POLMAR HELMHOLTZ GRADUATE SCHOOL FOR POLAR AND MARINE RESEARCH

SSP2.4 - EGU22-11180

AWI ALFRED-WEGENER-INSTITUT HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

Identification and characterization of vegetation loss during the last 50,000 years in Beringia

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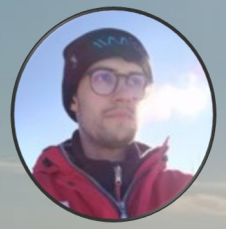
Does the loss of the Pleistocene steppe tundra induce plant taxa loss?



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SCAN ME

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CONTEXT

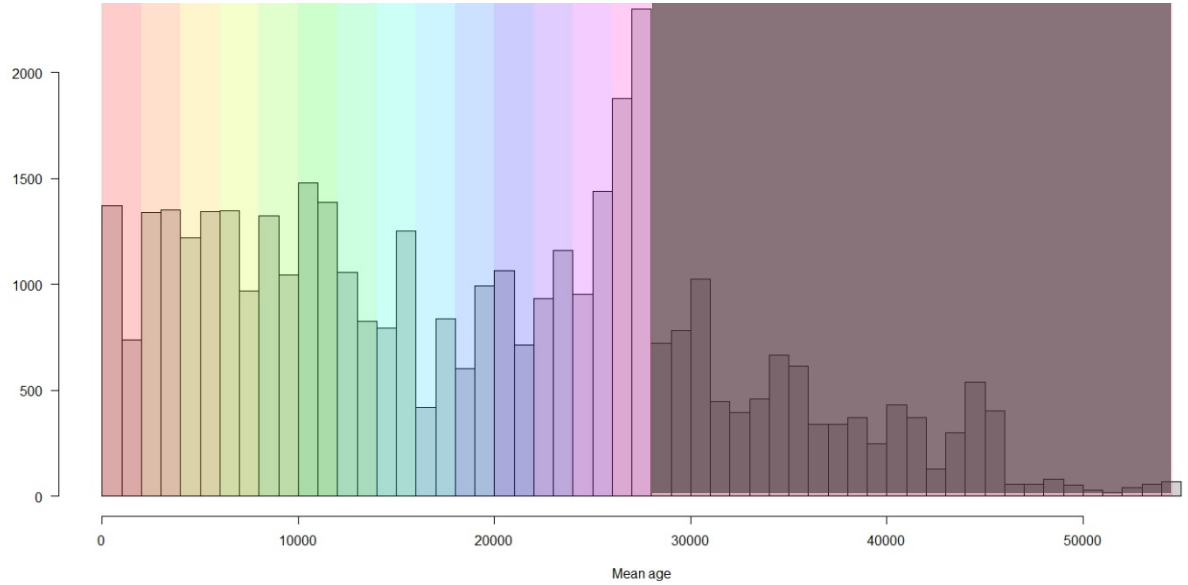
- With ongoing climate change: extinction events
  - Impact all Eukaryota groups worldwide[1]
  - Plants are also impacted (even in the arctic)[2] + similar proportion than mammals[3]

- Pleistocene / Holocene: major climatic change
  - Loss of Pleistocene steppe-tundra[4] + extinction event (megafauna)[5]
  - Extinction is not supposed to be group specific[2] + megafauna: keystone taxa[6]
  - No extinction of plant reported so far[7] (due to methodological biases)

- **AIMS:**
  - Improve detection of rare taxa with sedaDNA proxies from lake sediments
  - Identify potential extirpation and extinction events
  - Characterise the potential loss

work in progress

MATERIAL



Cores	Age
Bolshoe Toko	35kyrs BP
Levinson Lessing	55kyrs BP
Ilerney 16KP	54kyrs BP
Ilerney EN18208	28kyrs BP
Bilyakh	50kyrs BP
Lama	50kyrs BP
Kyutyunda	50kyrs BP
E5	30kyrs BP
Emanda	50kyrs BP
Rauchuagytgyn	30kyrs BP

9 lake sediment cores
Previous Pleistocene steppe-tundra
Covering last ~50,000 years
Investigate the last ~28,000 years

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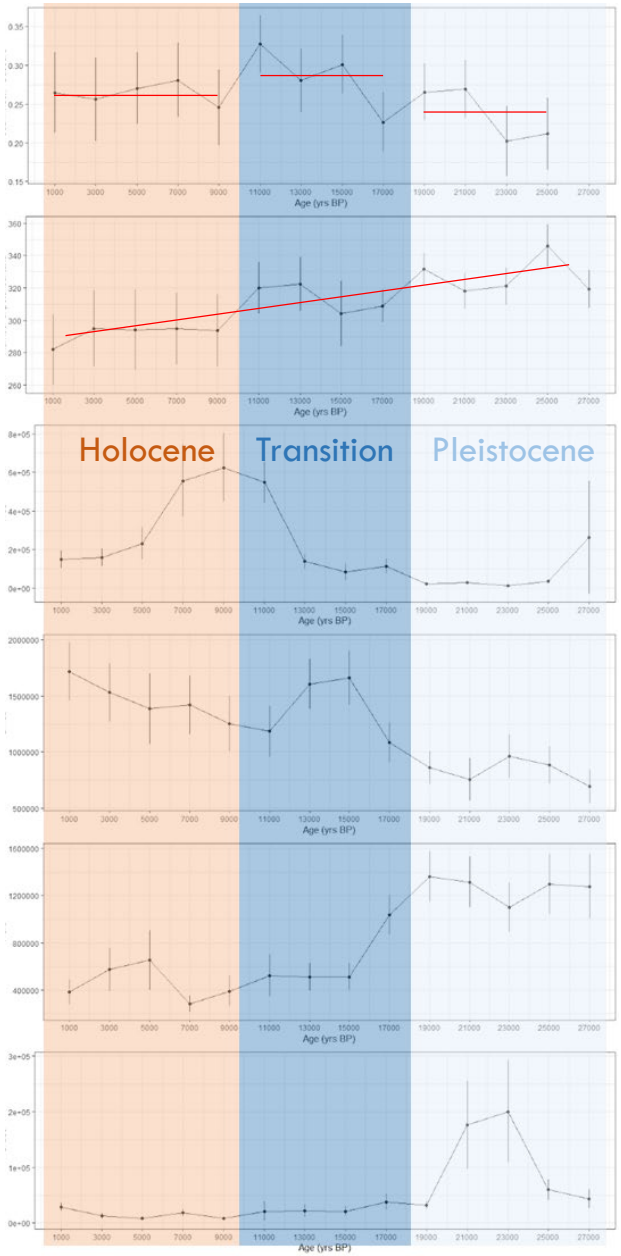
MAIN RESULTS



