



# Monitoring environmental effects of mine discharges in northern streams

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# Background

- There is an increasing pressure for exploitation of the mineral deposits of the Arctic region
- Mineral deposits can influence surrounding terrestrial and aquatic environments
- Mineral deposits can pose a natural stress:
  - Strong influence on diversity and composition of communities
  - Can influence species' responses to additional stress
  - Can inflate the outcome of bioassessment if not taken into account

# Aims

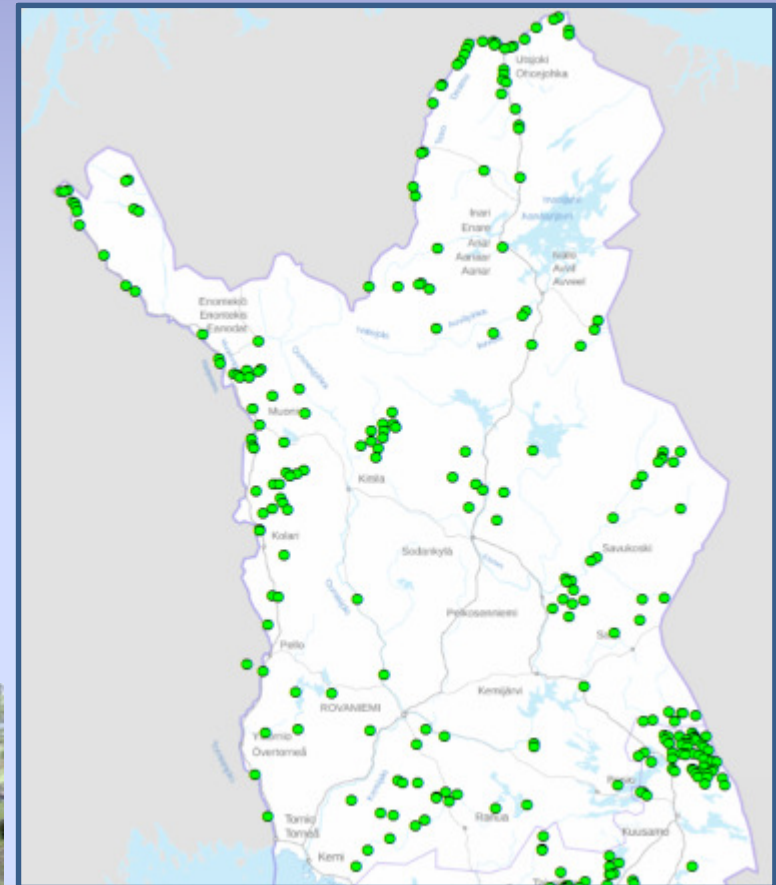
1. To examine how geological anomalies influence diversity and composition stream periphyton (diatoms) and macroinvertebrate communities in Finnish Lapland
2. To examine how mine discharges influence these communities in the receiving waters
3. Whether bioassessments of the influences could be improved by geologically specific reference condition



# Preparation of the data

## 1. Compilation of available data

- 110 stream sites sampled for Diatoms and macroinvertebrates
- Reference condition, i.e., only low intensity of land use in the catchments, no signs of hydromorphological alteration
- New data from three catchments with active and two catchments with closed mines and a catchment with a planned mine



## 2. GIS-based classification of geological influence

Classification of all sites based on mapping of mineral potential

Maps for Au, Ni\_Cu and volcanogenic massive sulfide deposits

Classification into two classes:

