# Response of macrofaunal, eukaryotic and prokaryotic diversity to environmental stressors in Arctic coastal waters

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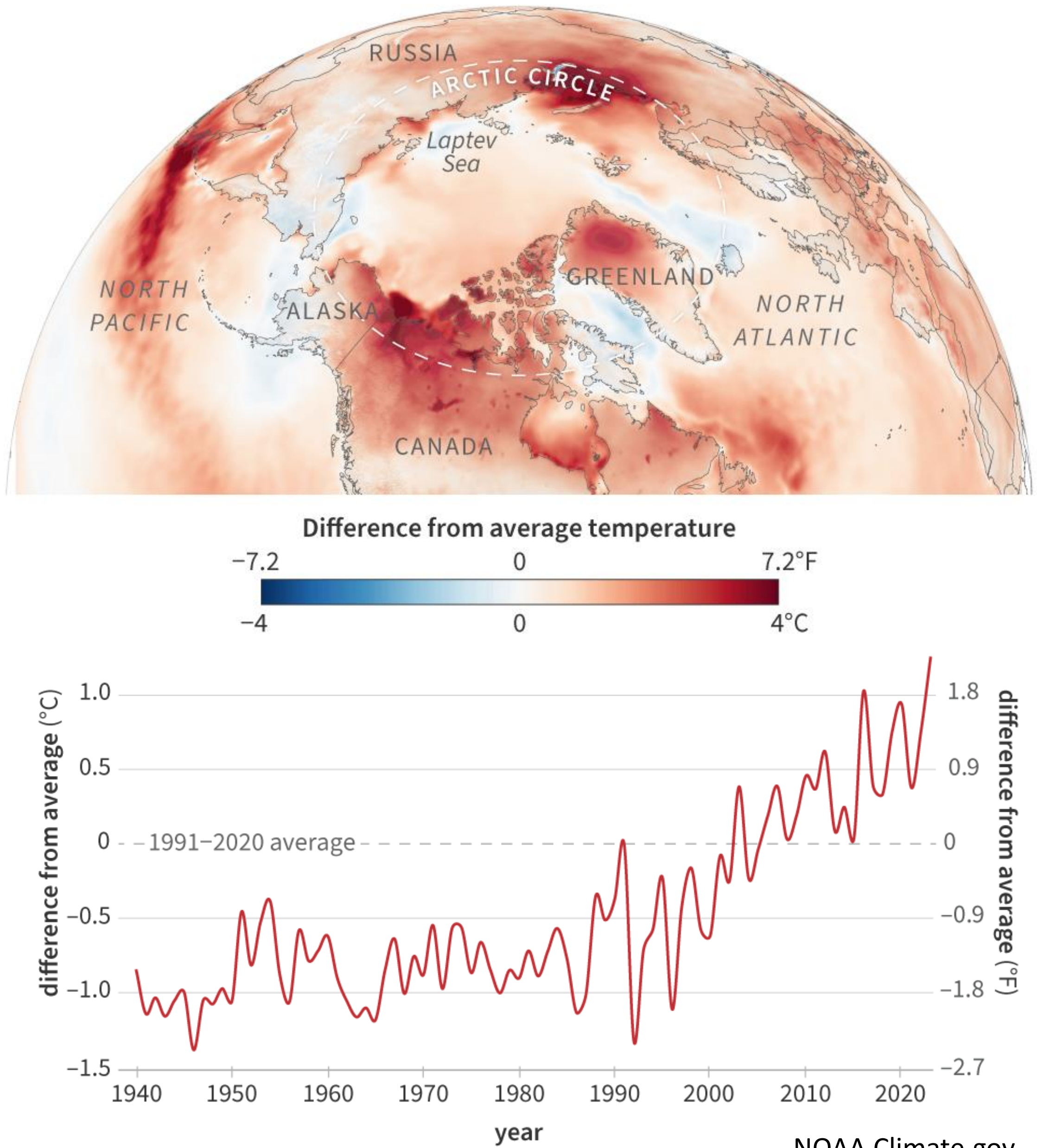
# Climate Change in the Arctic and Its Effects



