Investigating the dynamics of the aquatic community in Oslofjord through time series analysis of eDNA

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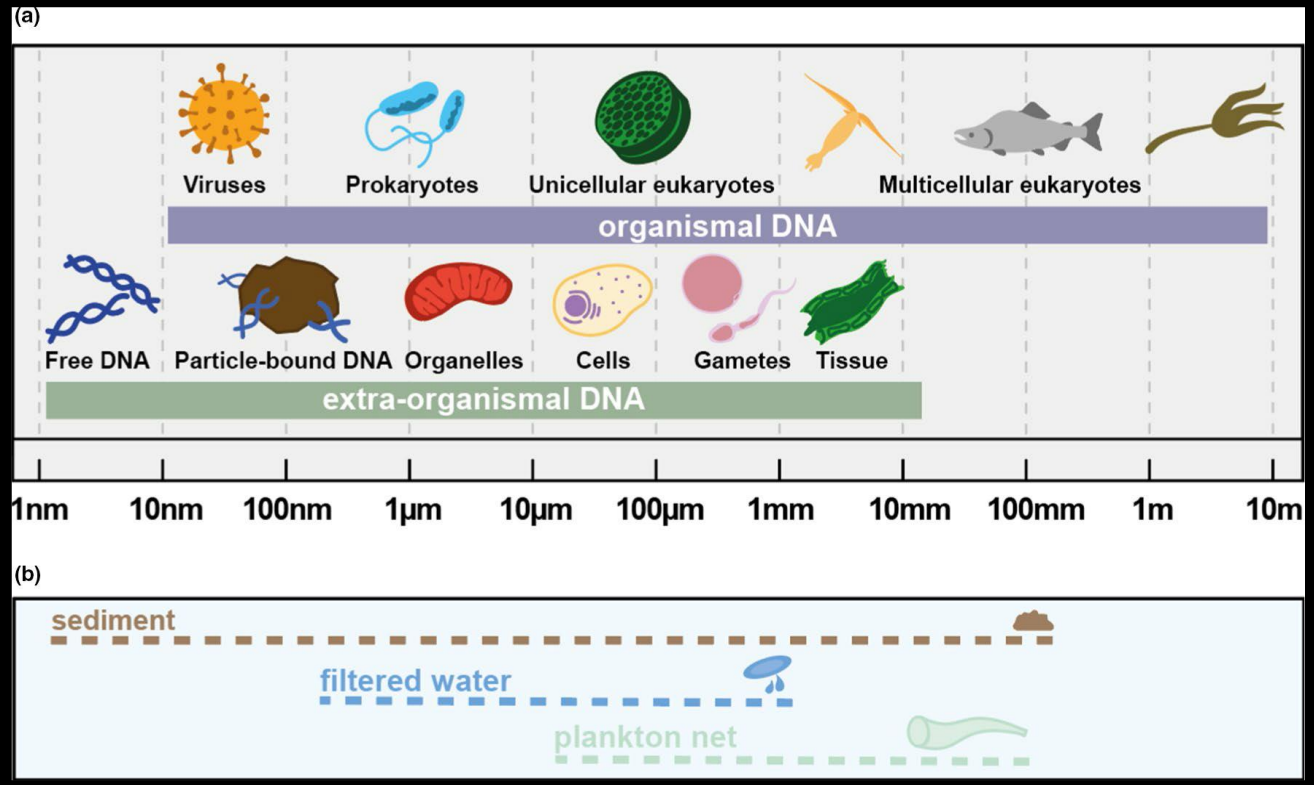
What is eDNA (environmental DNA)?

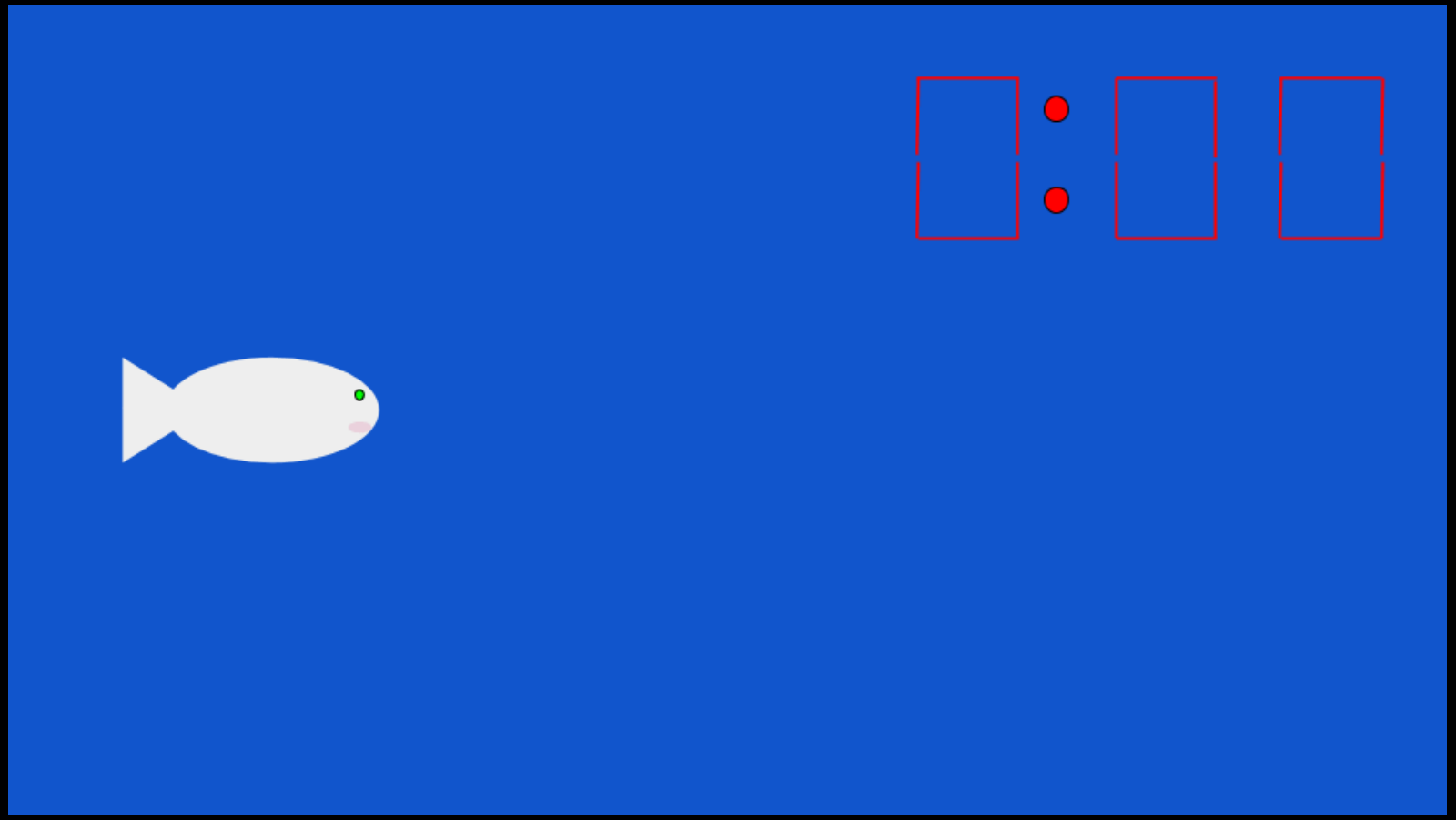


Rodriguez-Ezpeleta et al. 2021. *Molecular Ecology*

- **Free DNA originating from an organism which can be isolated from the habitat of the organism, rather than directly from the organism itself**
- **eDNA should be used to refer to the total pool of DNA isolated from the environment**
- **eDNA is composed of organismal and extra organismal DNA**

What is eDNA (environmental DNA)?

- **Limitations**
- **Persistence**
- **Abundance**
- **Sampling technique**
- **Habitat parameters**



False positive and false negative

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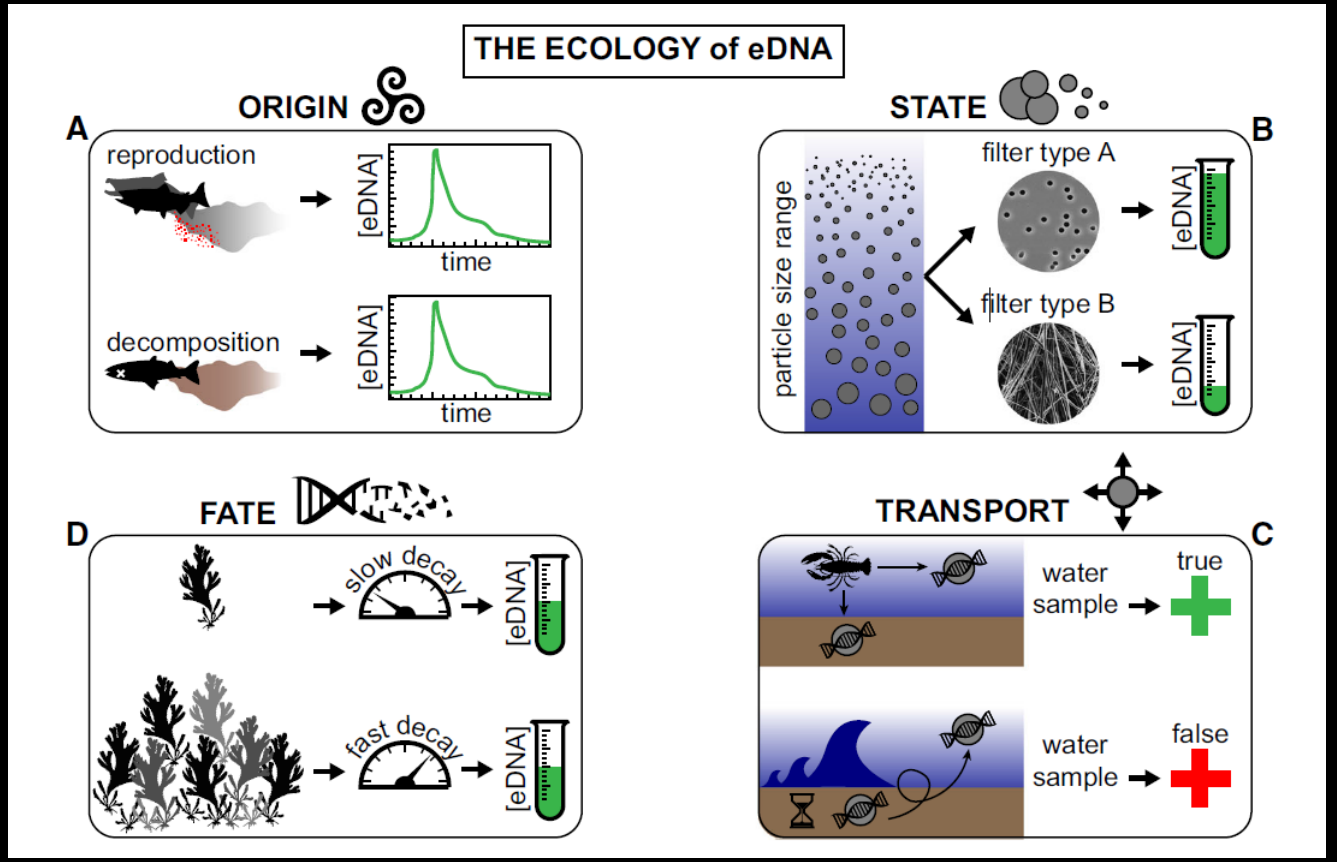
Limitations of eDNA based methods

