Individual-Based Modeling to Understand Climate Impacts on Aspen Parklands

Science

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ABSTRACT

SCIENCE

Using Individual-Based Modeling to Understand Future Climate Impacts on Canadian Aspen Parklands

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The Aspen Parklands Ecoregion of western Canada is a transitional biome between the Prairie and Boreal Transition Ecoregions, and is experiencing shifting vegetation dynamics at an alarming rate, brought on by climate change. This ABoVE-funded research utilizes an individual-based forest model (SIBBORK-TTE) and remote sensing to investigate the effects of changing climatic conditions on the region. The Parklands have experienced recent severe droughts (1980s, early 2000s), immediately followed by increasing tent caterpillar outbreaks, resulting in weakening stands and inviting secondary damage by wood boring insects and fungal pathogens. Studies have shown that the climate in this region is shifting toward being increasingly limited by moisture. The region experiences earlier springs thus increasing productivity earlier in the year, which tends to result in drought stress and lower productivity later in the year. Using the Climate Impacts on Productivity and Health of Aspen (CIPHA) dataset collected by the Canadian Forest Service, we parameterized and tested the SIBBORK-TTE model for Aspen Parklands. We then updated specific plant and stressor parameters at individual CIPHA nodestands and simulated CMIP6 future climate scenarios. Here we present results of initial model testing, subsequent statistical analysis conducted on model output after adjusting stress and mortality functions, and future climate scenario impacts. Our study indicates that shifting seasonality and climate are increasingly impacting Aspen Parklands and highlights the use of individual-based gap models for investigating complex feedback relating to drought, mortality and climate.

INTRODUCTION & BACKGROUND

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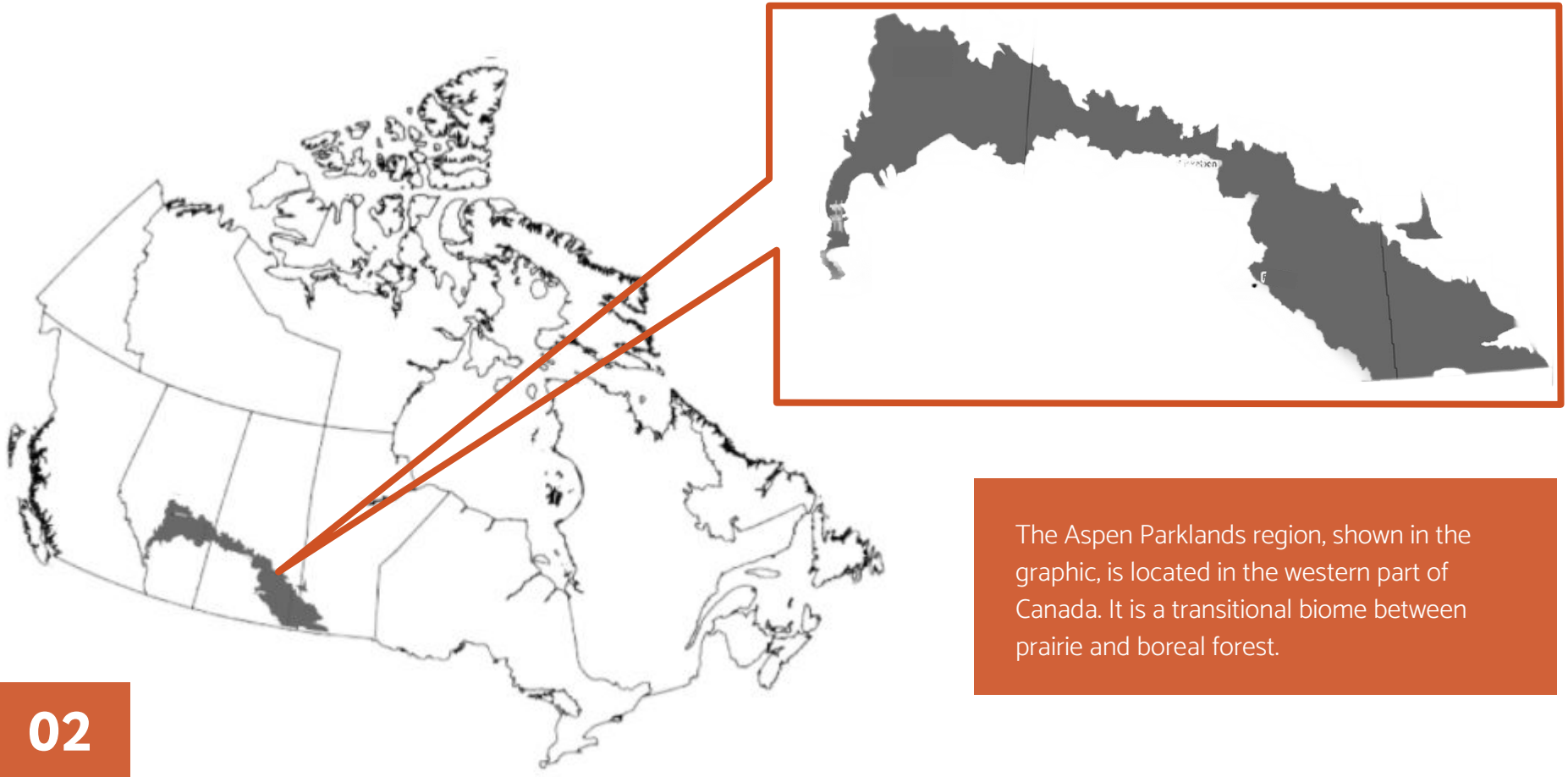
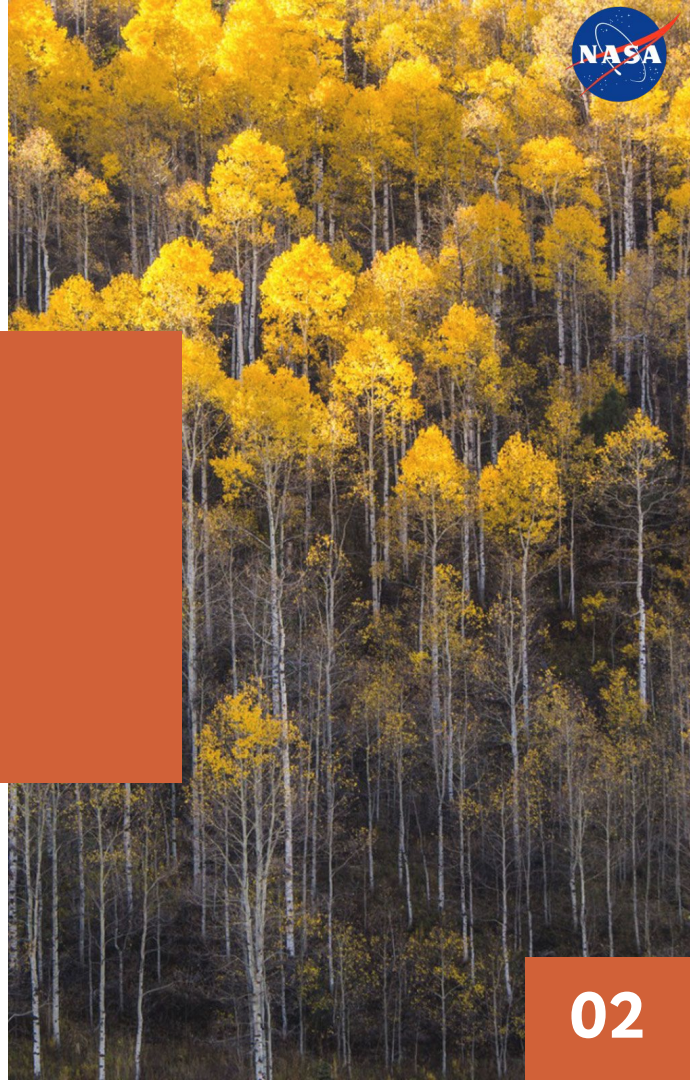
INTRODUCTION