NOAA Climate.gov

## Some of key drivers

- Glaciers retreat and melting
- Increased sediment loads
- Coastal „darkening”
- Sea currents range
- Reduction of sea ice extent and thickness
- Thawning of permafrost
- Increasing pollution from multiple sources
- Primary production changes
- Borealisation of marine fauna

# Pollution in Arctic

Heavy metals

Black carbon

Persistent organic pollutants (POPs)

Garbage & plastic

New emerging pollutants e.g., pharmaceuticals

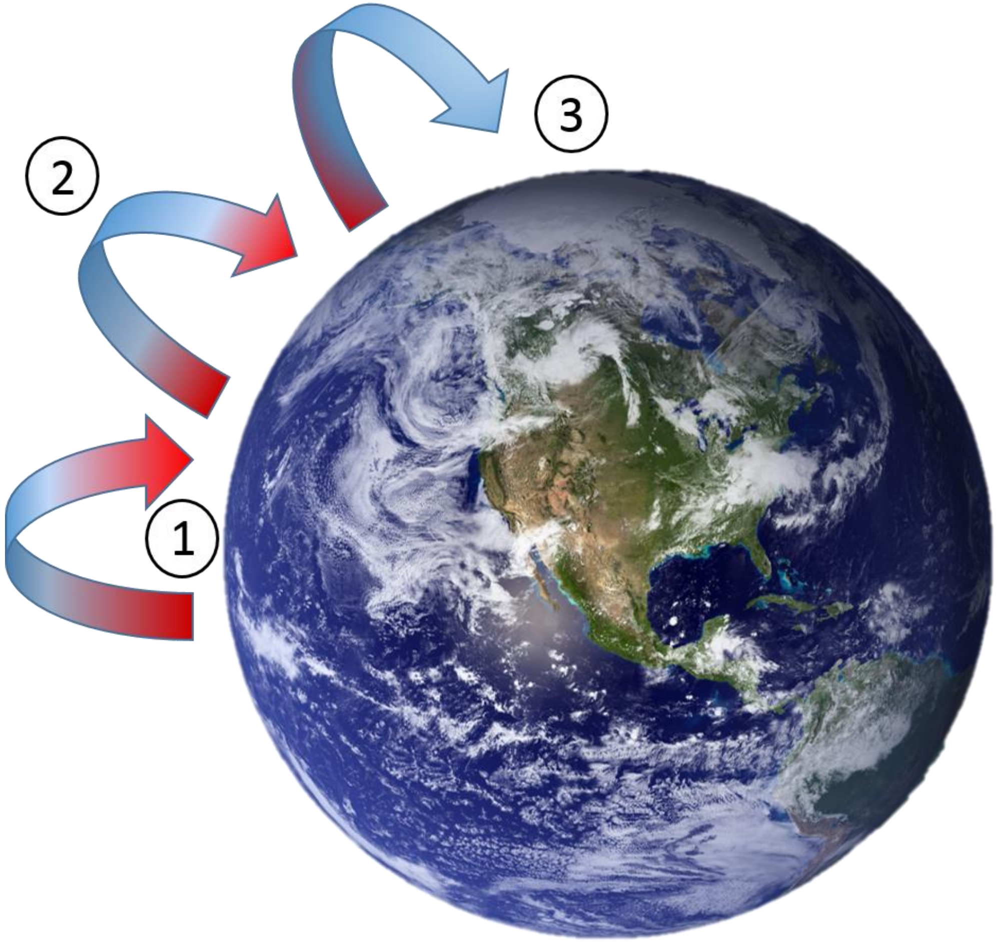

https://www.polartours.com/


https://forscience.pl


ISTOCK ©

# Sources

- ☐ Pollutants are transported to the Arctic through atmospheric circulation, oceanic currents and rivers from distant sources.
- ☐ Local human activity is increasing e.g., tourism, cargo traffic, oil and gas exploitation, extensive fisher
- ☐ Secondary sources: glaciers melting and thawing of permafrost