- ~60% of plant taxa are present in every time slice -> core community

- Composition shift: Pleistocene steppe-tundra to Holocene taiga
- Steady decrease in plant richness
- Stable Pleistocene / unstable transition / less stable Holocene

121 taxa absent from modern time slice -> extirpated
Average extinction rate per time slice:
0.95 E/MSY > background extinction rate (0.05 to 0.35 E/MSY)[9]

Reappearance rate

3 extinction events
Last Glacial maximum
Pleistocene / Holocene
Mid Holocene

Match megafauna extinction events[8]

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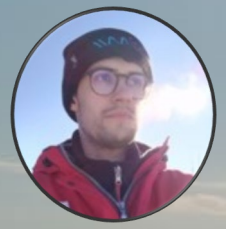
Does the loss of the Pleistocene steppe tundra induce plant taxa loss?

- Subcontinental plant taxa loss identified and quantified
- Happen at the transition to the Pleistocene to Holocene
- In parallel to steppe tundra disappearance & megafauna extinction



THANK YOU

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work in progress

METHODS

- After DNA extraction + metabarcoding (trnL g/h) + OBITools 3 pipeline: work with all ASVs >90%
- DNA databases: modern taxa. To investigate extinction, we look at taxa not present in databases:
  - 100% ASVs: assigned at 100% to modern taxon / Candidate ASVs: assigned 90%>ASV>100%: to modern taxon
- Work with ASVs with sufficient reads (>100 reads)
- From ASVs co-occurrence patterns: build communities. Assume that taxa are part of communities
- Each community has only unique taxa - merge unique assignments per community to identify 474 potential taxa
- We kept most of 100% signal and reduce the candidate ASVs one with a stringent method
- Potential extinct taxa are in the candidate portion absent from the modern time slice

	Starting (min 10 samples)			>100 reads			Community > 5 ASVs			Different assignments		
Type	Total	100%	candidates	Total	100%	candidates	Total	100%	candidates	Total	100%	candidates
Total	21977	556	21424	5302	475	4827	4957	409	4548	474	340	134
Percent		2.5	97.5		8.9	91		8.3	91.7		72	28

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BIBLIOGRAPHY

[1]Cowie, R.H., Bouchet, P. and Fontaine, B. The Sixth Mass Extinction: fact, fiction or speculation?. *Biol Rev* 97: 640-663 (2022). https://doi.org/10.1111/brv.12816

[2]Humphreys, A.M., Govaerts, R., Ficinski, S.Z. *et al.* Global dataset shows geography and life form predict modern plant extinction and rediscovery. *Nat Ecol Evol* **3,** 1043–1047 (2019). https://doi.org/10.1038/s41559-019-0906-2

[3]Brummitt, N. A., Bachman, S. P., Griffiths-Lee, J. *et al.* Green plants in the red: A baseline global assessment for the IUCN sampled Red List Index for plants. *PloS one 10*(8), e0135152 (2015). https://doi.org/10.1371/journal.pone.0135152

[4]Guthrie, R. D. Origin and causes of the mammoth steppe: a story of cloud cover, woolly mammal tooth pits, buckles, and inside-out Beringia. *Quat Sci Rev* 20, 549–574 (2001). https://doi.org/10.1016/S0277-3791(00)00099-8

[5]Johnson, C. N. Ecological Consequences of Late Quaternary Extinctions of Megafauna. *Proceedings: Biological Sciences* 276, no. 1667 2509–19 (2009). https://doi.org/10.1098/rspb.2008.1921

[6]Galetti, M., Moleón, M., Jordano, P., *et al*. Ecological and evolutionary legacy of megafauna extinctions. *Biological Reviews*, *93*(2), 845-862 (2018). https://doi.org/10.1111/brv.12374

[7]Jackson, S T, and C Weng. Late quaternary extinction of a tree species in eastern North America. *Proceedings of the National Academy of Sciences of the United States of America* vol. 96,24 :13847-52 (1999). https://doi.org/10.1073/pnas.96.24.13847

[8]Murchie, T.J., Monteath, A.J., Mahony, M.E. *et al.* Collapse of the mammoth-steppe in central Yukon as revealed by ancient environmental DNA. *Nat Commun* 12, 7120 (2021). https://doi.org/10.1038/s41467-021-27439-6

[9]De Vos JM, Joppa LN, Gittleman JL et al. Estimating the normal background rate of species extinction. *Conserv Biol* Apr;29(2):452-62 (2015). https://doi.org/10.1111/cobi.12380

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