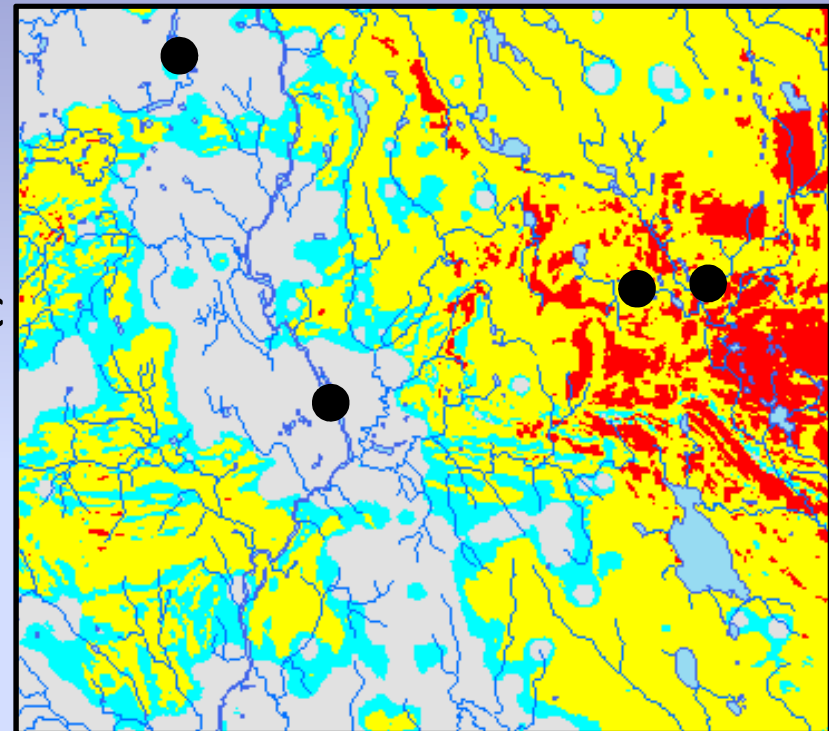
1)strong

background geological influence

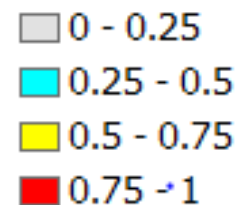
2)no geological influence

**32 sites with and 32 sites without geological influence**

**19 mine impacted sites**



Gamma Ni\_Cu



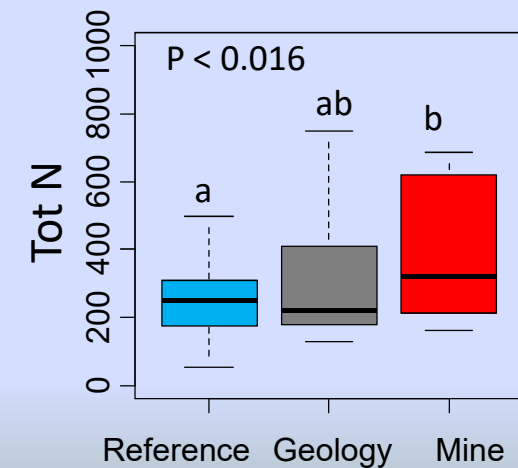
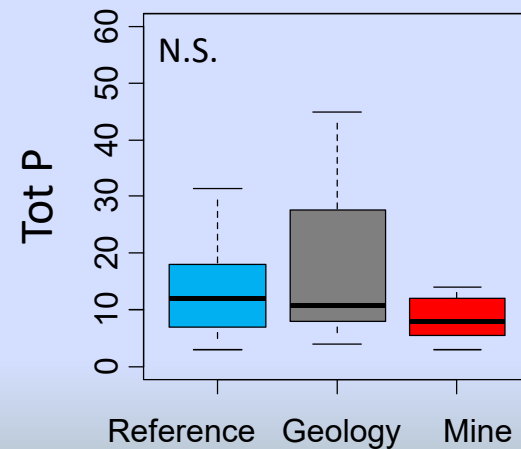
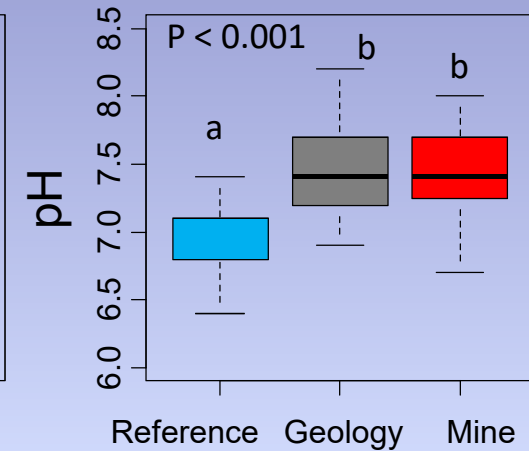
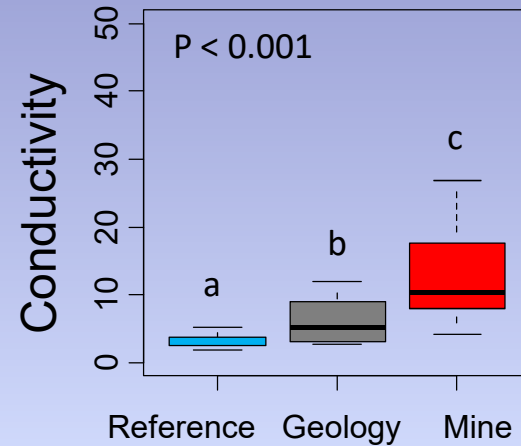
# Analyses

