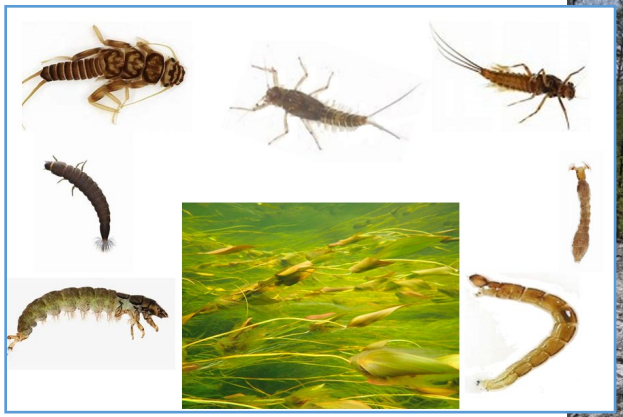
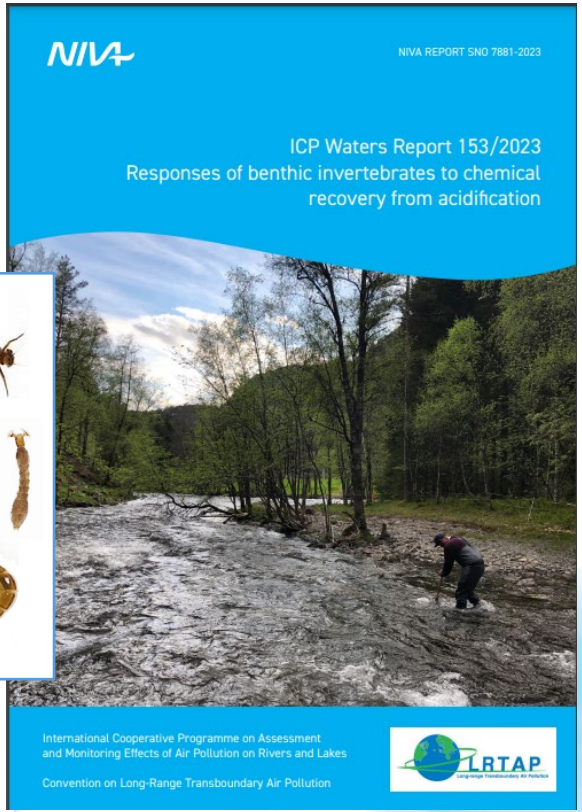
Linking chemistry and biology in aquatic ecosystems

Heleen de Wit & Gaute Velle

ICP Waters





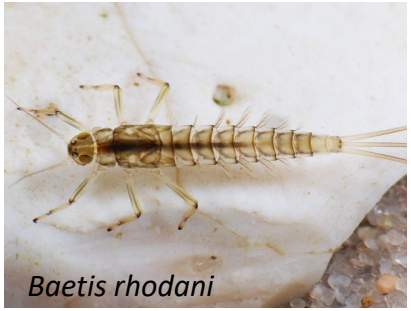
Structure report

Joint analysis of diversity of aquatic macro-invertebrates across six European countries

National contributions on biological recovery from five European countries

Aquatic benthic invertebrates

Water-dwelling insects


Baetis rhodani


Limnephilus sp.


Diura nanseni

Focus on **EPT species** of Ephemeroptera (Mayflies), Plecoptera (Stoneflies), and Trichoptera (Caddisflies):

- Common in freshwaters, acid-sensitive species, well-studied
- High-quality international and long-term records from acid-sensitive lakes and rivers in Europe

Objectives

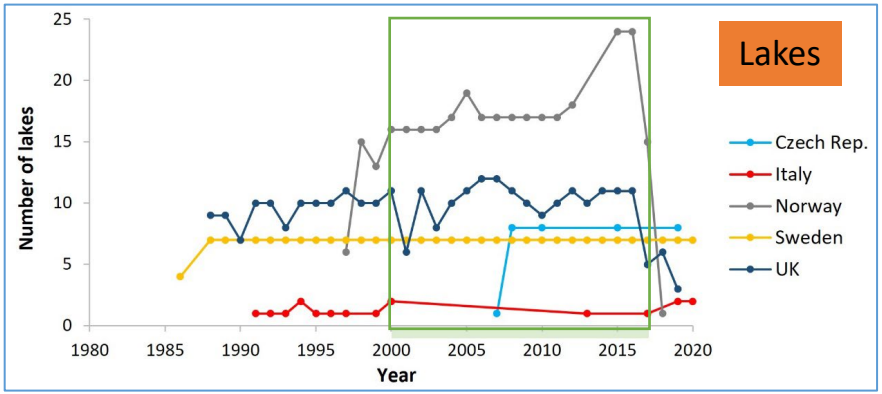
Use benthic invertebrates to:

(1) Assess temporal changes in biological diversity as determined by the number of EPT- species

(2) Assess temporal changes in functional traits

(3) Examine whether observations of biological change can be interpreted as biological recovery from acidification