- **Experimental design**
- **Weather / seasonality**
- **Environment / habitat constraints**
- **Sampling technique**
- **UV / pH / temperature**



Barnes & Turner 2015. *Conservation Genetics*

False positive / negative

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Metabarcoding – Benefits

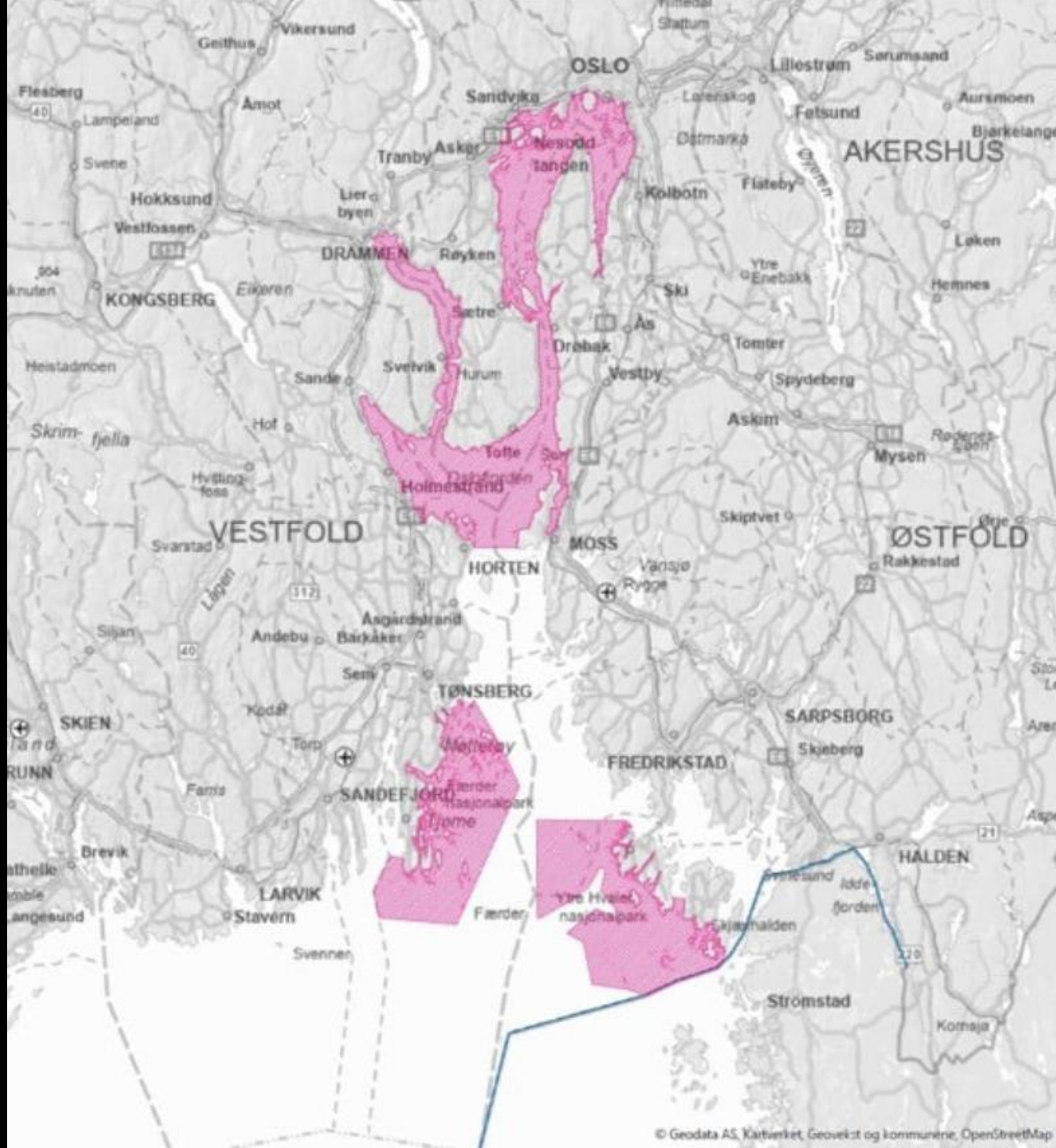
- **Non-destructive and non-invasive**
- **Detect rare, invasive, cryptic and elusive species**
- **Monitor imminent or ongoing environmental changes in remote locations**
- **Easily standardized**
- **Simultaneous assessment of wide range of organisms**

Limitations?

False positive/negative

Oslofjord

- Sever threats on the ecosystem
- Fisheries, pollution and runoff from agriculture, sewages
- Fishing ban for cod in 2018: “not had the desired effect”
- Extensive consultation process
- Introduction of zero-fishing zones for 10 years



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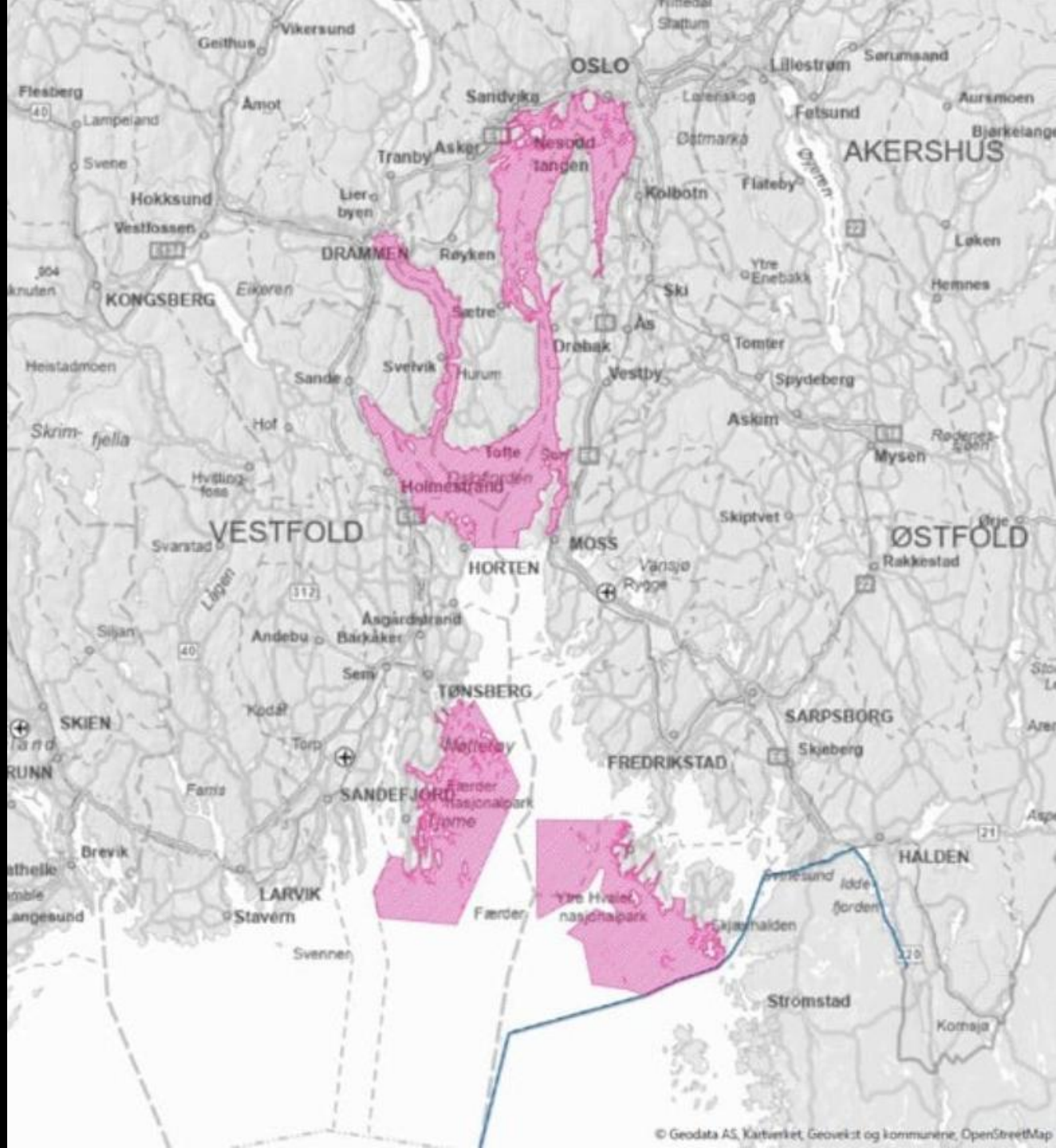
Oslofjord in Drøbak

- How to monitor the Oslofjord with minimal impacts on the environment?
- Environmental DNA based monitoring?
- Does eDNA time series analysis allow to observe ecosystem shifts?
- Past and ongoing work



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www.nature.com/scientificreports

scientific reports

Check for updates

OPEN

Harnessing eDNA metabarcoding to investigate fish community composition and its seasonal changes in the Oslo fjord