- Anovas to explore the influence of geology and mining on water chemistry of the study streams
- Anovas to examine differences in species richness and evenness of diatom and macroinvertebrate communities among the stream types (reference, geological influence, and mined)
- NMDS ordinations to examine differences in community composition of diatoms and macroinvertebrates among the stream types
- Comparisons of species occupancies among the stream types

# Results

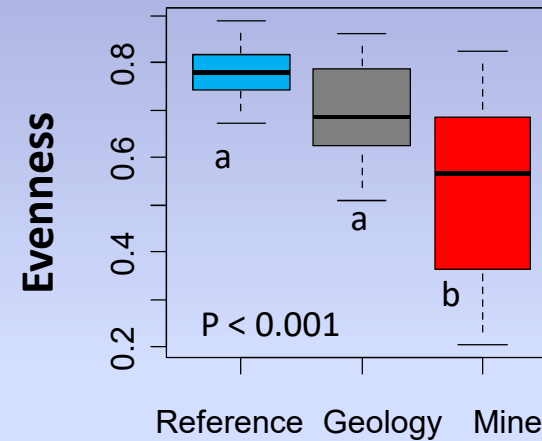
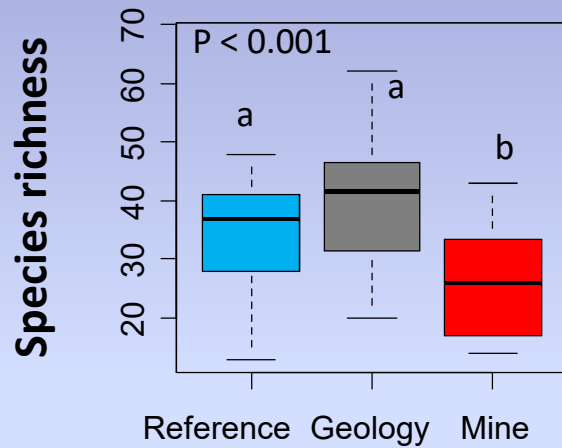
## Water chemistry

- Increased conductivity and pH in streams with geological influence and in streams receiving mine discharges
- Increased concentrations of nitrogen in mine impacted streams

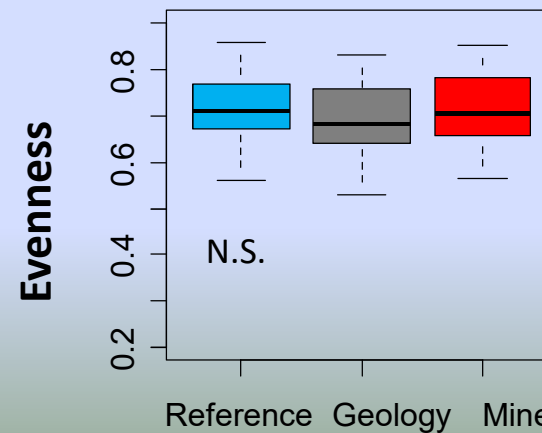
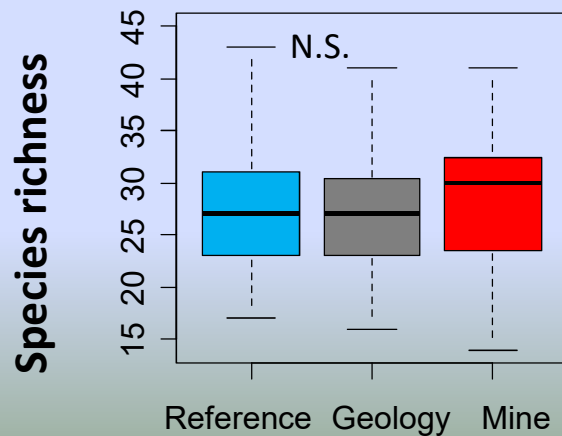


