Distribution of Pleistocene megafauna and deglacial wetlands

Martina Gjevori
Centre for Global Change Science
University of Toronto

UNIVERSITY OF TORONTO

Introduction

- The last deglaciation brought about rapid climate changes and megafaunal extinctions in North America, with habitat loss being one of many hypotheses for these extinctions (Gill et al. 2009).
- Byun et al. (2021) used novel methods and identified tree taxa indicative of wetlands to predict the location and cover of possible wet forest environments (WFEs) in the Great Lakes region during the Bølling-Allerød warming period (14.6-12.8 ka).
- Giant beavers (*Castoroides ohioensis* Foster, 1838) depended on aquatic plants in wetland environments (Plint et al. 2019). Mastodons (*Mammut Americanum* Kerr, 1792) were browsers that fed on leafy material in wet forests (Cocker et al. 2021). Stag-moose (*Cervalces scotti* Lydekker, 1898) also fed on leafy vegetation in marshes and peat bogs (Long & Yahnke 2011).
- This study investigates the relationship between the distributions of wetland-associated taxa and deglacial wetland habitats.

Methods

- Fossil data for the three species were downloaded from the Paleobiology Database (https://paleobiodb.org/) and extracted via an SQL query from the Neotoma Paleoecology Database (https://www.neotomadb.org/).
- Fossil data were filtered to include only those within the study area of Byun et al. (2021) and those temporally overlapping the Bølling-Allerød.
- Fossil data were projected onto the WFEs projected by Byun et al. (2021) where each grid cell is 50×50 km^2.
- The number of localities that fell on projected WFEs and the number that occurred per grid cell distant from a projected WFE were counted. Counts were divided by the total number of localities per species to get proportion of overlap.
- Species distribution models (SDMs) predict species' distributions based on environmental conditions they may have preferred and were created in R using MaxEnt and paleoclimate data from PaleoClim (http://www.paleoclim.org/) for the Bølling-Allerød.

Results & Discussion

1. How much overlap is there between the species' distributions and wetland cover?

- The fossil localities closely follow the projected WFEs of Byun et al. (2021) (Fig. 1), with overlap per species quantified in Table 1.

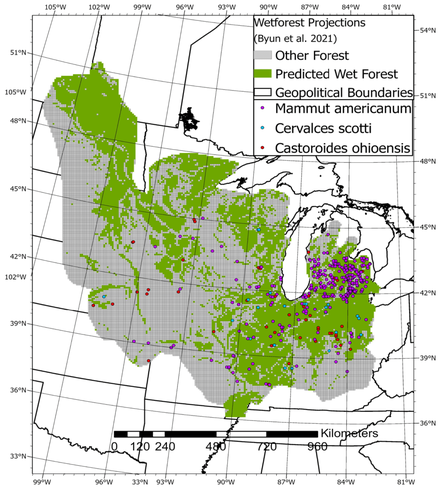

Figure 1. Fossil localities over Byun et al. (2021) study area.

	C. ohioensis	*M. americanum*	*C. scotti*
Falls within a projected WFE	40 specimens (67%)	286 specimens (75%)	29 specimens (78%)
Doesn't fall within a projected WFE	20 specimens (33%)	94 specimens (25%)	8 specimens (22%)

Table 1. Overlap counts between fossil localities and projected WFEs for each species.

2. Are these species found in higher prevalence within hypothesized wetland areas than outside of them?

- Fig. 2 shows that not only are these fossils significantly overlapping with the projected areas, but very few are found with increasing distance from projected WFEs.

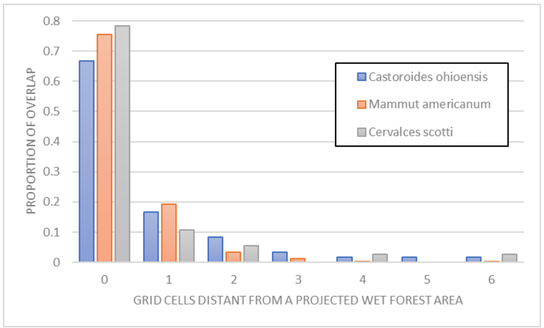

Figure 2. Overlap counts and distances of non-overlapping fossils based on how many grid cells away from a projected wetland that they were.

3. How much overlap is there between the distributions of the three species due to their habitat?

- SDMs show the highest probability of occurrence for the three species within a similar region, so they occurred in areas with similar climatic conditions, with temperature and precipitation seasonality being the most important predictors.

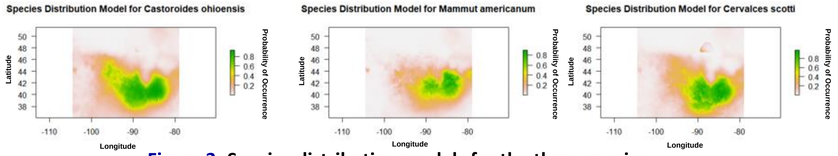

Figure 3. Species distribution models for the three species.

Limitations of the Study

- There is a lack of precise temporal data for the vertebrate fossil specimens, making it difficult to pinpoint them to the Bølling-Allerød.
- Collector's bias can be seen with more sampling in metropolitan areas and a large sample of mastodons in present-day Michigan.
- SDMs have many biases when used for fossil data, including taphonomic biases and a lack of good-quality, meaningful environmental data as predictors (Varela et al. 2011).

Conclusion

The megafauna taxa considered here likely inhabited wetlands and thus provide an independent line of evidence for the extensive forested wetlands during the deglacial. Byun et al. (2021) show that these extensive wetlands rapidly dried up just after the Bølling-Allerød, suggesting an important change in habitat availability. I encourage future investigation into the role that the loss of wetlands might have played on the end-Pleistocene megafauna extinctions.

Acknowledgments

Thank you to Sharon Cowling and Sarah Finkelstein for their supervision, Eunji Byun for providing her data and guidance, and my lab mates for their support. This research was funded by the Centre for Global Change Summer Undergraduate Intern Programme to M. Gjevori and research grants from the Natural Sciences and Engineering Research Council (NSERC) to S. Cowling and S. Finkelstein.

References

Byun et al. (2021) Nat Geosci; Cocker et al. (2021) CJES; Gill et al. (2009) Science; Long & Yahnke (2011) J Mammal; Plint et al. (2019) Sci Rep; van Beest et al. (2021) Divers Distrib; Varela et al. (2011) Palaeogeogr Palaeoclimatol Palaeoecol