**GLOBAL DISTILLATION**

https://earthlyhorizon.wordpress.com/

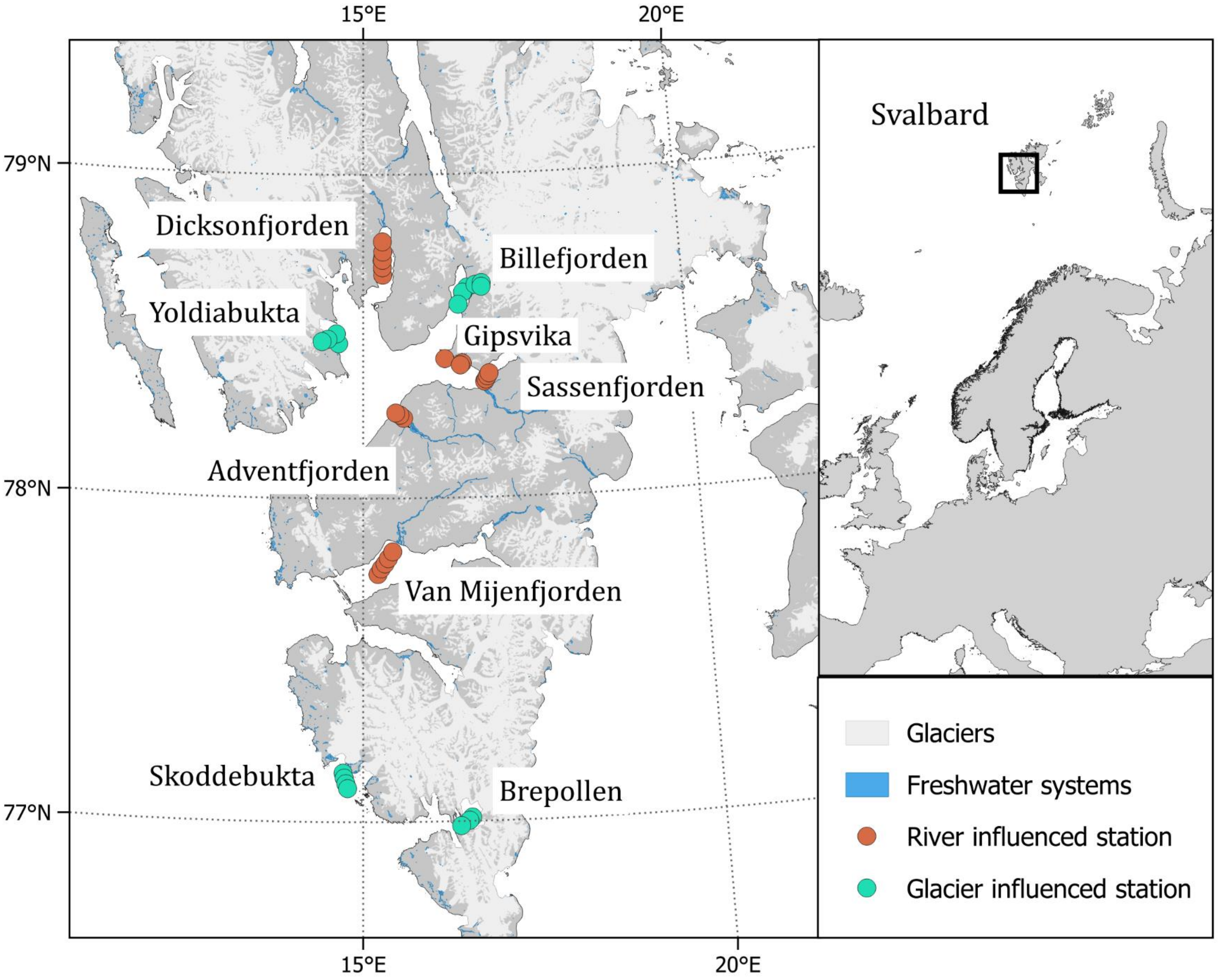
# Aim

- compare the environmental conditions and macrofaunal (assessed morphologically) and eukaryote and bacterial (sediment eDNA) composition and diversity in glacial and glaciofluvial bays,
- explore the relationships between the biotic communities and environmental variability to assess the response of various taxonomic groups to environmental conditions and determine their sensitivities to natural and anthropogenic stressors

https://blogs.helmholtz.de/

# Study area

r/v Oceania (photo K. Deja)