Cintia Oliveira Carvalho[1,2,5], William Gromstad[1,5], Micah Dunthorn[1], Hans Erik Karlsen[3], Audun Schrøder-Nielsen[1], Jonathan Stuart Ready[2], Torbjørn Haugaasen[4], Grete Sørnes[3], Hugo de Boer[1] & Quentin Mauvisseau[1]

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REGULAR ARTICLE

JOURNAL OF FISH BIOLOGY fsbi

Investigating the dynamics of the aquatic community in Oslofjord through time series analysis of eDNA

Sibusiso Mahlangu[1] | Isabelle Ewers[1] | Cintia Oliveira Carvalho[1,2] | Audun Schrøder-Nielsen[1] | Micah Dunthorn[1] | Hans Erik Karlsen[3] | Grete Sørnes[3] | Louise Chavarie[2] | Dag Endresen[1] | Jonathan Stuart Ready[4] | Hugo J. de Boer[1] | Quentin Mauvisseau[1]

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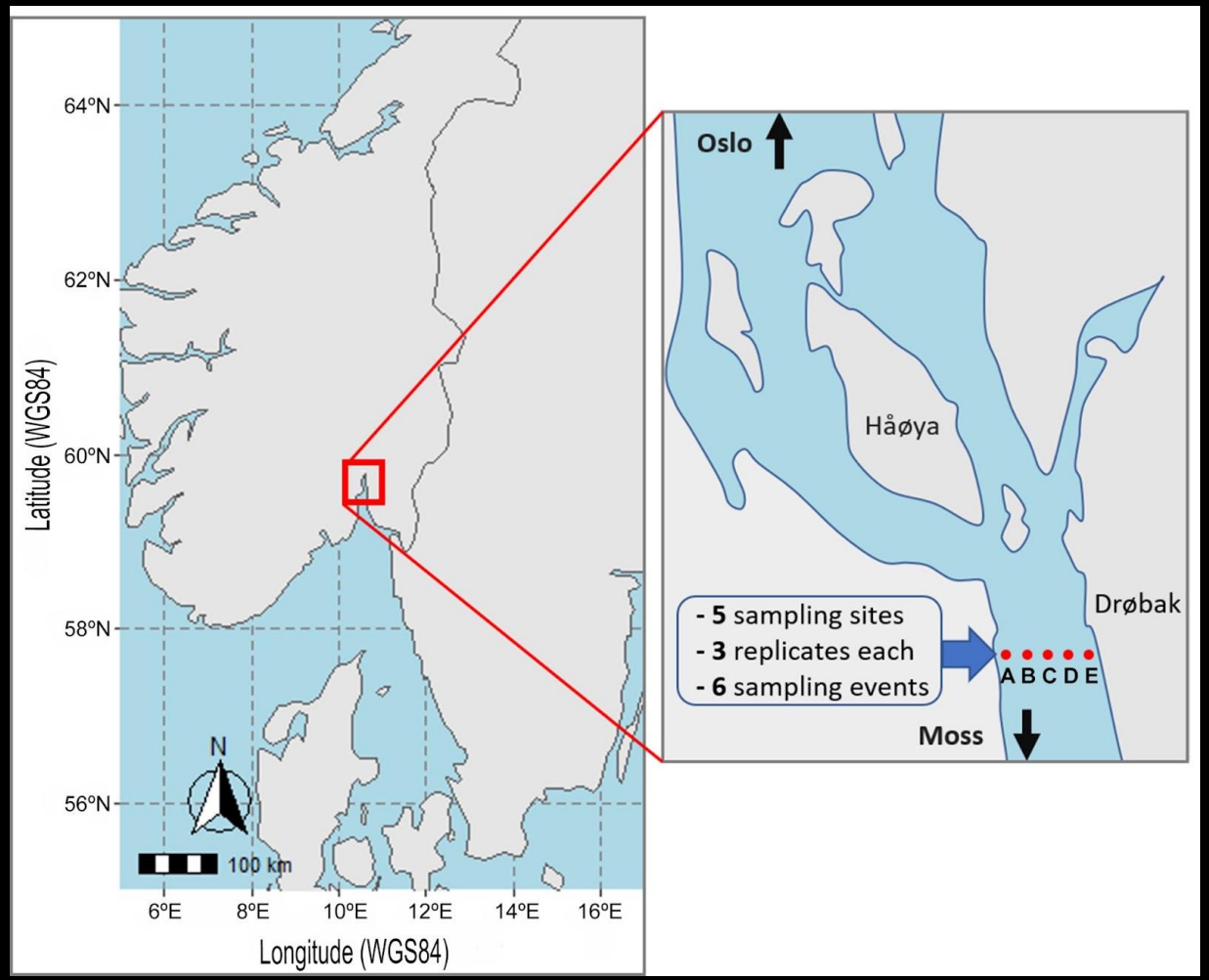
eDNA in Drøbak: method

- Oslofjord stretches 100 km from Skagerrak/North Sea to Oslo
- Maximum depth of 258 m
- Inner fjord separated from outer fjord near Drøbak
- Drøbak: shallow sill of about 20 m
- Dramatic environmental decline



Carvalho et al 2024. *Scientific Reports*

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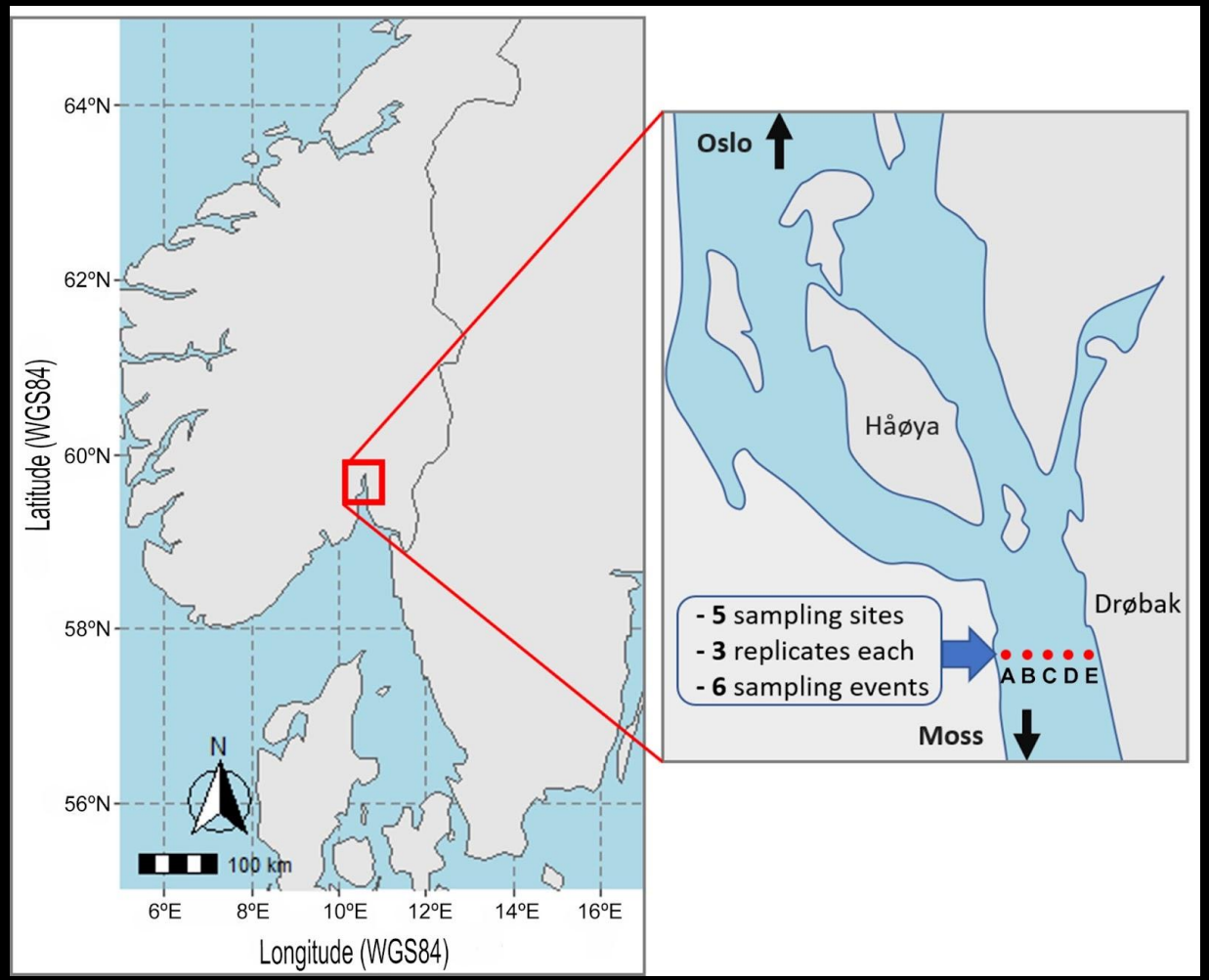
eDNA in Drøbak: method

- Two years of sampling: March 2022 to January 2024 (January 2025…)
- 180 eDNA samples, 12 field negative controls
- Sampling every two months
- Other environmental parameters
- MiFish and Elas02 primers. MiSeq. Custom bioinformatics pipelines



Carvalho et al 2024. *Scientific Reports*

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eDNA in Drøbak: method

- Collect water in sterile containers
- Filter holders and sterile membranes
- 0.8 µm pore size and 22 mm diameters
- Freeze samples until DNA extraction and analysis