The Aspen Parklands region, shown in the graphic, is located in the western part of Canada. It is a transitional biome between prairie and boreal forest.

BACKGROUND

The Aspen Parklands ecoregion is experiencing shifting vegetation dynamics at an alarming rate, due to climate change. Using the SIBBORK-TTE individual-based forest model and remote sensing, we are looking to investigate the effects of climate change on the region.



HYPOTHESIS

The shifting climate is increasingly affecting the Aspen Parklands region, which highlights the use of individual-based gap models for investigating complex feedback relating to drought, mortality and climate.

METHODS & APPROACH

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METHODS AND APPROACH

GATHER DATA

Data has been collected from various sources including the Canadian Forest Service, which is used for model calibration and model verification.

CALIBRATE MODEL

The data collected is used to calibrate model parameters to accurately represent the Aspen Parklands region and the tree species within.

ANALYZE OUTPUT

The model produces output that is able to be analyzed and studied to determine results.

DETERMINE RESULTS

The model output is compared with the data collected to determine the accuracy of the model run.

MODEL CALIBRATION

EVALUATING DATA

Taking a look at the data from the Canadian Forest Service and evaluating the distribution of the species in the region.

CALCULATING DISTRIBUTION

Calculating the distribution of species in the region to be used in the model's calibration.

APPLYING TO MODEL

Applying the calculations to calibrate the model within species' "dictionaries".

RESULTS

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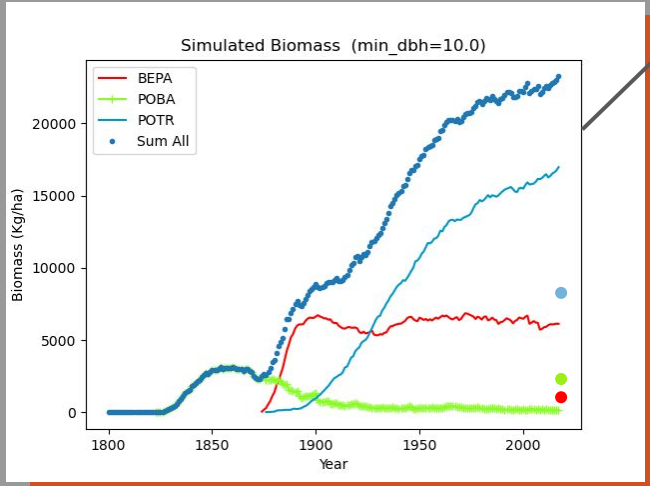
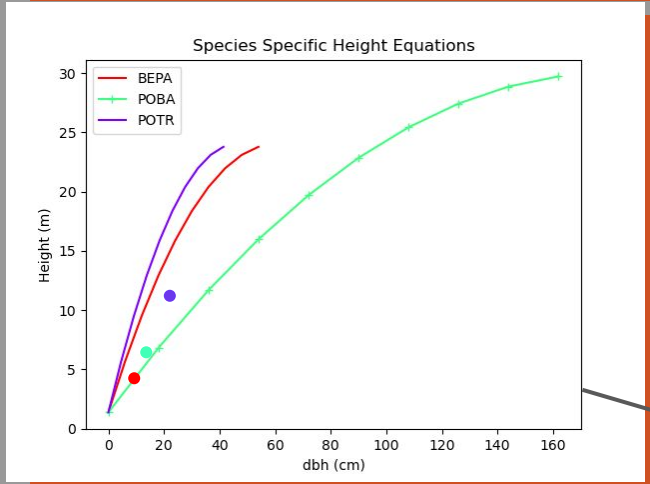
BAT1-2 SITE

