# The longer temporal pattern of terrestrial plant diversity in northern Fennoscandia

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## Background

- The Holocene is a period of post-glacial recolonization, temperature rise and fall, and increased human population, which therefore makes it an ideal time interval for assessing the impacts of these drivers on past and present biodiversity patterns.
- Modern ecology often lacks the longer temporal dimension of biodiversity[1]
- Palaeoecological approaches can bridge the existing gap in ecological studies by including a temporal dimension of the biodiversity. Environmental DNA metabarcoding and pollen analysis of soil and lake surface samples show a reasonable correspondence between DNA/pollen taxa and extant taxa of the surrounding vegetation[2,3,4], which opens avenues to explore temporal biodiversity patterns.
- We used metabarcoding of sedimentary ancient DNA to detect terrestrial vascular plant taxa from across northern Fennoscandia
- Using these data, we aim to:
  - Explore temporal pattern of taxonomic richness and turnover, and
  - Analyse the impact of regional climate on taxonomic richness and turnover throughout the Holocene.

## Methods

- Sediment cores were retrieved from 10 lakes in Northern Fennoscandia (**Figure 1**).
- Metabarcoding of sedimentary DNA was performed targeting *trn*L p6-loop locus of the chloroplast genome[5].
- The plant taxa were identified by matching the DNA sequences to arctic-boreal-bryophyte and EMBL nucleotide databases.
- We modeled temporal trends and effect of temperature on taxonomic richness and turnover using generalized additive models (GAM). We included delta oxygen isotope values from North Greenland Ice Core Project[7] as a proxy for regional temperature.

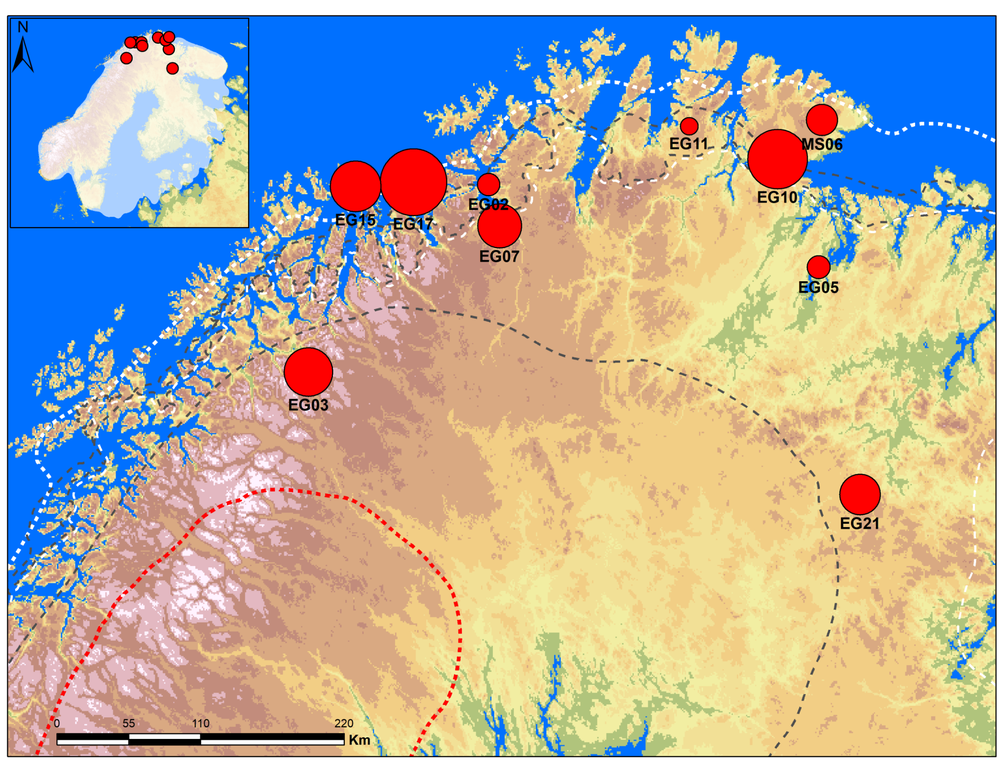


**Figure 1**: Geographical location of the study area in Northern Fennoscandia. The most credible extent of the Scandinavian ice sheet with 1000 years time slices from 15000 to 10000 years BP are indicated by dashed lines[6]. The size of the circles are scaled to mean taxonomic richness of sites which ranges from 15 to 58 taxa. Inset shows the extent of the Scandinavian ice sheet at 15000 years BP.