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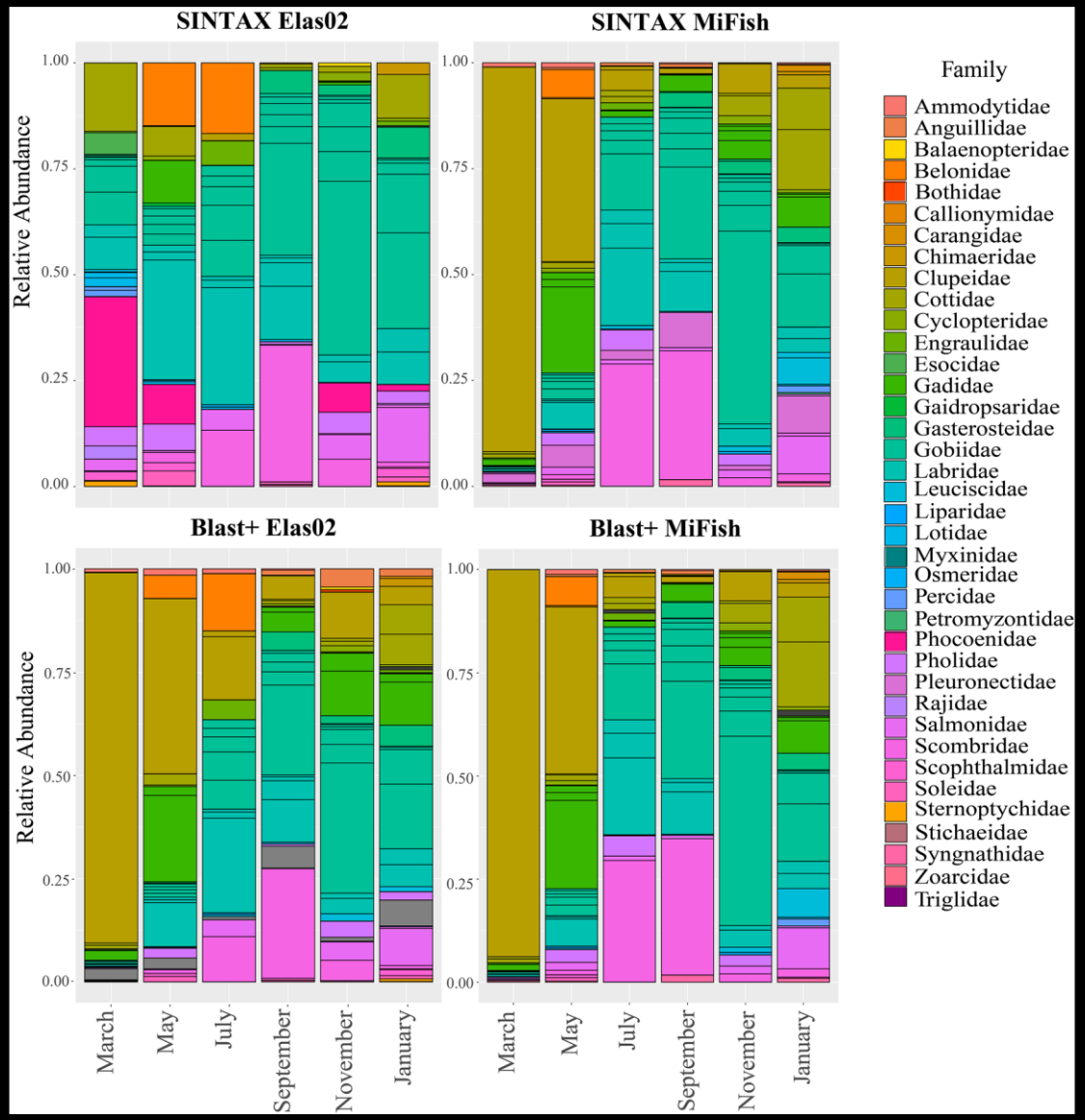
eDNA in Drøbak - year 1

- 63 unique fish species + Sei whale and Harbour porpoise
- 35 species detected with both primers (16 Elas02, and 14 MiFish only)
- Many other birds and mammals detected
- No differences between SINTAX and Blast+ for the taxonomic assignment (using the same database MIDORI2)



Carvalho et al 2024. *Scientific Reports*

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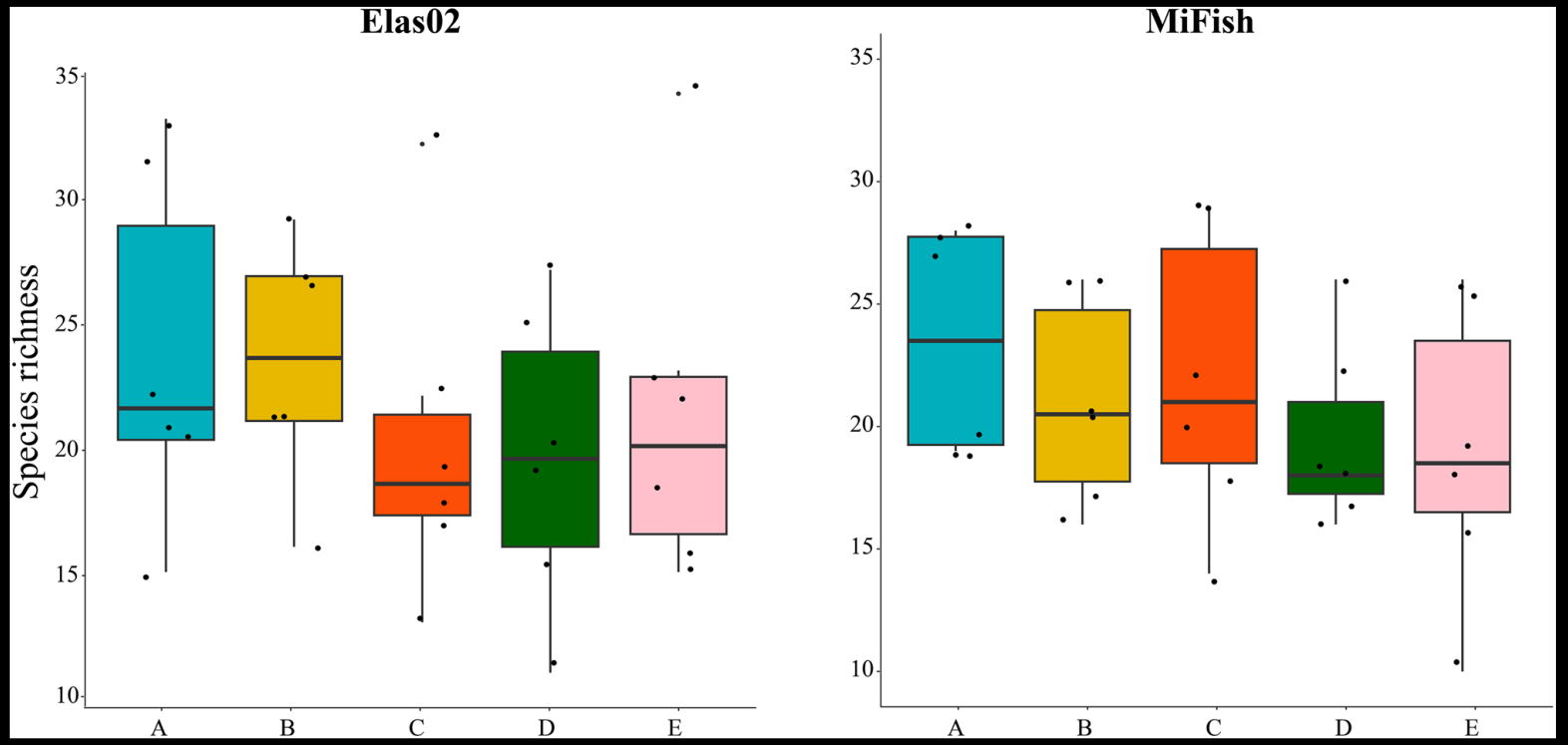
eDNA in Drøbak - year 1

No significant difference of species richness across sampling sites for each primers



Carvalho et al 2024. *Scientific Reports*

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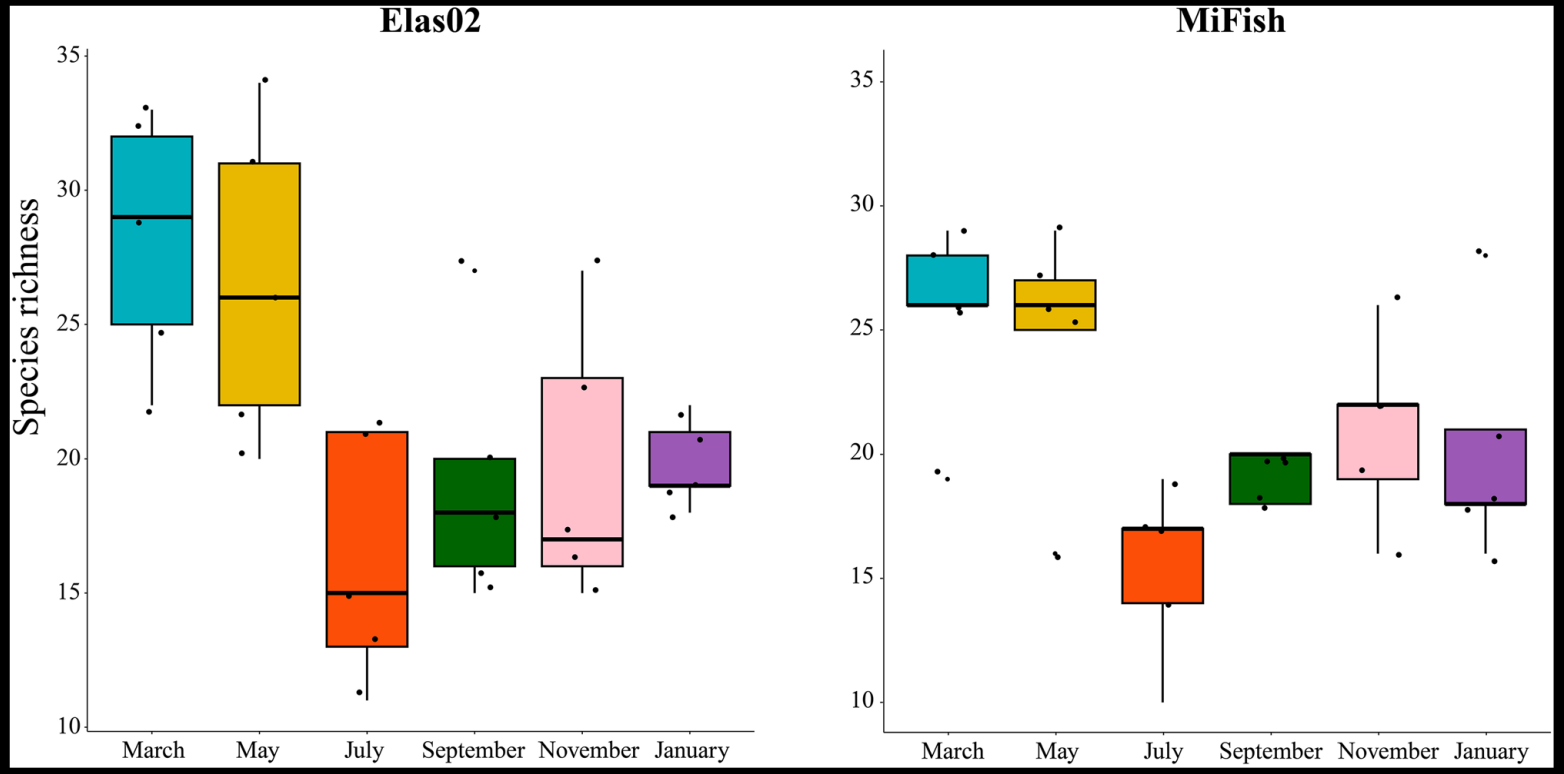
Oslofjord in Drøbak - year 1