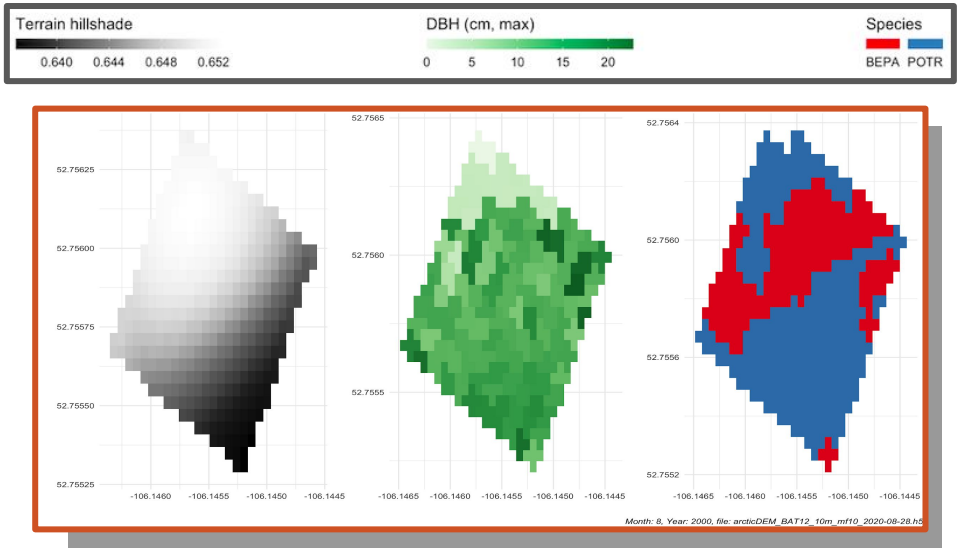
RESULTS



Model-simulated biomass (in kg/hectare) for each species; colored dots represent mean biomass from CIPHA data.

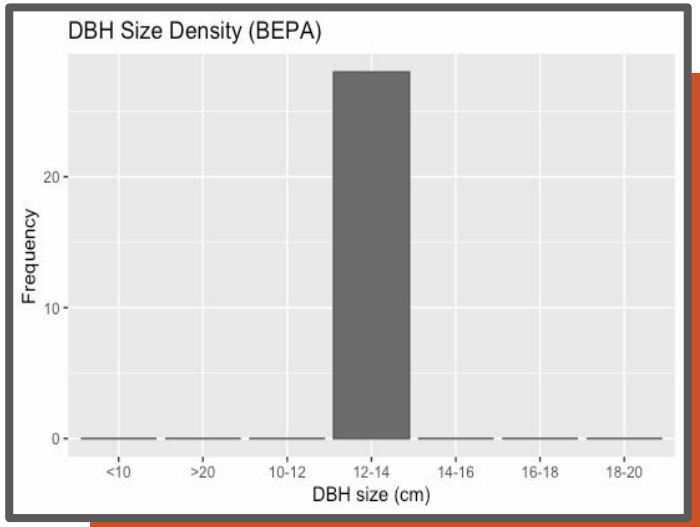


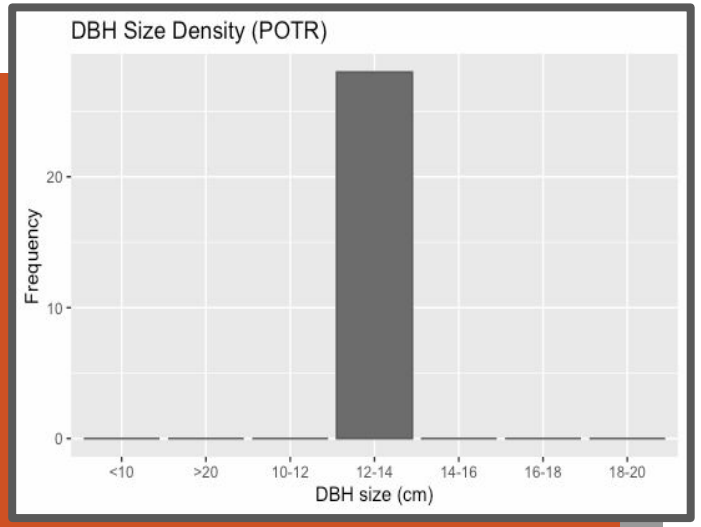
Height vs. DBH curves of each species from model; dots represent mean overall height and DBH of each species, from CIPHA.

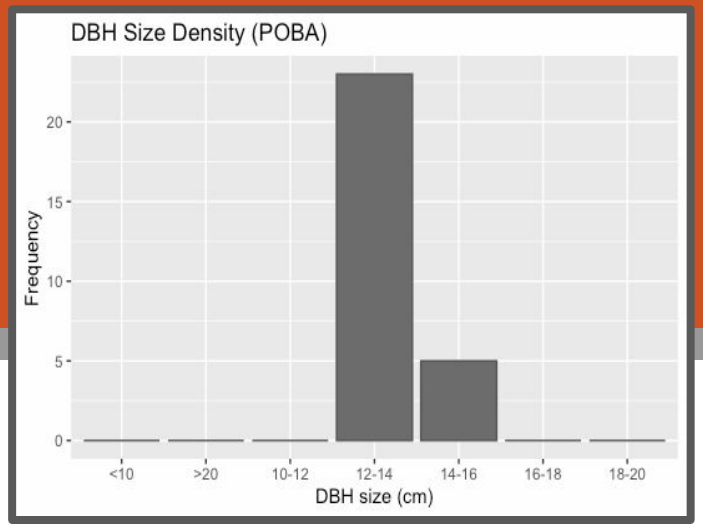


Spatial maps (year 2000) showing geographical spread of terrain (left) and species locations (right), and trees with largest and smallest DBH sizes (center).