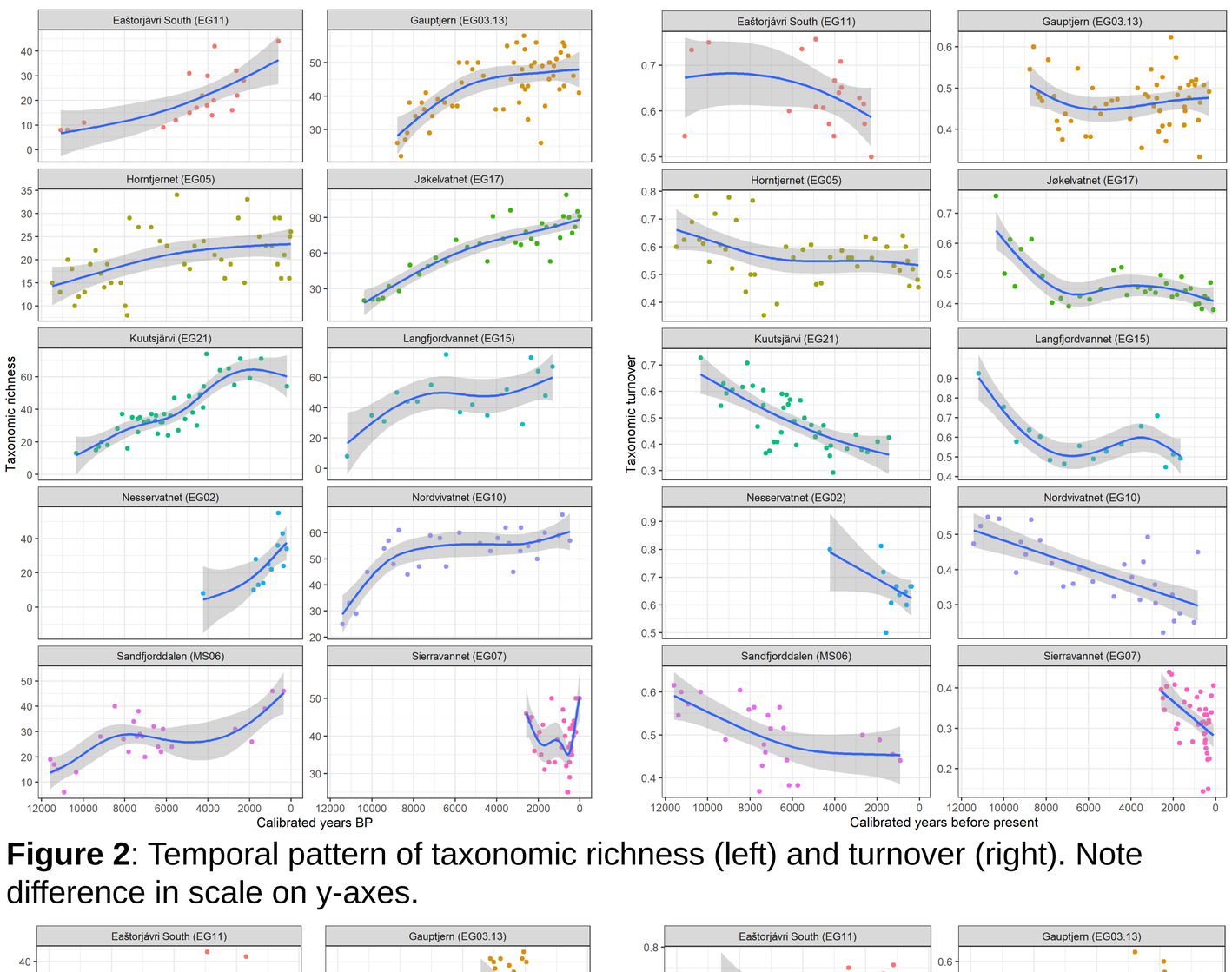


**Figure 2**: Temporal pattern of taxonomic richness (left) and turnover (right). Note difference in scale on y-axes.

## Results

- We observed a non-linear gradual increase (five lakes) and near-linear increase (three lakes) of taxonomic richness when the sediment record covered a major range of the Holocene (**Figure 2**). Based on extensive quality checks, this pattern is not due to DNA quality
- We observed steep linear (three lakes) to gradual non-linear (four lakes) decrease in taxonomic turnover (**Figure 2**). It remained stable throughout the Holocene in three lakes.
- Taxonomic richness either gradually decreases or increases in two lakes each (**Figure 3**). It attains a weak to strong maxima along temperature gradient in four lakes. However, in two of the lakes, it does not show any pattern.
- Taxonomic turnover gradually decreases in four lakes and increases in one of the lakes along temperature gradient (**Figure 3**). However, it remains insensitive to temperature in five lakes.
- The variability of taxonomic richness and turnover along regional temperature most likely indicates that there are other variables at a more local scale which determine the pattern.