Selection of suitable records

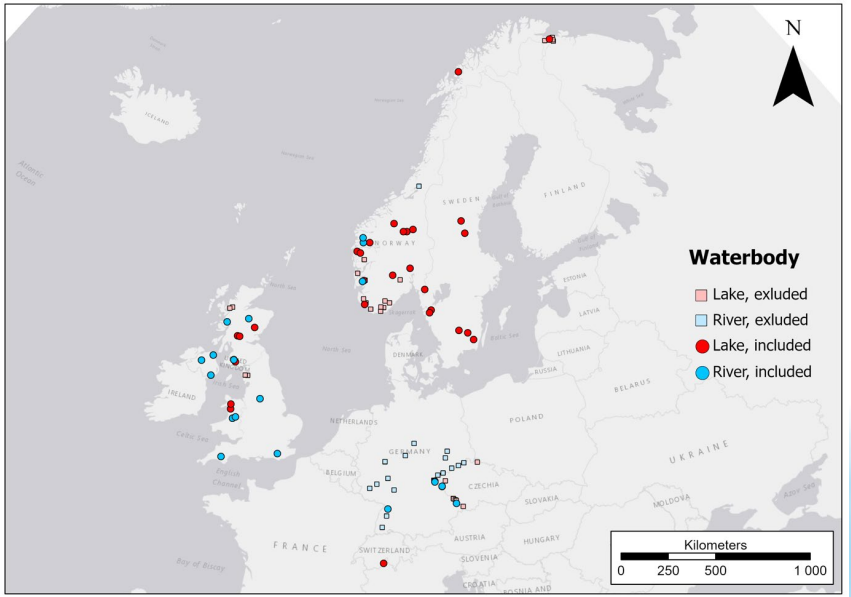


i. Lakes with records covering 2000-2018, with at least one year of data in 2000-2003 and at least one year of data in 2015-2018

ii. Rivers covering the period 1994-2018, with at least one year of data in 1994-1997 and at least one year of data in 2015-2018

Lakes and rivers across Central and northern Europe

Records of water chemistry and biology from Czech Republic, Germany, Italy, Norway, Sweden, the UK, and Switzerland.