RESULTS







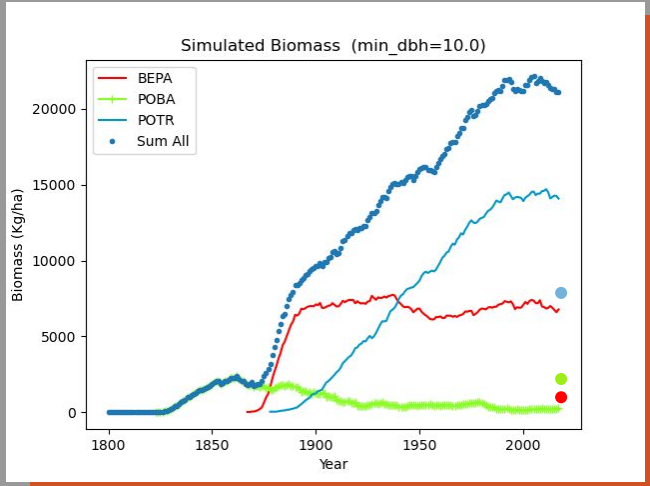
Mean DBH (cm) for each species (from CIPHA):

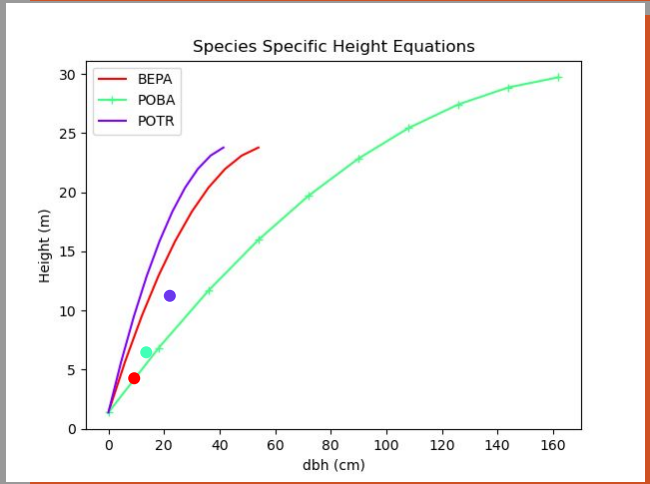
BEPA - 9.558

POBA - 15.9

POTR - 19.28

EDG2-2 SITE





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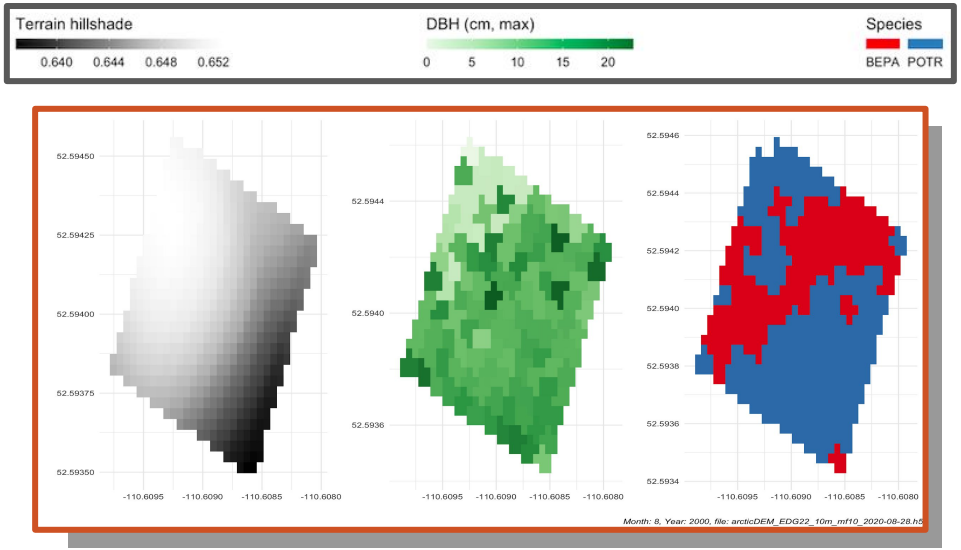

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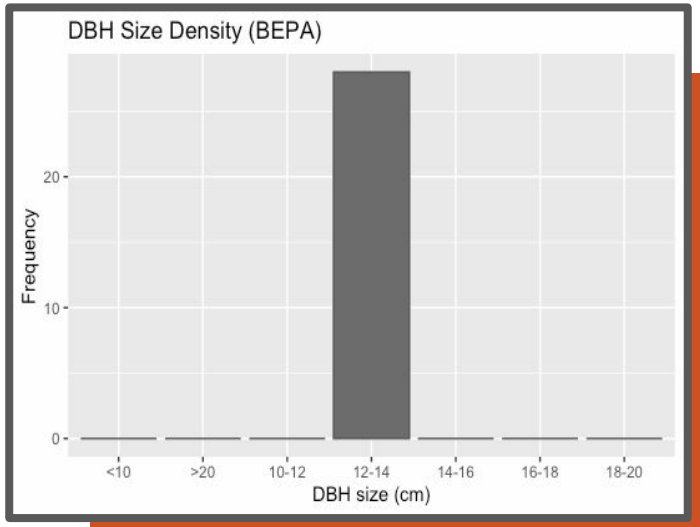
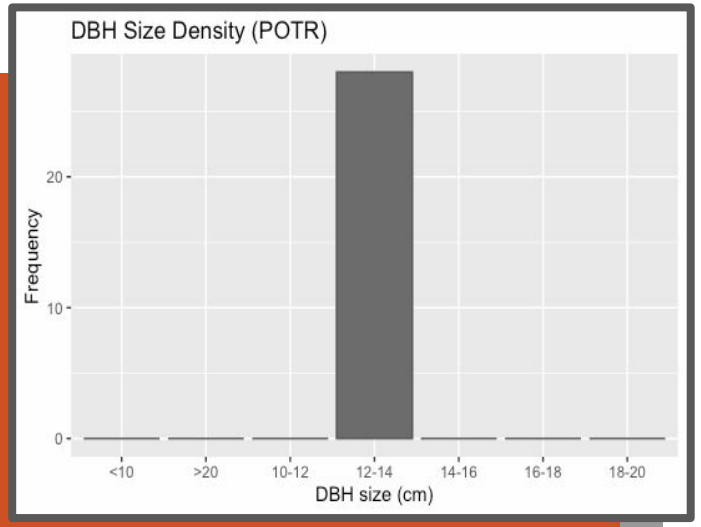
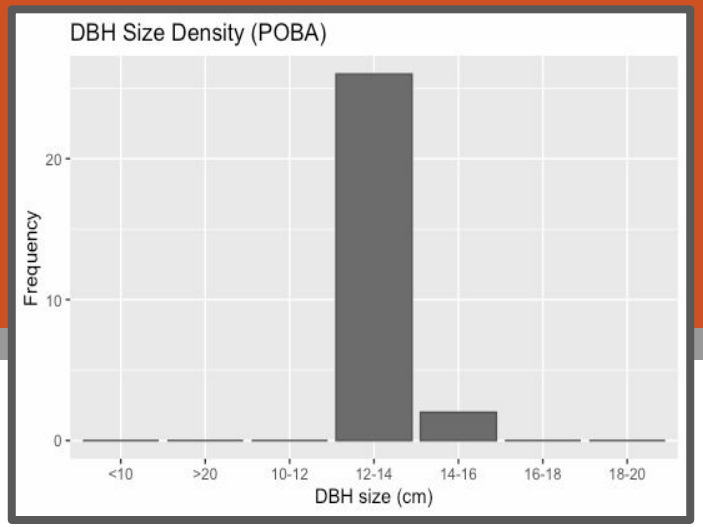
RESULTS