Strong seasonal variation for both primer sets

Volume, temperature, conductivity (linked to seasons)



Carvalho et al 2024. *Scientific Reports*

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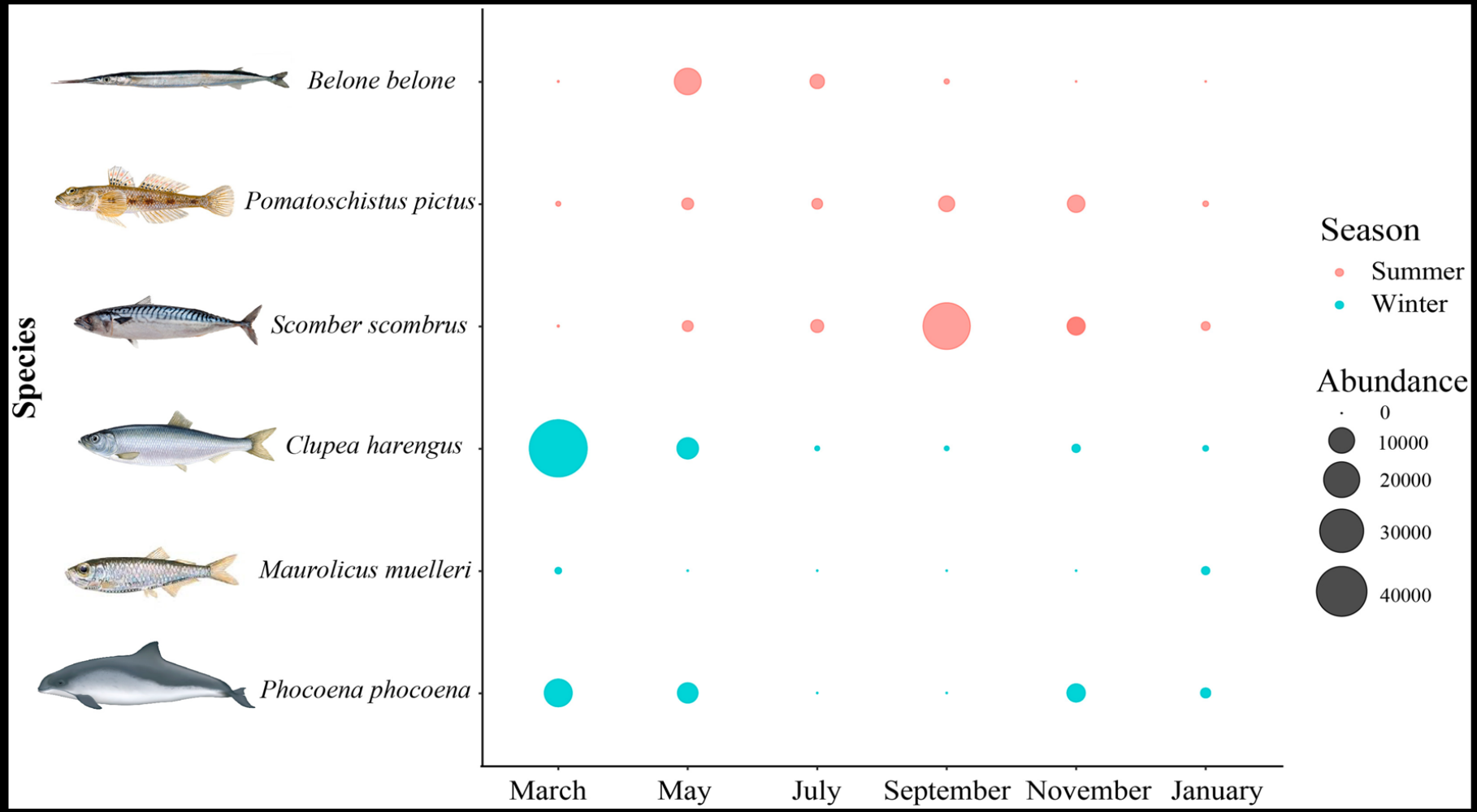
Oslofjord in Drøbak - year 1

Interesting pattern of seasonal changes (read counts as a proxy for relative abundance)

Winter vs summer species



Carvalho et al 2024. *Scientific Reports*

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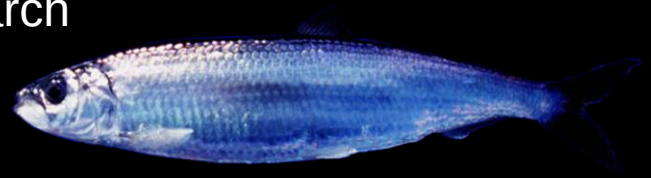
eDNA in Drøbak - year 2

- 63 unique fish species, key species patterns
- *Clupea harengus* in March



- *Scomber scombrus* in Summer

- *Gobiusculus flavescens* in Autumn months

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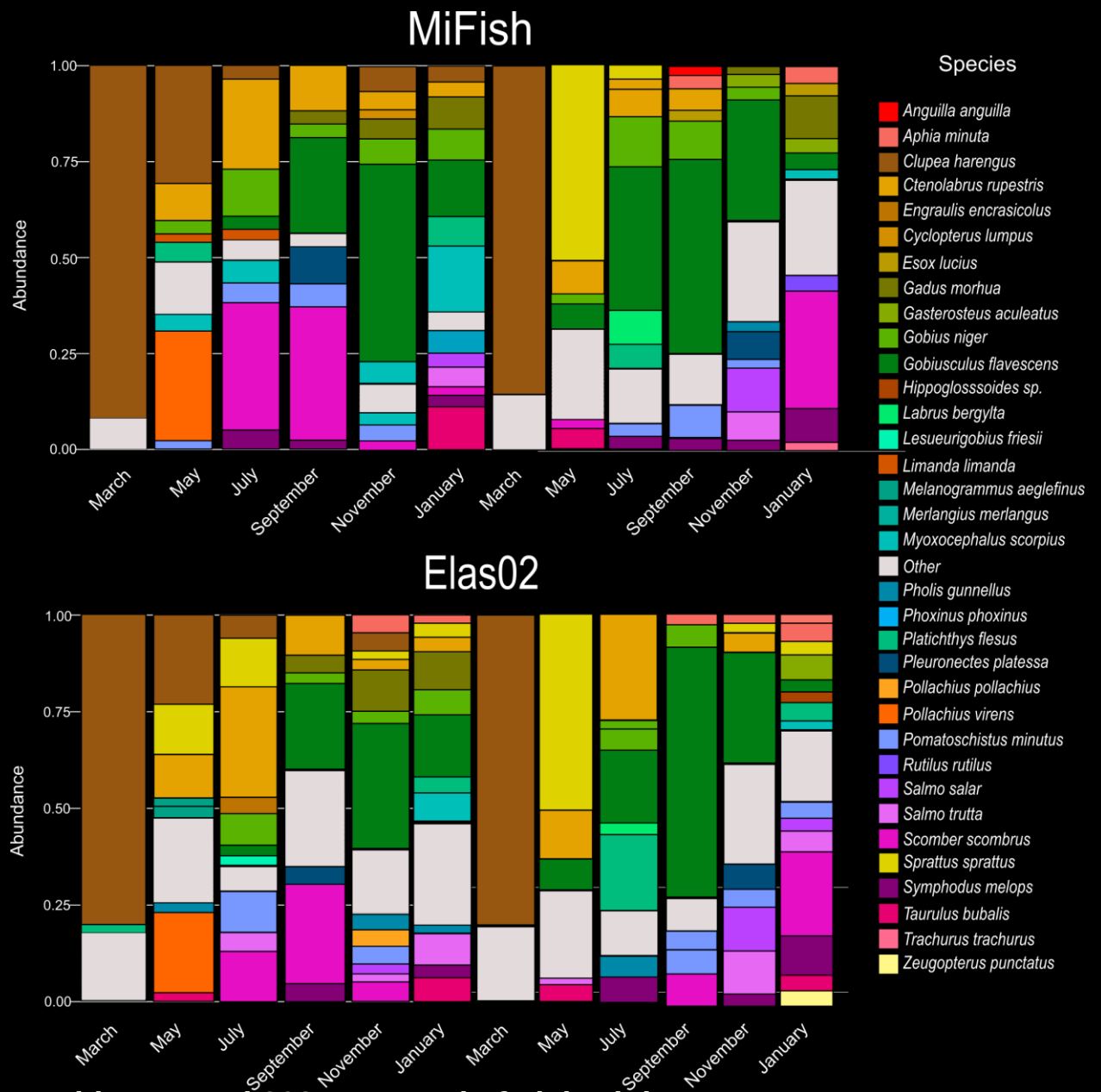
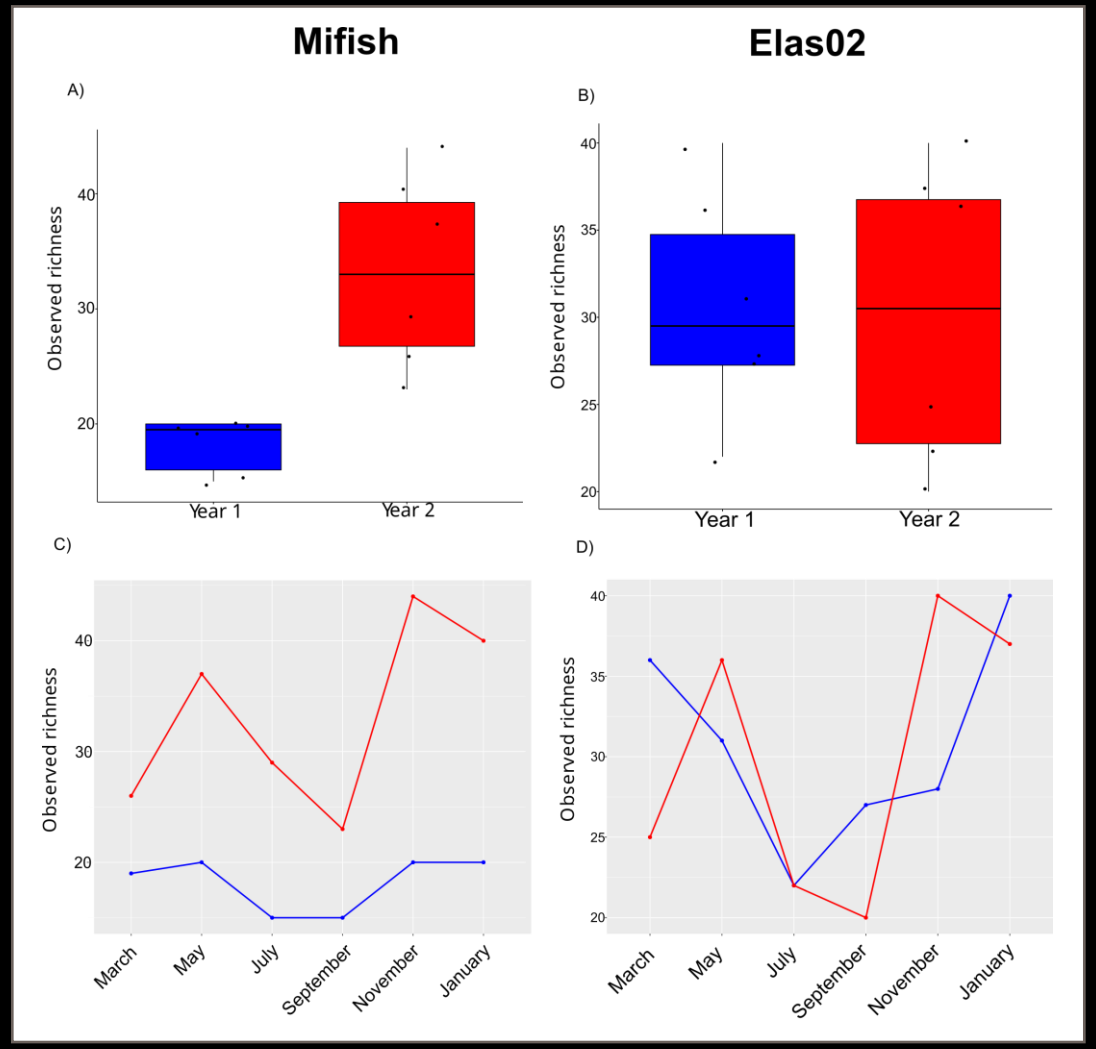


