season is shortened and starting much later.

References

Acknowledgements:

Figure Captions
Introduction
1. Interior spruce - partition by ecovariants
2. Lodgepole pine - partition by ecovariants
3. Project objective
4. Preliminary results
Methods
a) Seed sources
b) Common garden experiment
1. Montana AB
2. Lower Boreal Highlands AB
3. Dry Mixed Wood AB
4. Sub-boreal
5. Sub-boreal
6. Interior Valleys
7. Coastal BC

Analysis
1. MAT 1°C
2. MAT 6°C
3. MAT 11°C
4. MAT 11°C dry
5. Climate
6. Ecosystem classification
7. Response variables
8. Predictor variables
Multivariate regression tree analysis (MRT)
Spatial projection

In the west. Best growth was observed in the interior valleys. Montane areas (5,6,8) generally show a shorter growing season which leads to poor growth. Sub-boreal populations in BC show intermediate characteristics.

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