Mean DBH (cm) for each species (from CIPHA):

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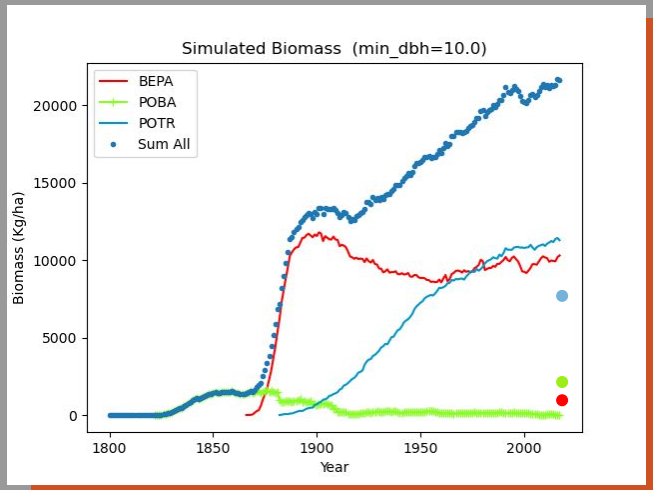
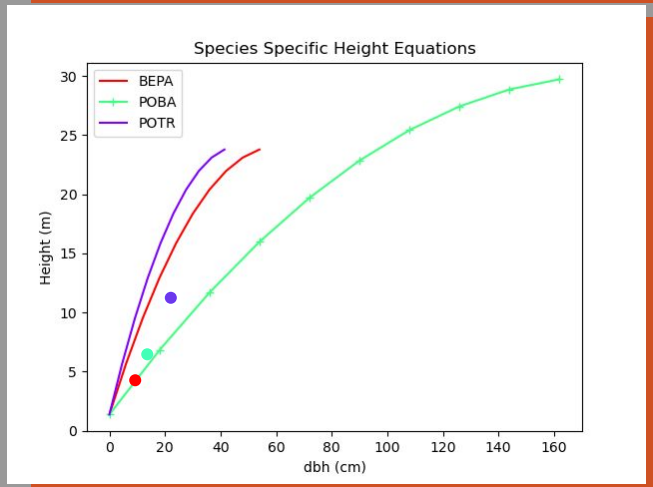
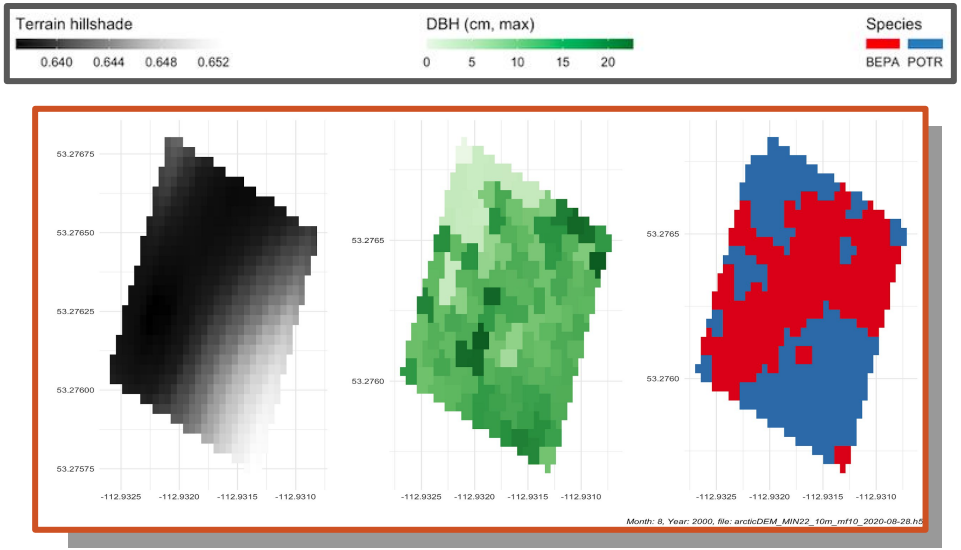
POTR - 19.28

MIN2-2 SITE





RESULTS



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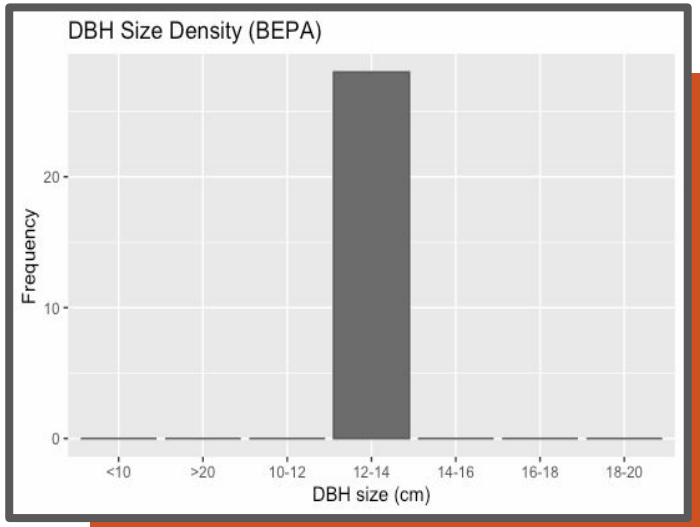