Mahlangu et al 2025. *Journal of Fish Biology*

eDNA in Drøbak - year 2

- MiFish: significant increase in species richness in year 2 (linked to library-prep before sequencing)
- Elas02: stable richness across years but turnover in taxa
- Presence/absence data showed significant differences between years (MiFish *p= 0.002*, Elas02 *p = 0.007*)
- Community shifts driven by species turnover, not abundance



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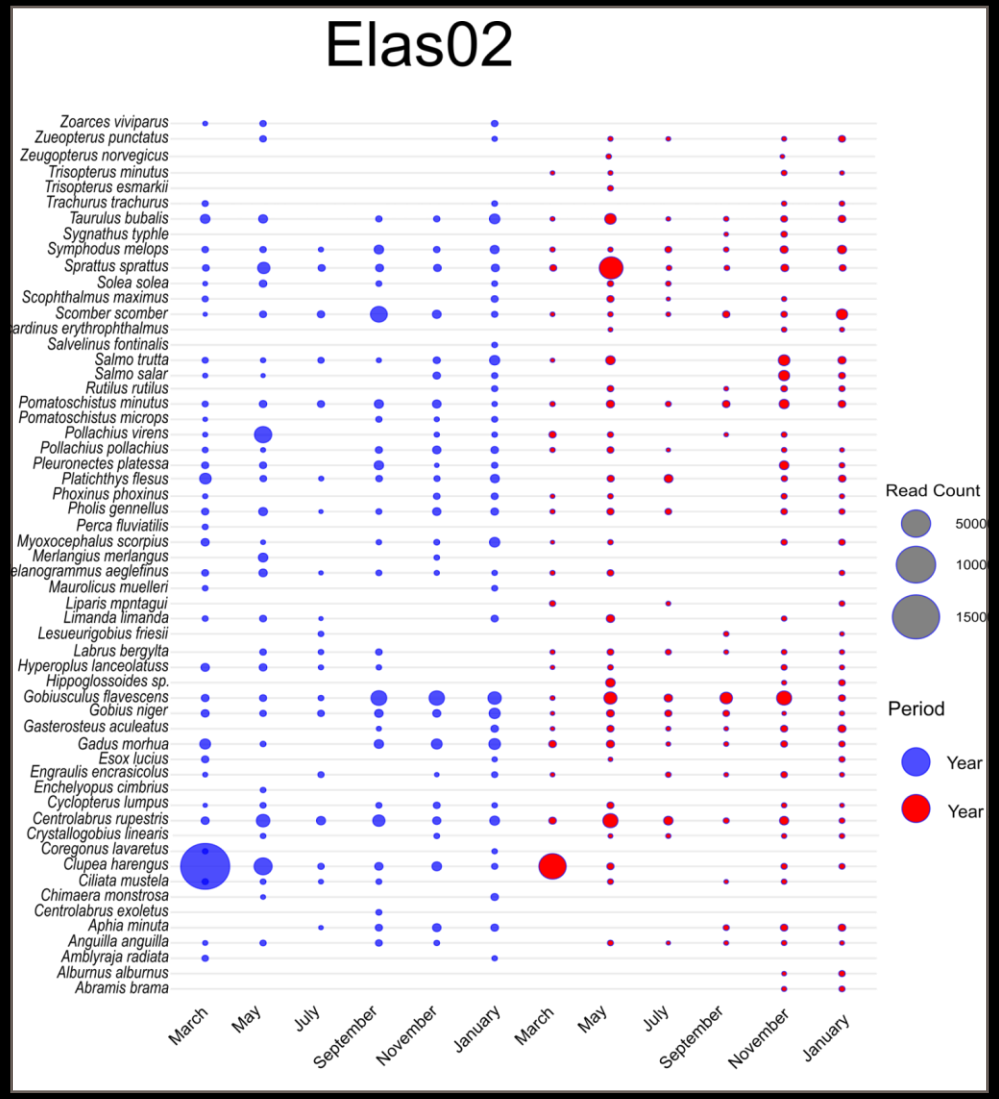
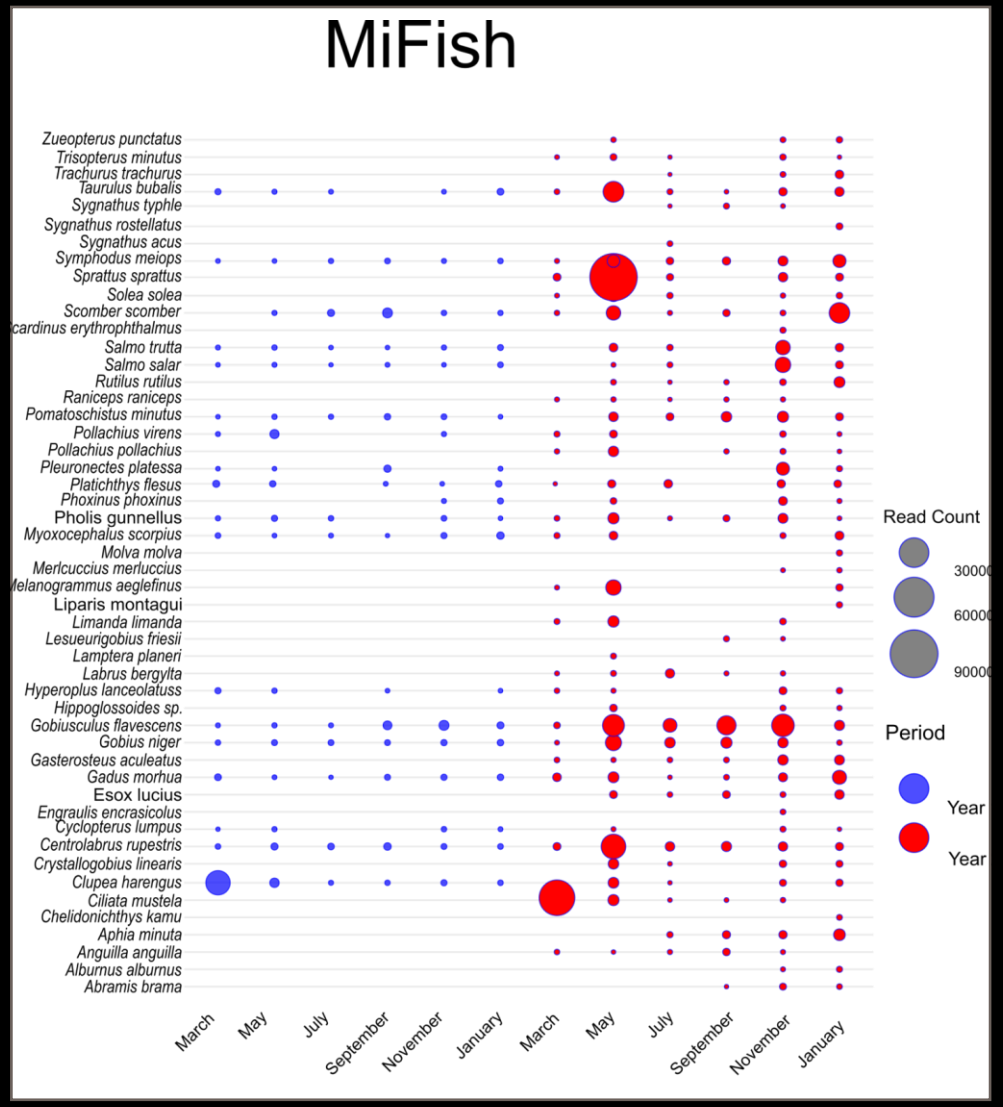
eDNA in Drøbak - year 2