# Species richness and evenness of diatom and macroinvertebrate communities

## Diatoms



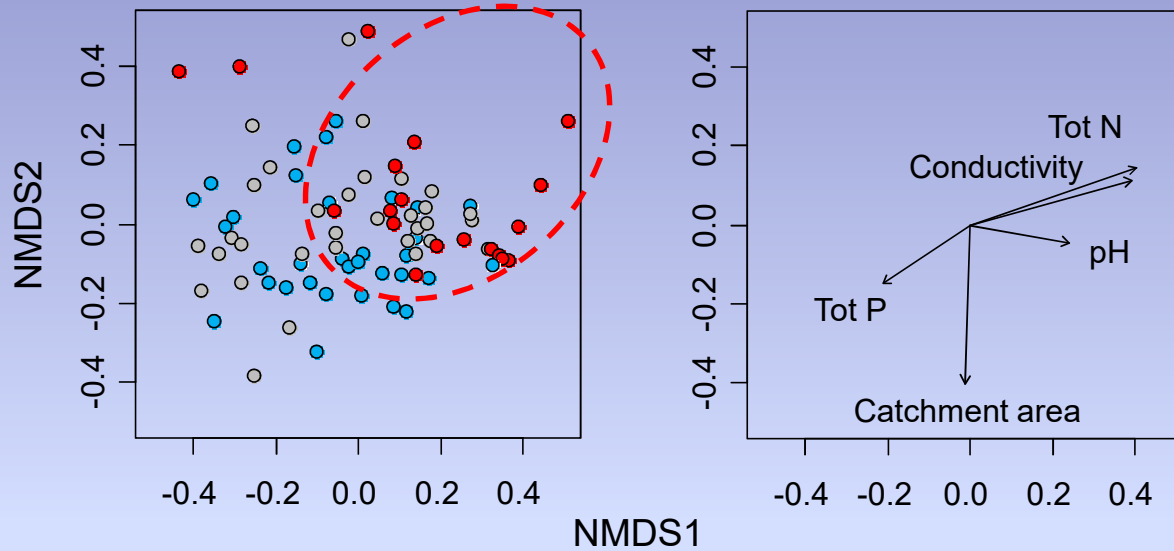
## Macroinvertebrates





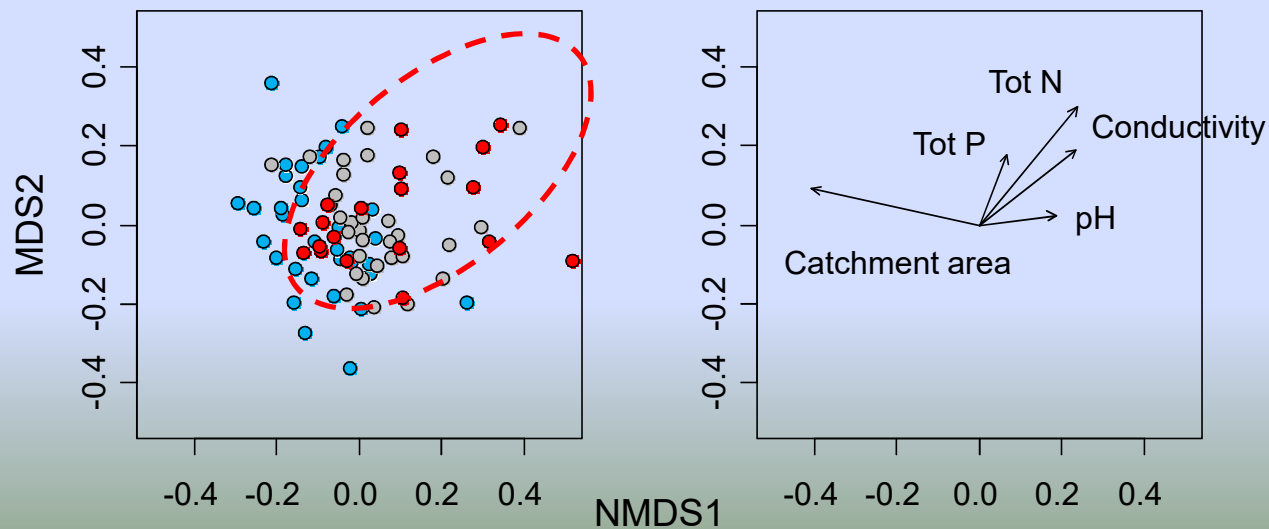
# Variability in community composition

## Diatoms



- Ref
- Geo
- Mine

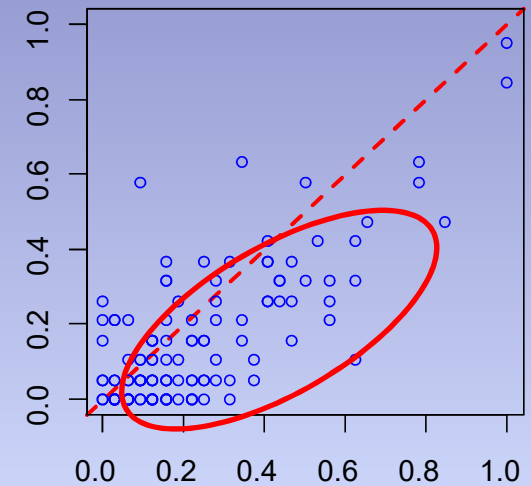
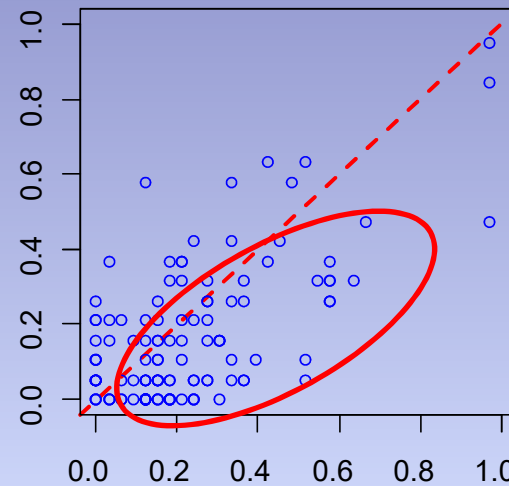
## Macroinvertebrates



# Species occurrence

Decreased frequencies of occurrence for diatoms in mine impacted streams

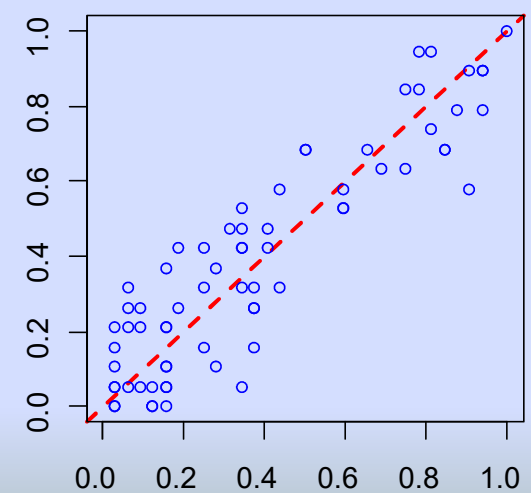
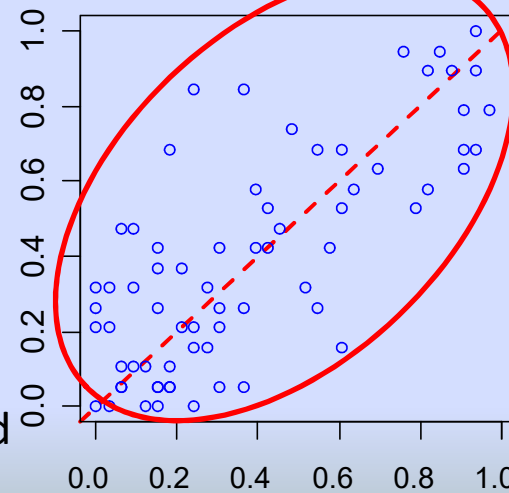
## Diatoms



Mine impact

## Macroinvertebrates

Strong deviations in frequencies of macroinvertebrates between reference and mine impacted streams, not between the latter and geologically influenced streams



Reference

Geological influence

# Conclusions

- Mineral deposits and geological anomalies can influence water chemistry and composition of biological communities in streams
  - Increase electric conductivity, but the influence on biological communities is likely dependent on water pH
- Discharges from mines have a clear impact on water chemistry, but the influence on biological communities is variable and depends on organism group
  - Macroinvertebrates can be tolerant to additional stress, diatoms are more sensitive
- Local geological features need to be taken into account in bioassessment
  - Better match between biological communities and environmental conditions enable more precise assessments

Thank you