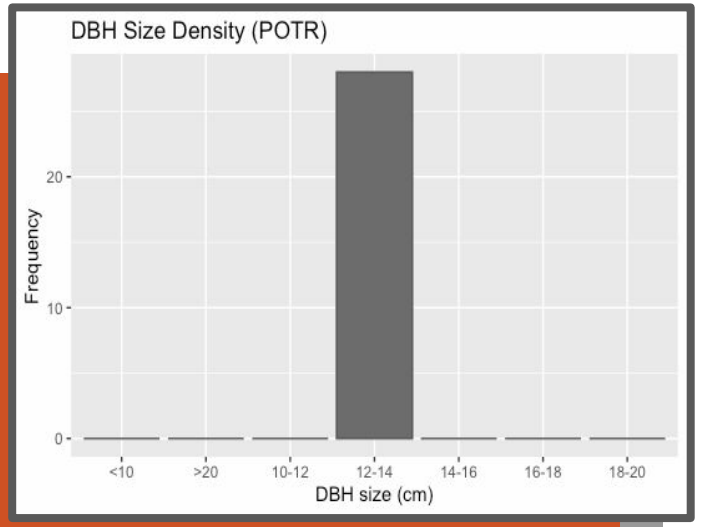

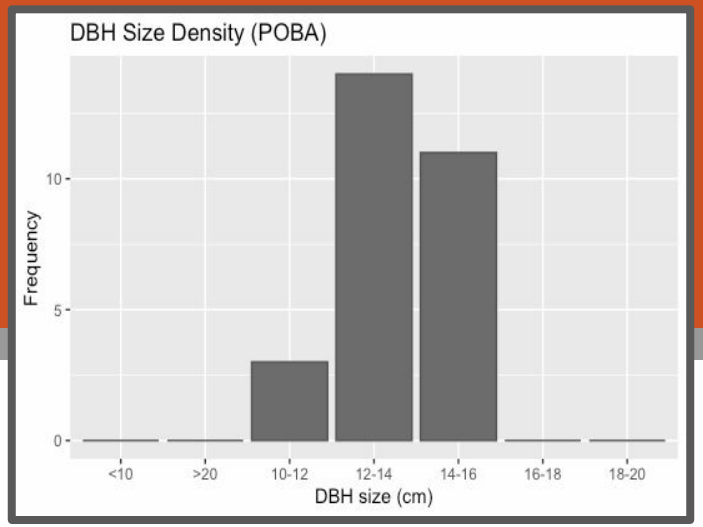

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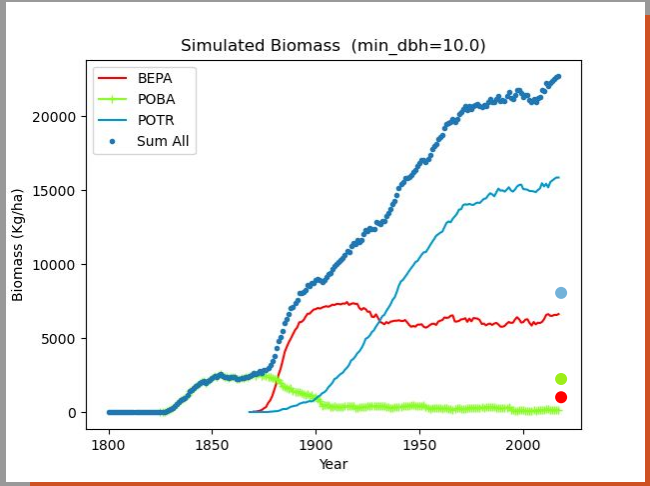
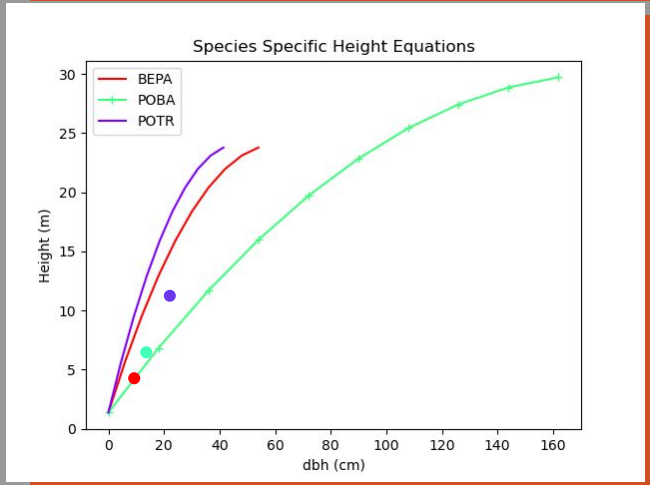
YRK1-1 SITE





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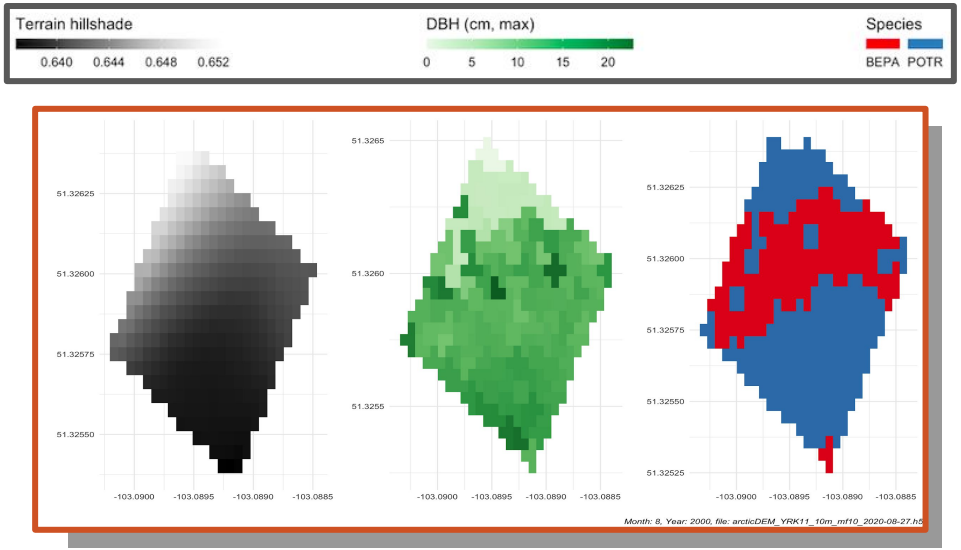