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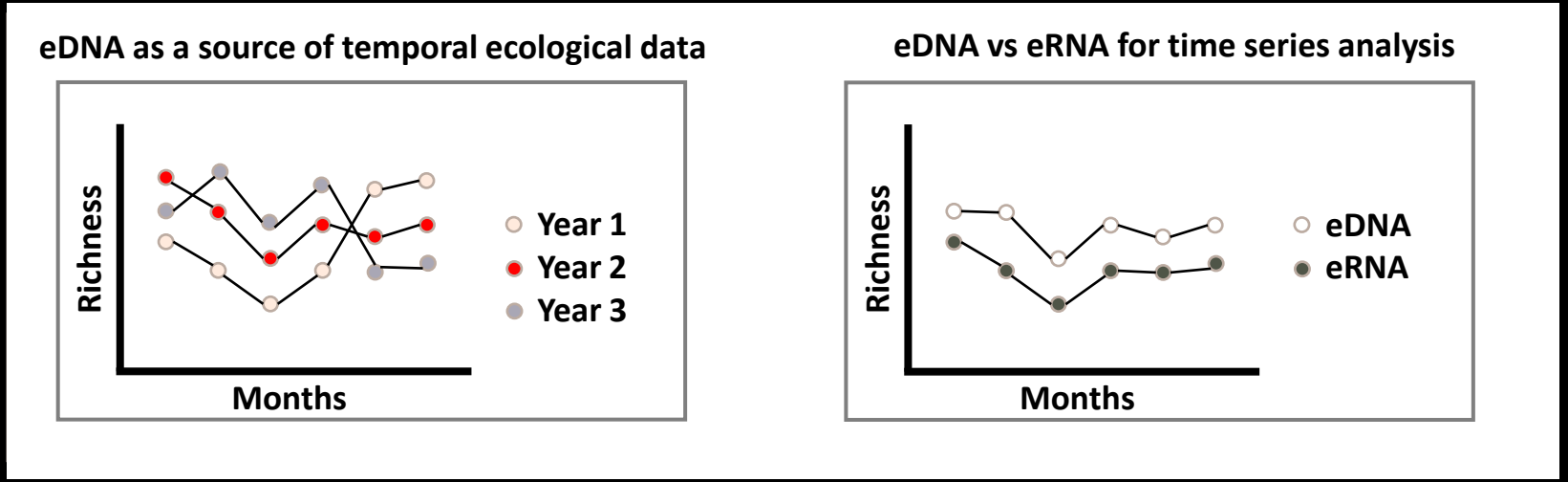
eDNA in Drøbak - year 3 incoming!

- Third year of sampling (until January 2025)
- eDNA following the same protocol as studies 1-2
- eDNA/eRNA using different protocol
- MiFish, Elas02 (and ITS2!)



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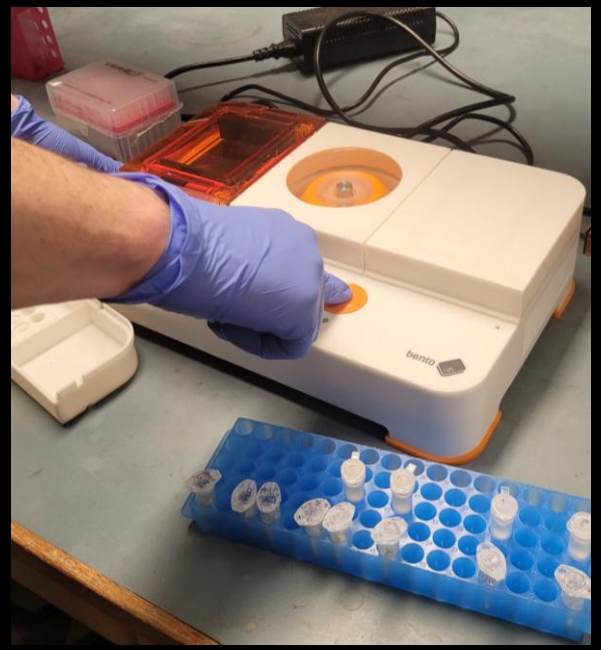
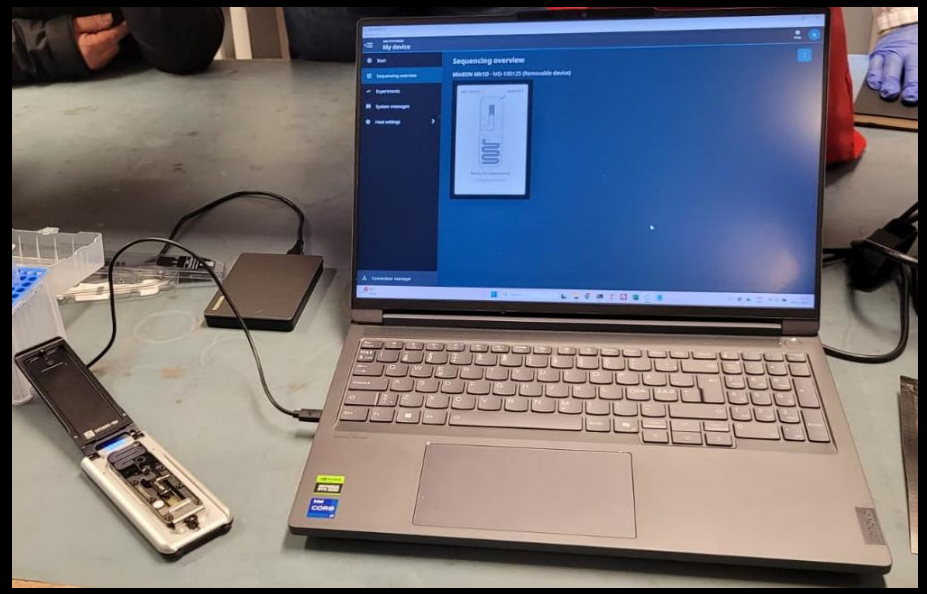
What about on-site monitoring?





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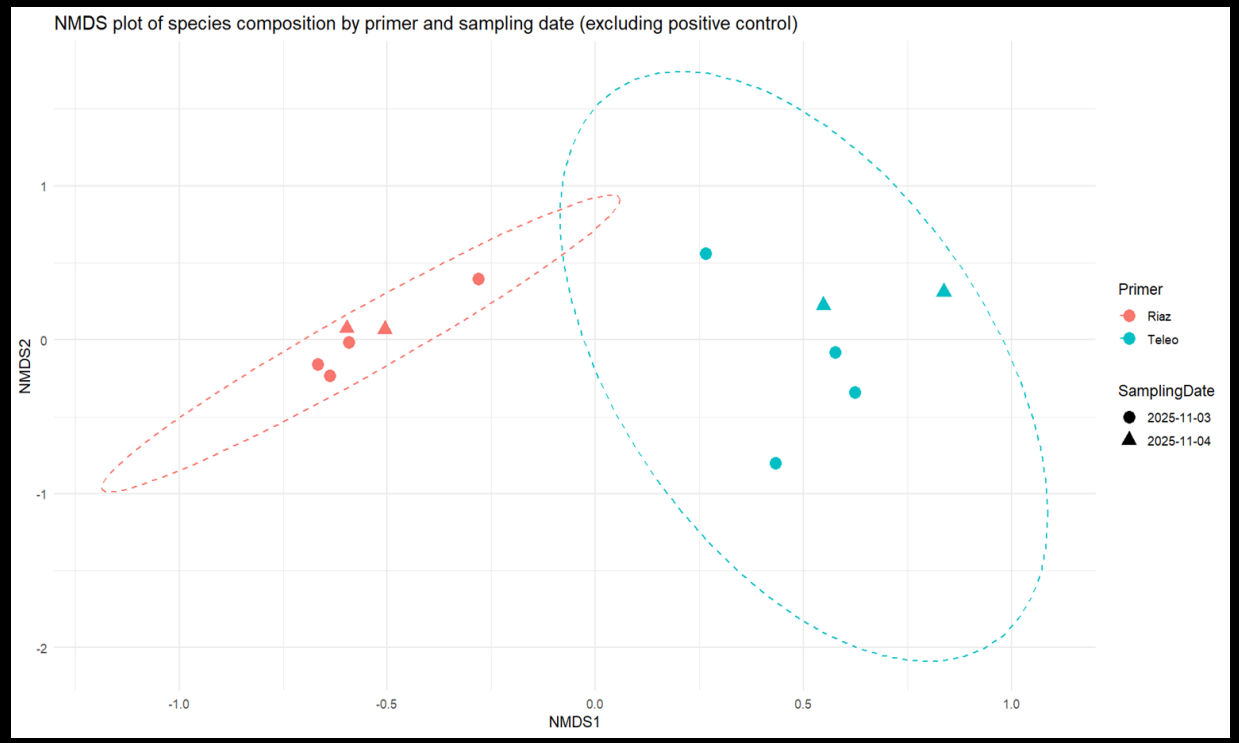