# Research methods

van Veen grab

Box corer

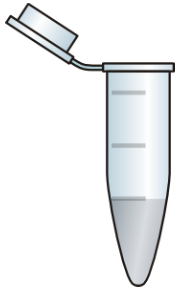
Nemisto corer

☐ Macrofauna

☐ Sediments

- Environmental parameters →
  - Chl a, pheophytin
  - Grain size
  - Sediment accumulation rate
  - POC, TOC, TN, $\delta^{13}C$, $\delta^{15}N$
  - Heavy metals
  - PCBs
  - PAHs
- eDNA
  - (~10g of sediments)
  - 3 replicates / station

# Molecular methods



DNA extraction using
Qiagen PowerMax Soil Kit
~10g of sediments

PCR amplification with 3 different markers:

- mtCOI
- 18S V1V2 (Eukaryota)
- 16S V3V4 (Bacteria)

NGS sequencing on
Illumina MiSeq

Bioinformatics

sleim

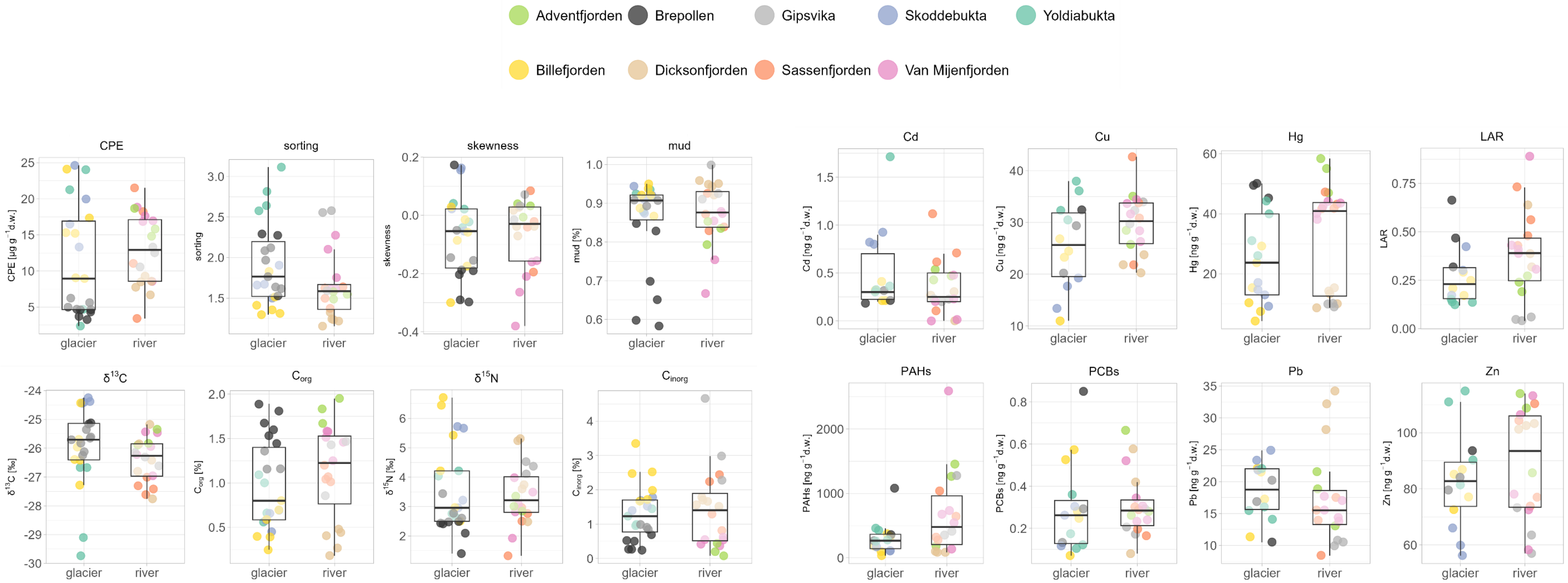
DADA$^2$
Amplicon Sequencing. Exactly. Version 1.18