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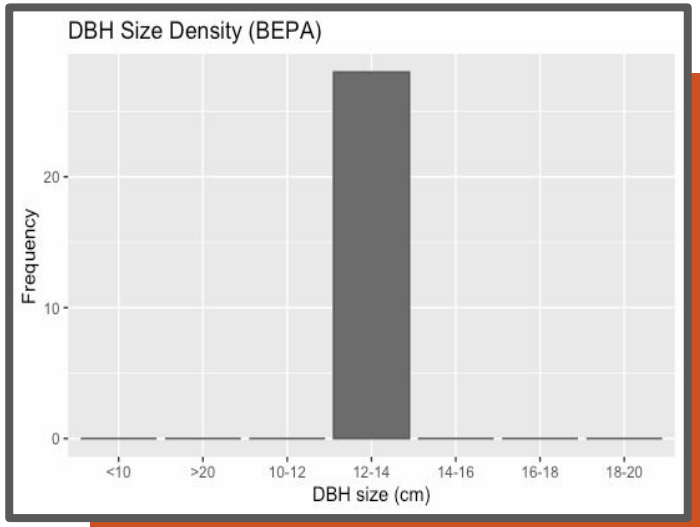

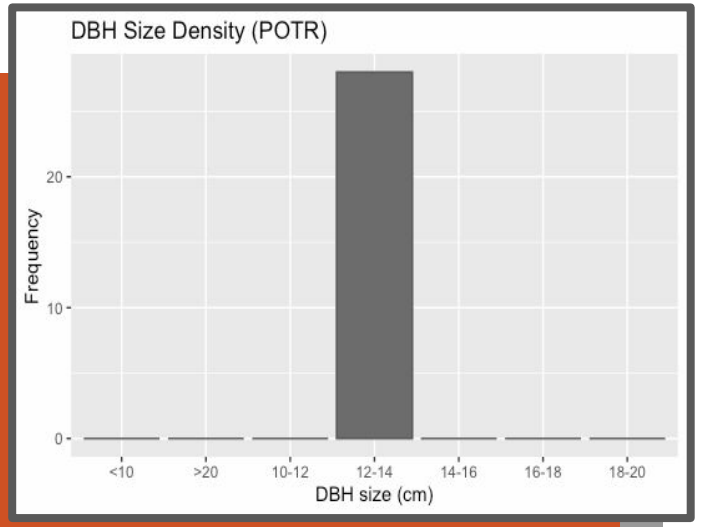

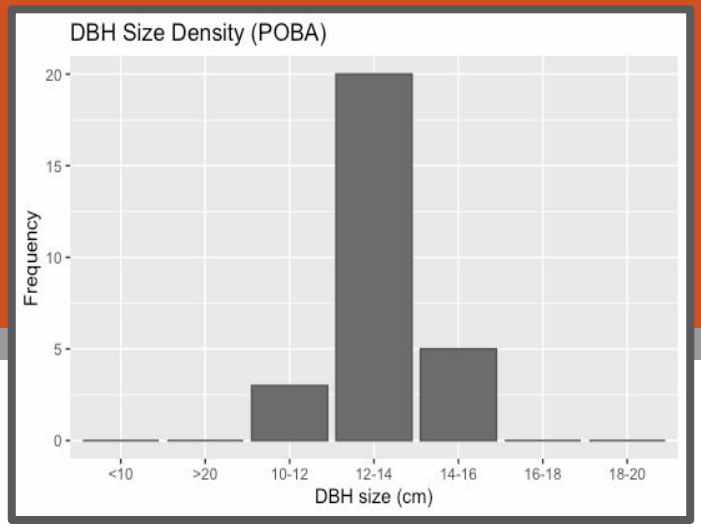

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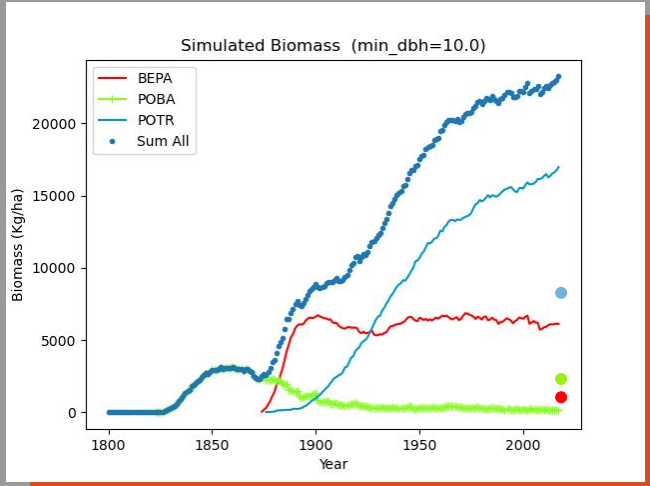
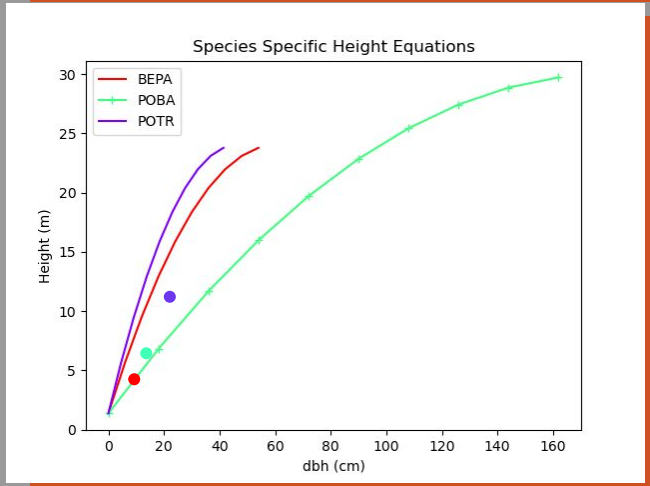
RESULTS