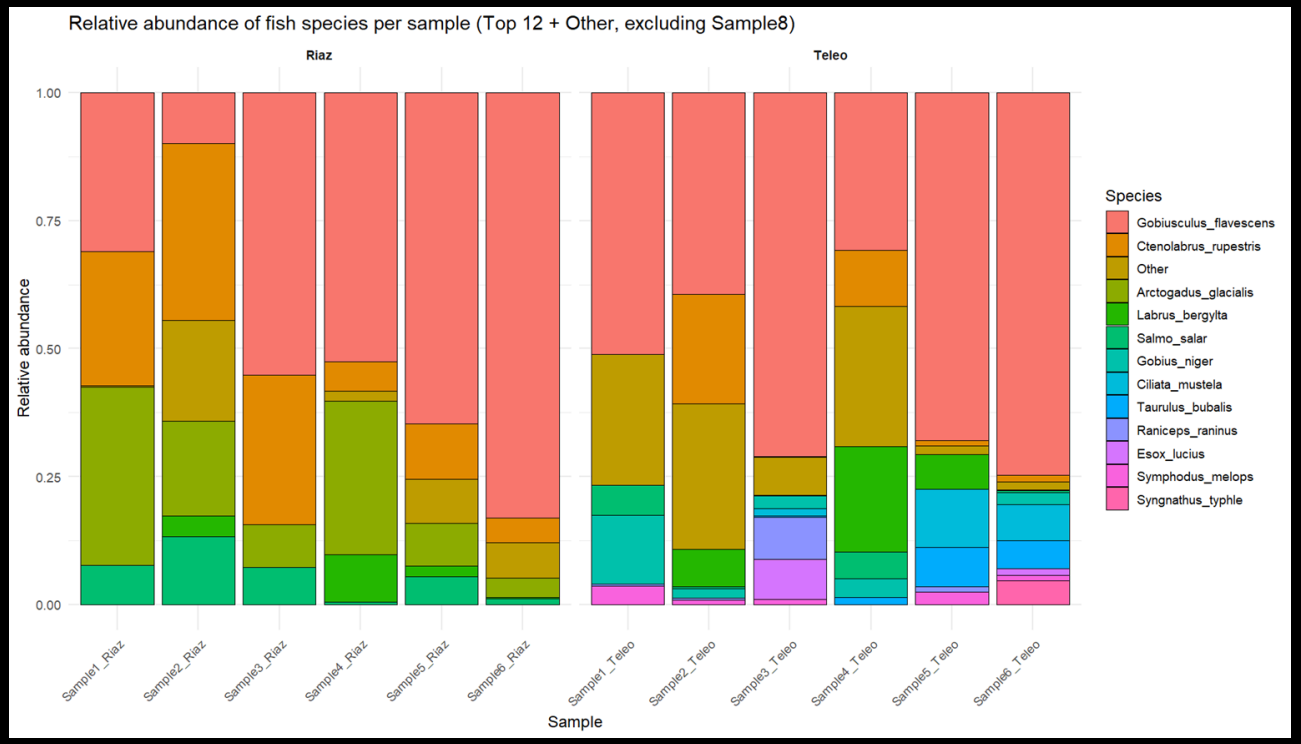

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How to increase results reliability?

Environmental DNA
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Dedicated to the study and use of environmental DNA for basic and applied sciences

ORIGINAL ARTICLE | Open Access

eDNA Replicates, Polymerase and Amplicon Size Impact Inference of Richness Across Habitats

Jarl Andreas Anmarkrud, Fabricio dos Anjos Santa Rosa, Lisbeth Thorbek, Audun Schrøder-Nielsen, Silvana Melo Sviggum, Jonathan Stuart Ready, Hugo J. de Boer, Quentin Mauvisseau

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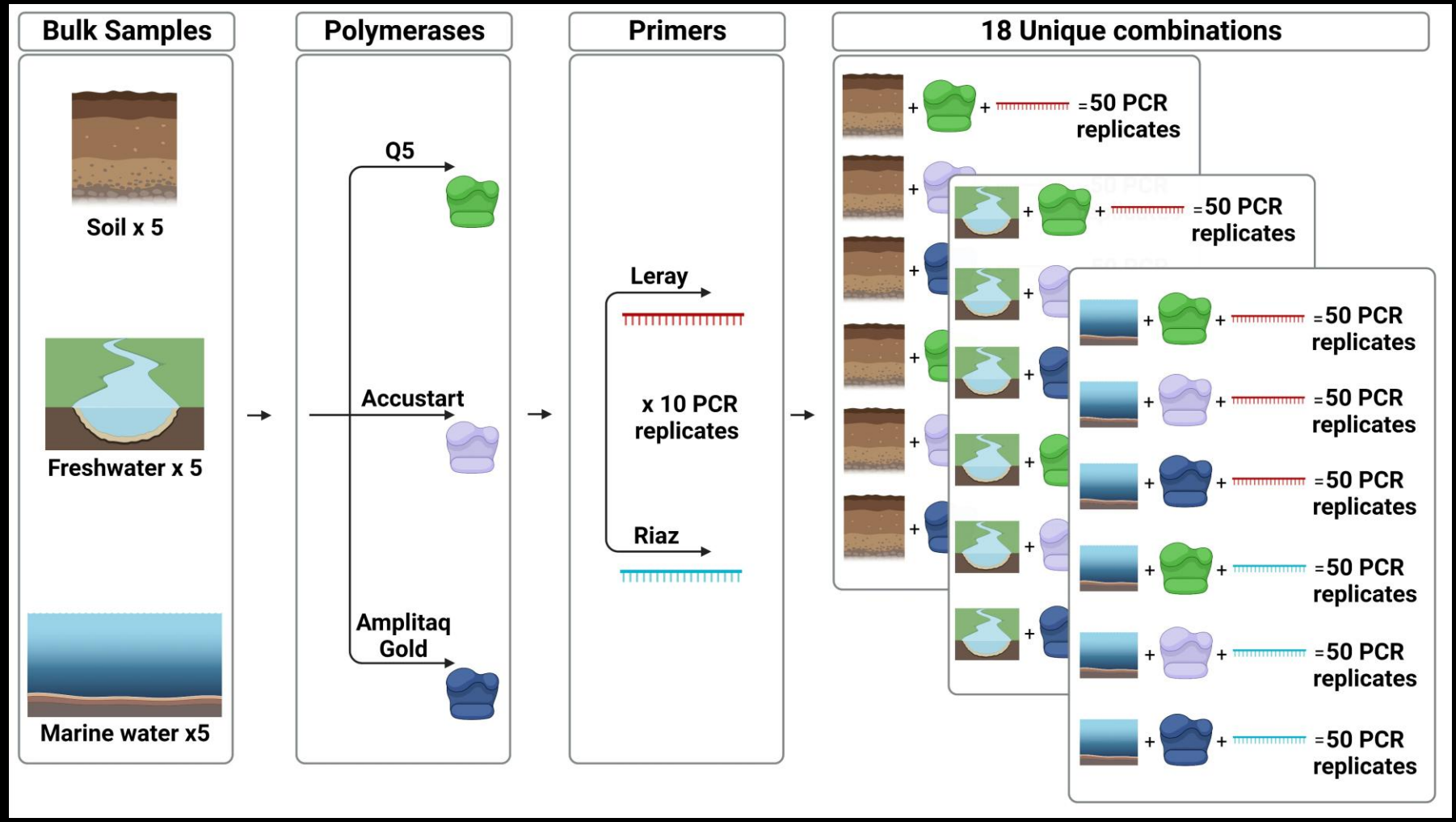

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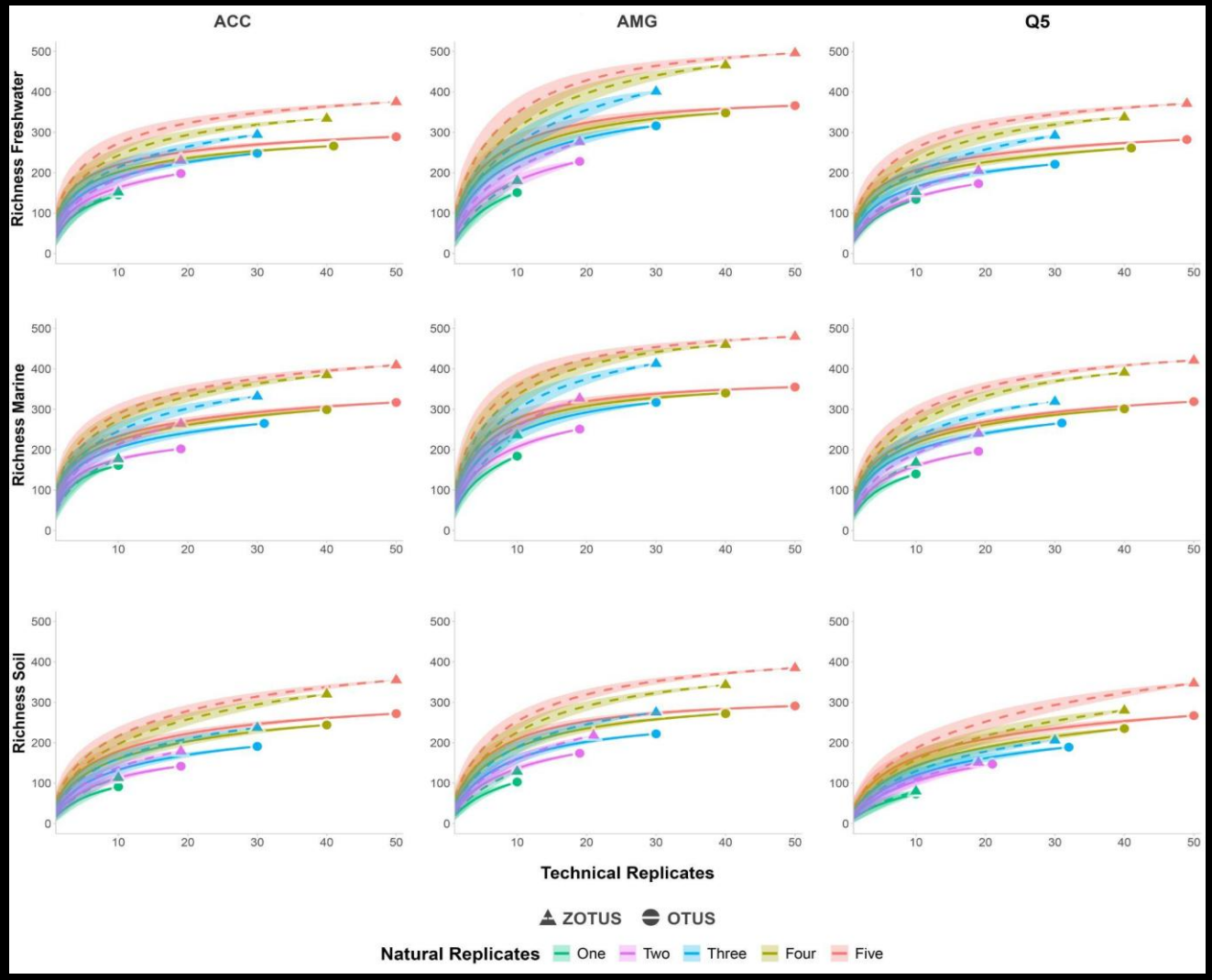

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Thanks!!!

The Research Council of Norway

BRC Biodiversity Research Consortium Brazil-Norway

UiO : University of Oslo

Any questions?

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