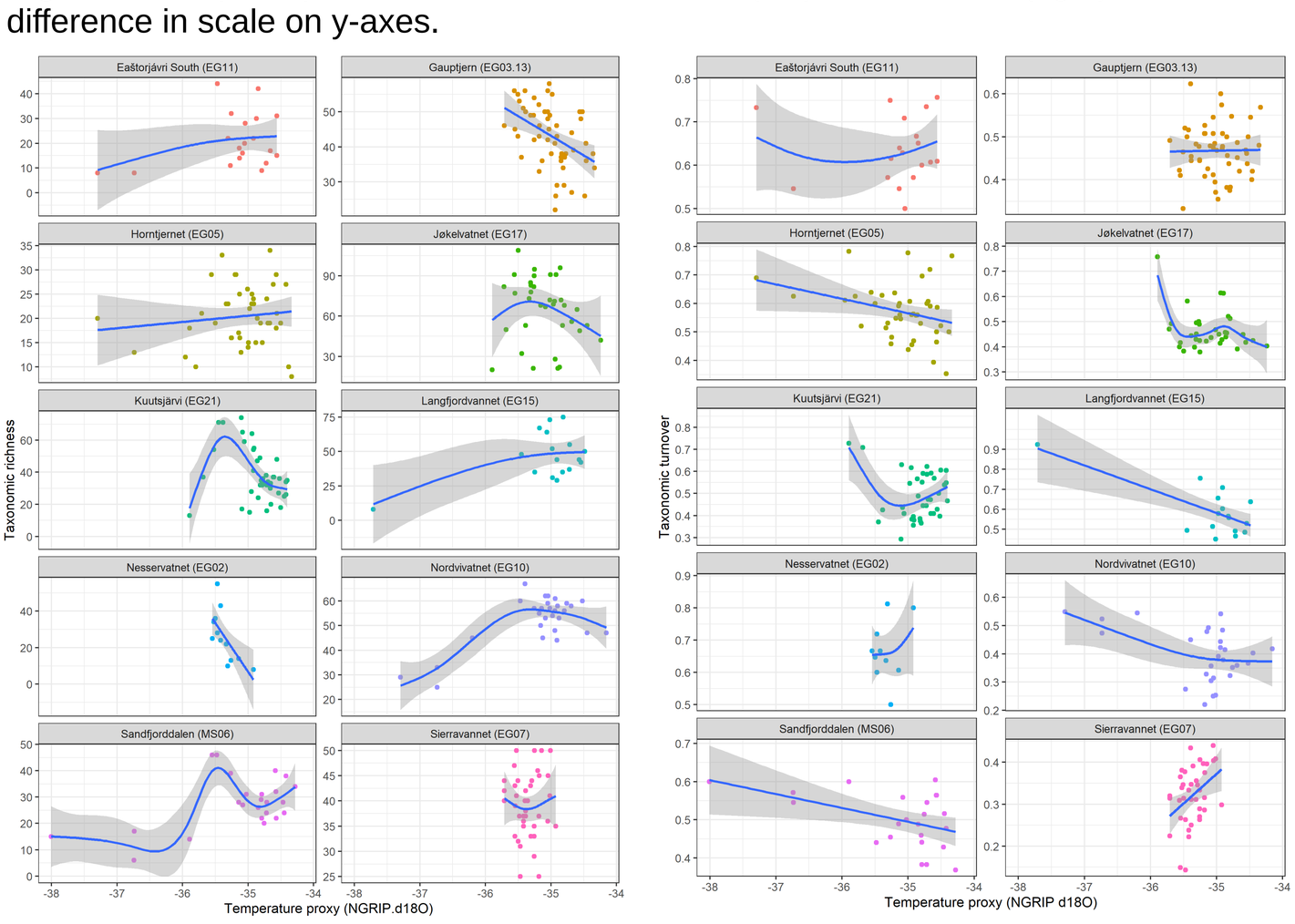


**Figure 3**: Impact of regional climate on taxonomic richness (left) and turnover (right). Note difference in scale on y-axes.

## Significance

- The diversity dynamics across lakes may be the result of differential deglaciation history and hence colonization time for terrestrial plants.
- This is the first study investigating regional changes in diversity based on sedimentary DNA from multiple lakes covering environmental gradients.

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