YRK3-1 SITE





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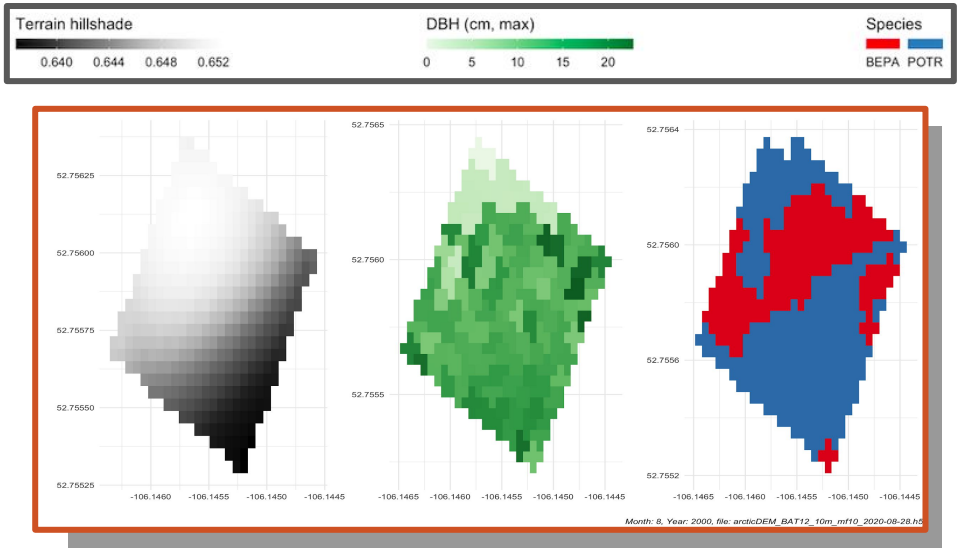

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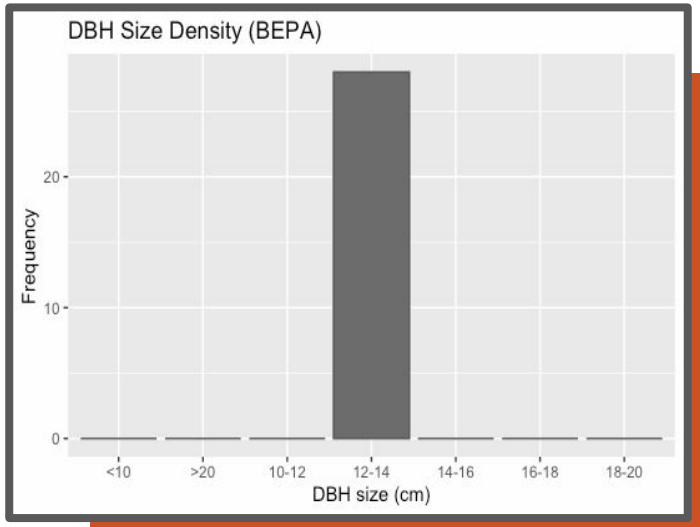

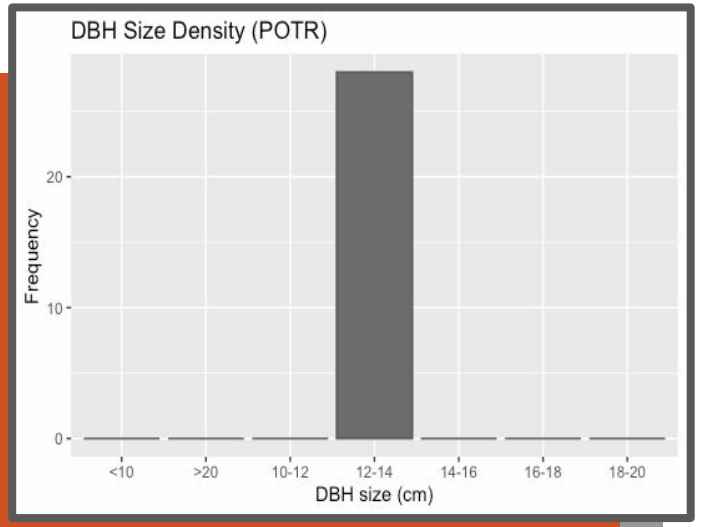

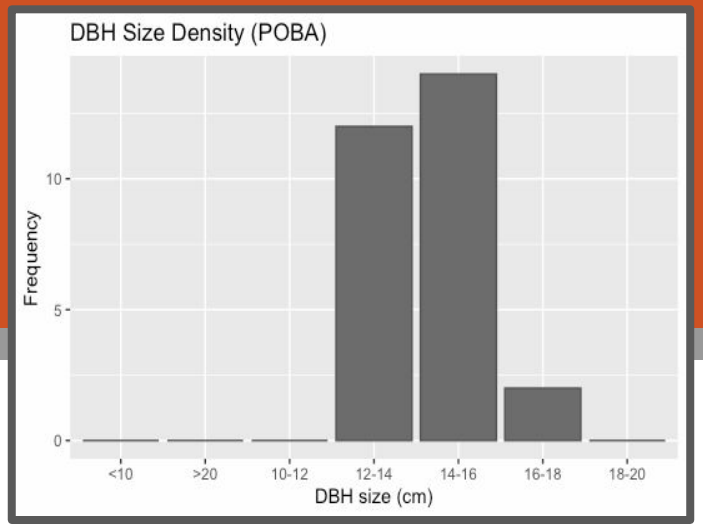

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CONCLUSION

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CONCLUSION

SUMMARY OF RESULTS

- Calibration required to determine whether accurately-set runs will produce data to coincide accurately with data
- CIPHA data and model output follow same general shapes
- Biomass diagrams show climate change leveled off increase (EDG shows start of decrease)
- Model can provide useful insight into climate effects

OVERALL

CLIMATE CHANGE

The shifting climate is increasingly affecting the Aspen Parklands region.

MODEL

The model is effective at showing the impacts of climate change on the Parklands.

CONCLUSION

THANK YOU

REFERENCES

ABoVE PROJECT

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PHOTOS

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