Hamann Lab

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Modeling ecosystem migration across North America in the era of climate change

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Introduction

Climate change poses an unprecedented challenge to the stability and equilibrium of forests worldwide. Proposed climate adaptation strategies center around actively moving seed sources to adapt to climate change and preserve ecological function. This climate change intervention is called assisted migration. The first step in assisted migration is predicting how tree species should move to adapt to the changing climate. Current known distributions of ecosystems and climate data can be utilized to create climate envelope models. With the aid of climate change projections, envelope models can be used to predict how ecosystem climates will shift under different climate scenarios. For this project I created an envelope mode for all the ecosystems in North America and analyzed the predicted ecosystem shifts under future climate predictions. This model is a great starting place for assisted migration projects, however it is important to clarify that it only considers climate variables; so these findings should be verified by field work before policy or management decision making takes place.

Methods

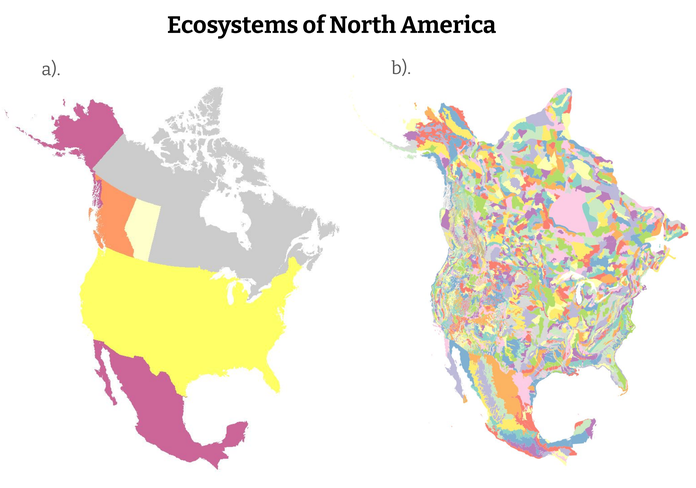

Figure 1 a). Ecosystem datasets I combined (level four ecoregions in the continuous US, Ecodistricts in Ca, level three ecoregions in Alaska and Mexico, the seed zones of Alberta and the ecozones of BC b). The smallest granularity of ecosystem classification for all of North America (2051 ecosystems total) and the target variable for the model. Note: the ecosystems in Alaska and Mexico have a lower level of detail

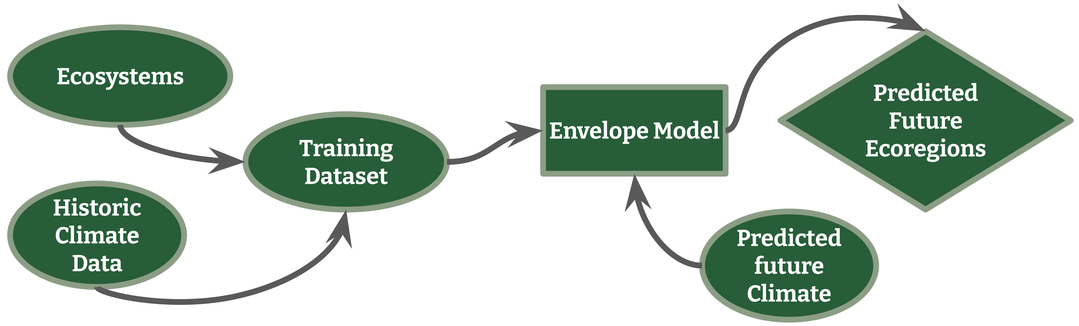

Figure 2. Flow chart of data and model development. Note: the ecosystems are the target variabel and the climate data is the training data or predictor variables

Modeling

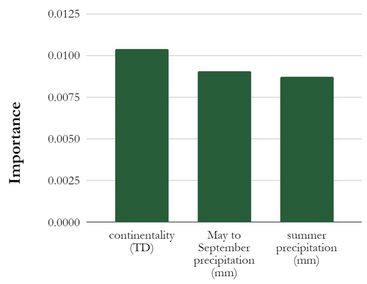

Figure 3. RF model's features with the highest importance

Model	Accuracy	Data transformations
LDA	61%	Balanced, Standardized
RF	70%	Balanced
Neural Network	63.6%	Balanced, Standardized