Taxonomic assignment
based on reference
databases

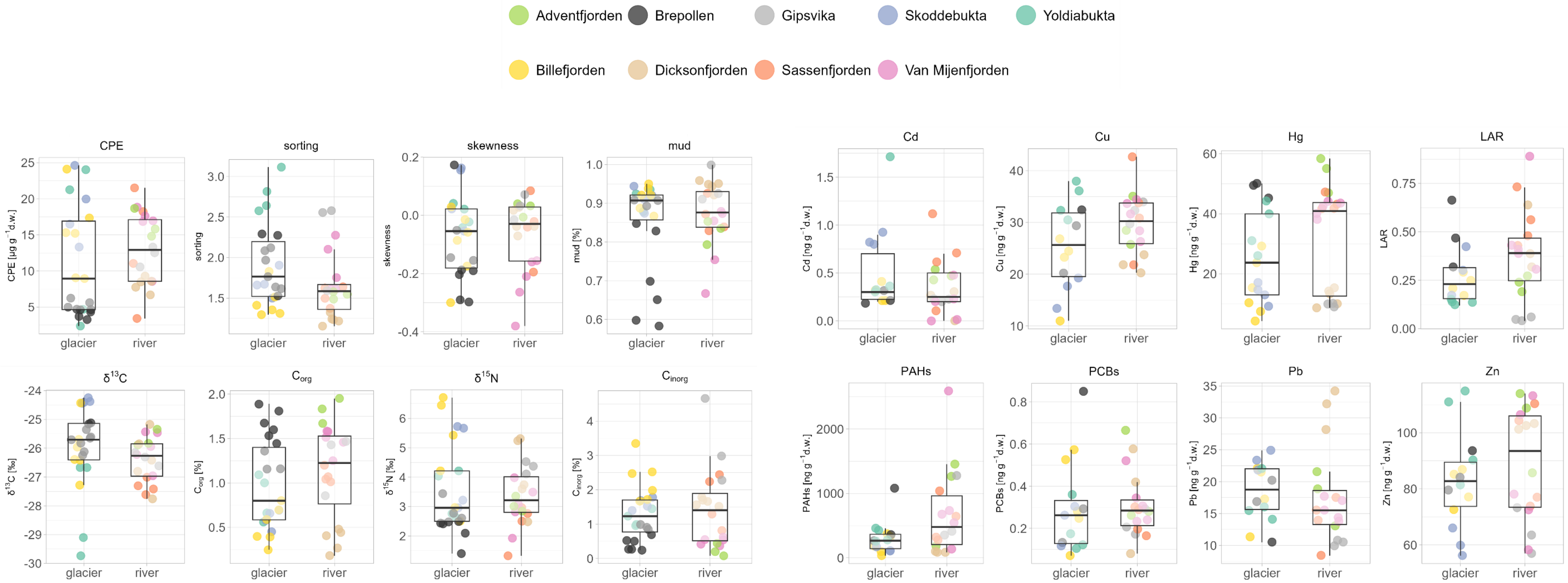
PR$^2$

silva ngs

# Environmental conditions at studied locations

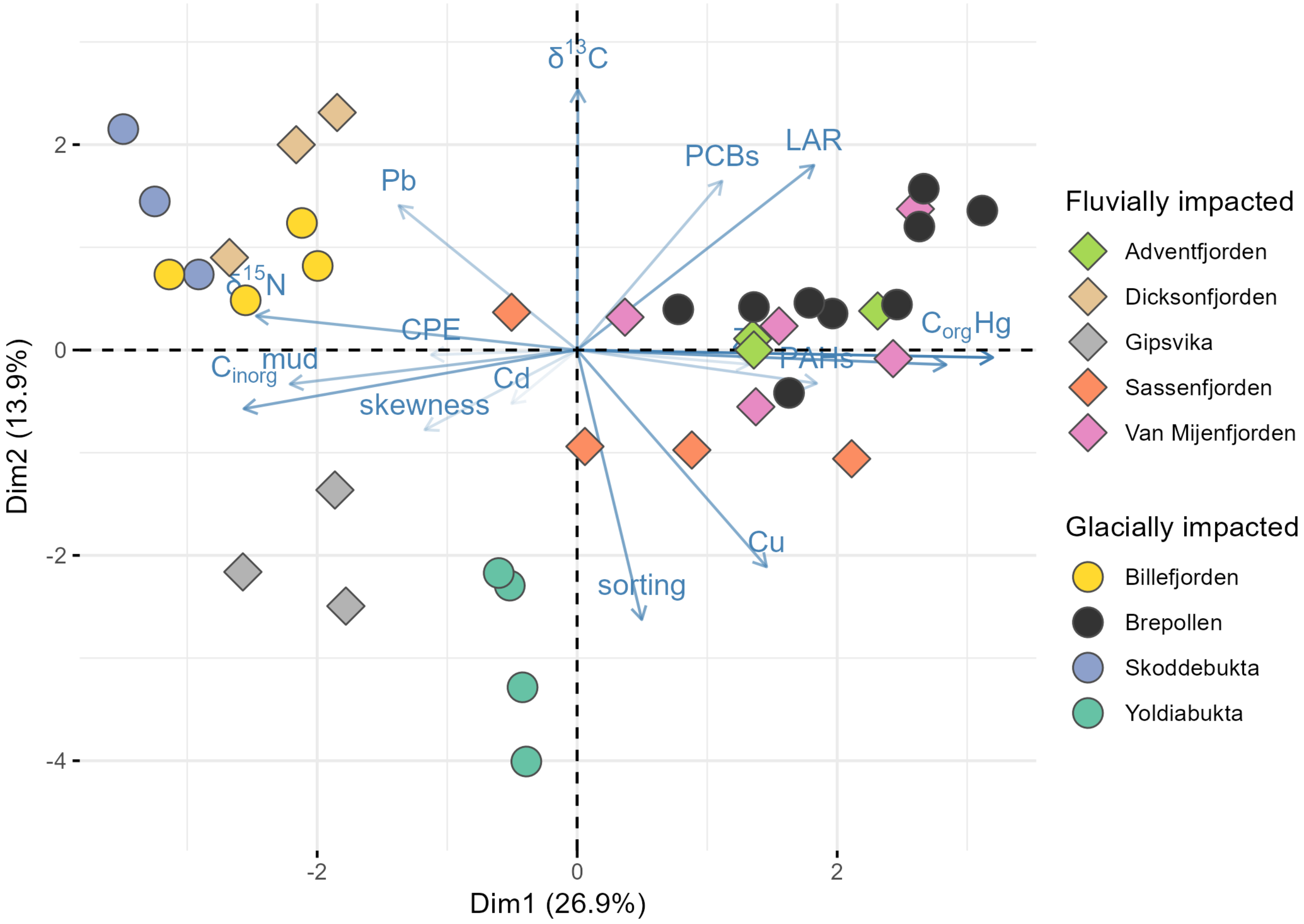


# Environmental conditions at studies locations

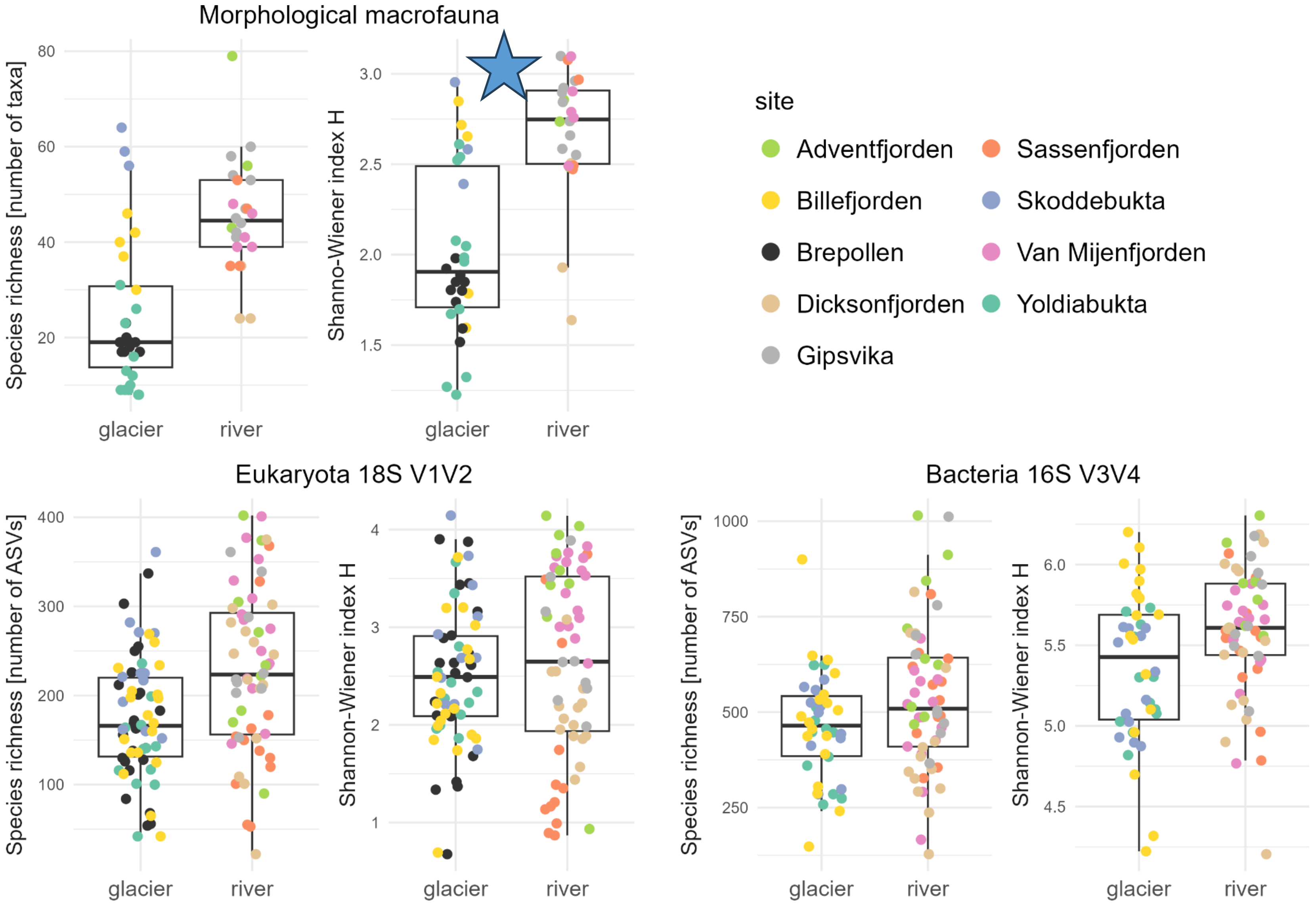


**No statistically significant difference between glacier and river in all cases (indicated by Linear Mixed Models)**

# Environmental conditions at studies locations

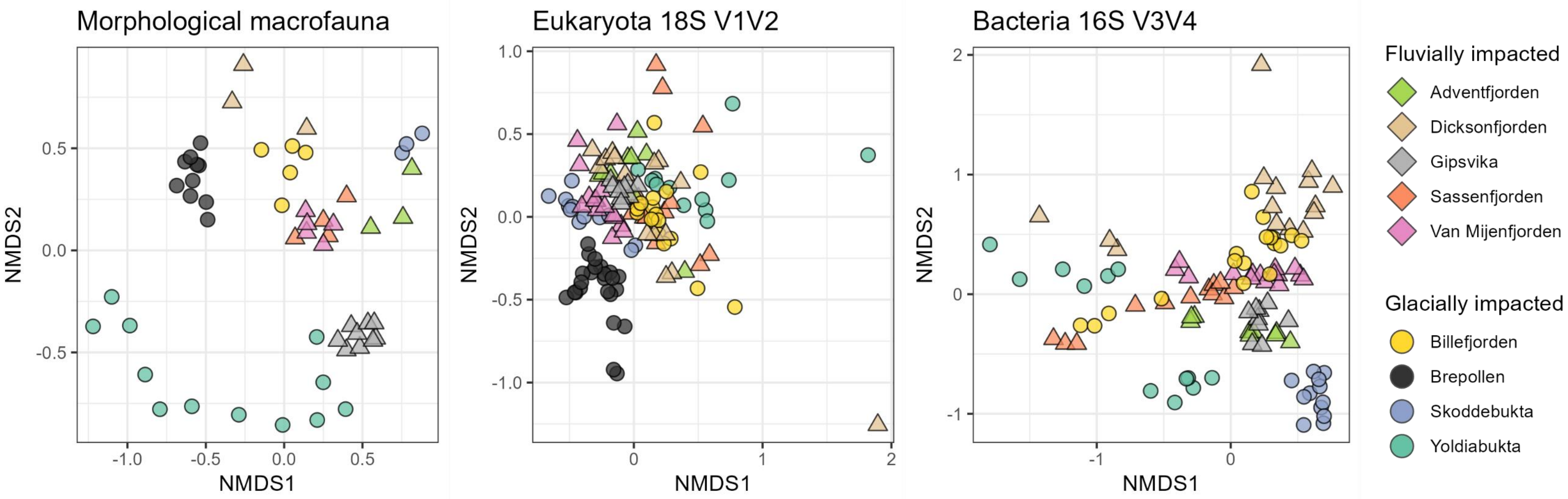


# Alpha diversity



★ $p<0.05$