Figure 4. Models tested and the transformations performed on the data

Predictions

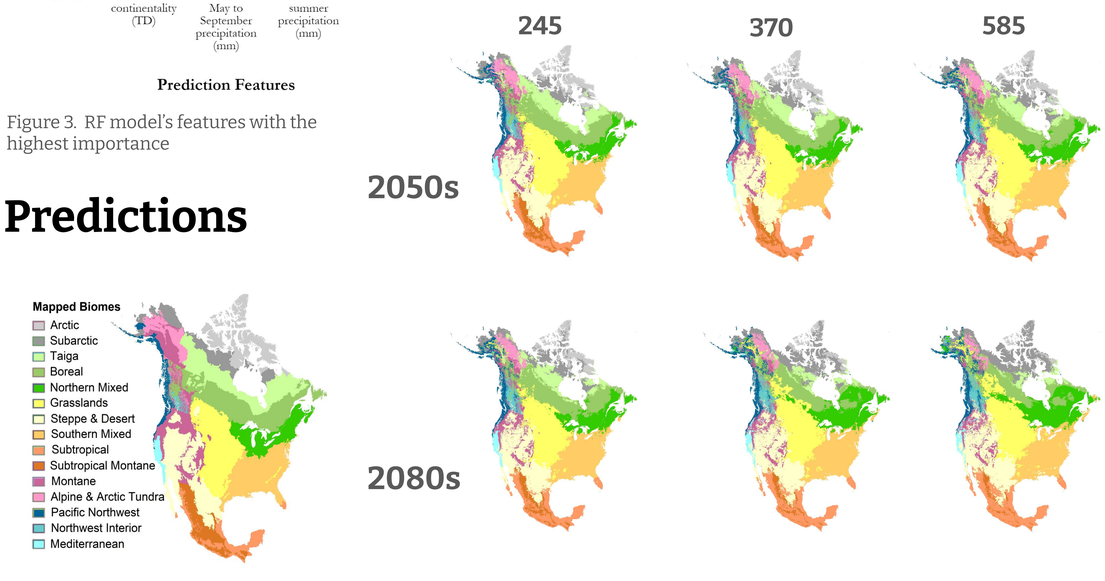

Figure 5. Diagrams of how the RF model predicts ecosystems to shift across North America for different time frames and shared socioeconomic pathways

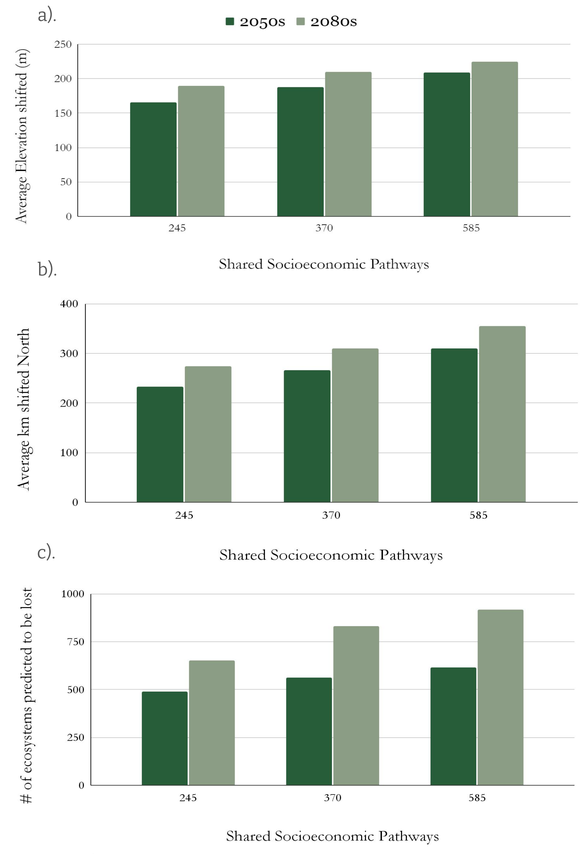

Figure 6. a). The original number of ecosystems minus the number of predicted ecosystems for each predicted climate. Both b). and c). Were calculated by taking the average for each ecosystem and subtracting the average for the historic ecosystem.

Next Steps

- Create a website to expose the models results to a broader audience
- Verify envelope models with experiments in the field

Acknowledgments

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Mahony, C. R., Wang, T., Hamann, A., & Cannon, A. J. (2022). A global climate model ensemble for downscaled monthly climate normals over North America. International Journal of Climatology, 42(11), 5871-5891.