# Beta diversity



Step-wise DistLM based on BIC

| Variable | Pseudo-F | R2 | R2 cum |
|---|---|---|---|
| **CPE** | 8 | 0.14 | 0.14 |
| **sorting** | 8.2 | 0.12 | 0.26 |
| **$C_{inorg}$** | 5.7 | 0.08 | 0.33 |
| **$C_{org}$** | 5 | 0.06 | 0.4 |
| **$\delta^{13}C$** | 4.1 | 0.05 | 0.45 |

| Variable | Pseudo-F | R2 | R2 cum |
|---|---|---|---|
| **$\delta^{13}C$** | 9 | 0.08 | 0.08 |
| **CPE** | 9.7 | 0.08 | 0.15 |
| **$C_{org}$** | 7.2 | 0.05 | 0.21 |
| **Hg** | 5 | 0.04 | 0.24 |
| **$C_{inorg}$** | 4.6 | 0.03 | 0.27 |
| **sorting** | 4.9 | 0.03 | 0.31 |

| Variable | Pseudo-F | R2 | R2 cum |
|---|---|---|---|
| **$\delta^{13}C$** | 11.4 | 0.12 | 0.12 |
| **Cd** | 7.4 | 0.07 | 0.19 |
| **$C_{org}$** | 6.5 | 0.06 | 0.25 |
| **PCBs** | 6 | 0.05 | 0.3 |
| **sorting** | 4.9 | 0.04 | 0.34 |
| **skewness** | 5.3 | 0.04 | 0.38 |
| **$C_{inorg}$** | 5.1 | 0.04 | 0.42 |
| **Zn** | 4.9 | 0.03 | 0.45 |

# Summary

- There is no significant difference between glacier and river-influenced locations; site-specific characteristics are more pronounced
- Macrofauna alpha diversity differs between glacier and river-impacted locations, with no effect on Eukaryotic and Bacterial eDNA
- The taxonomic composition of macrofauna seems site-specific, contrary to eDNA data
- Distinct environmental variables shape each community

The research was founded by the National Research Center (OPUS17: 2019/33/B/NZ8/02542 Metabarcoding applied in revealing environmental stressors effects on the coastal benthic diversity in the warming Arctic - MetaDivA)

# Thank you!