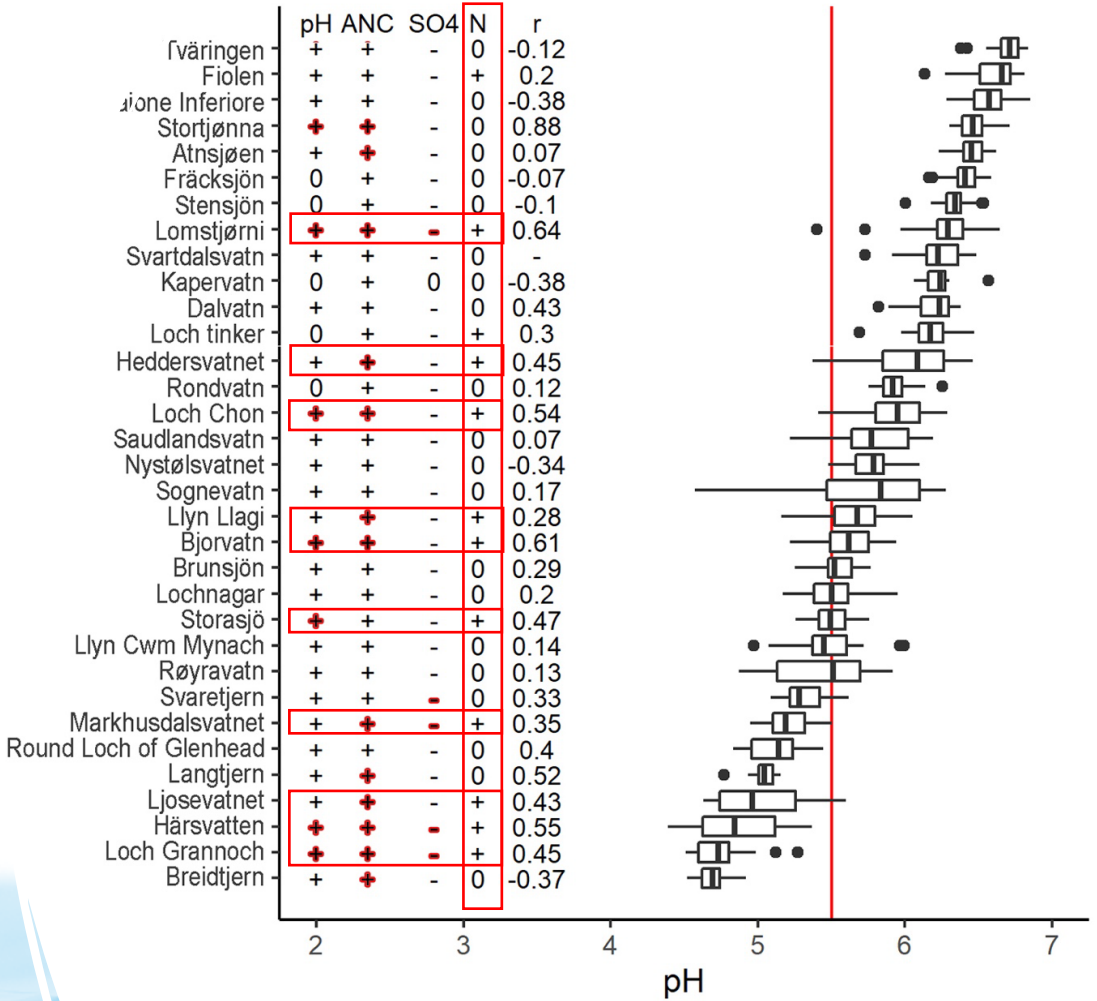
RESULTS - lakes

Trends in species richness (number of species)

- 36% of lakes with significant increases in species number

Temporal correlation between richness and water chemistry

- ANC: 40% of lakes
- pH: 21% of lakes
- SO_4: 15% of lakes

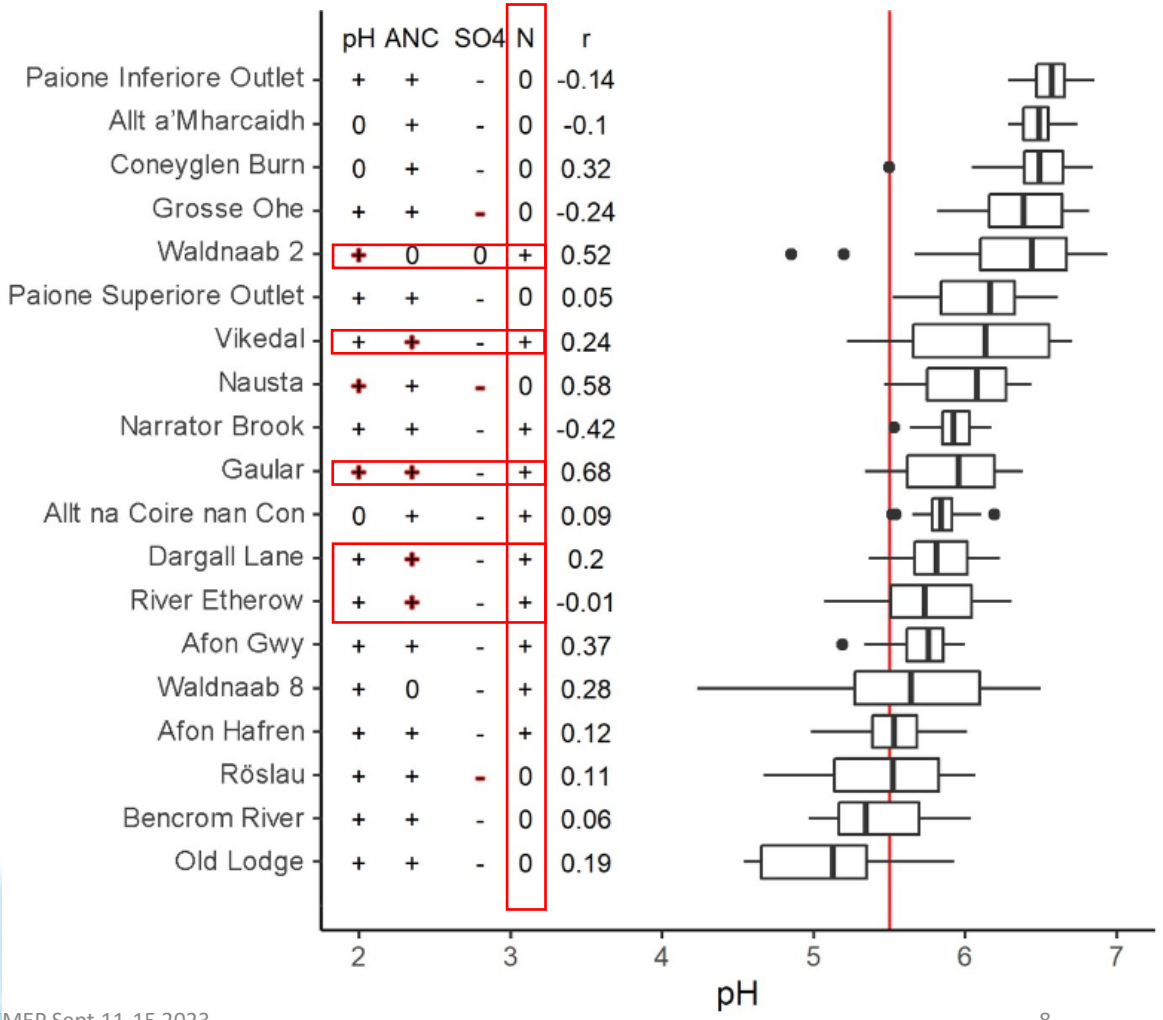


RESULTS - rivers

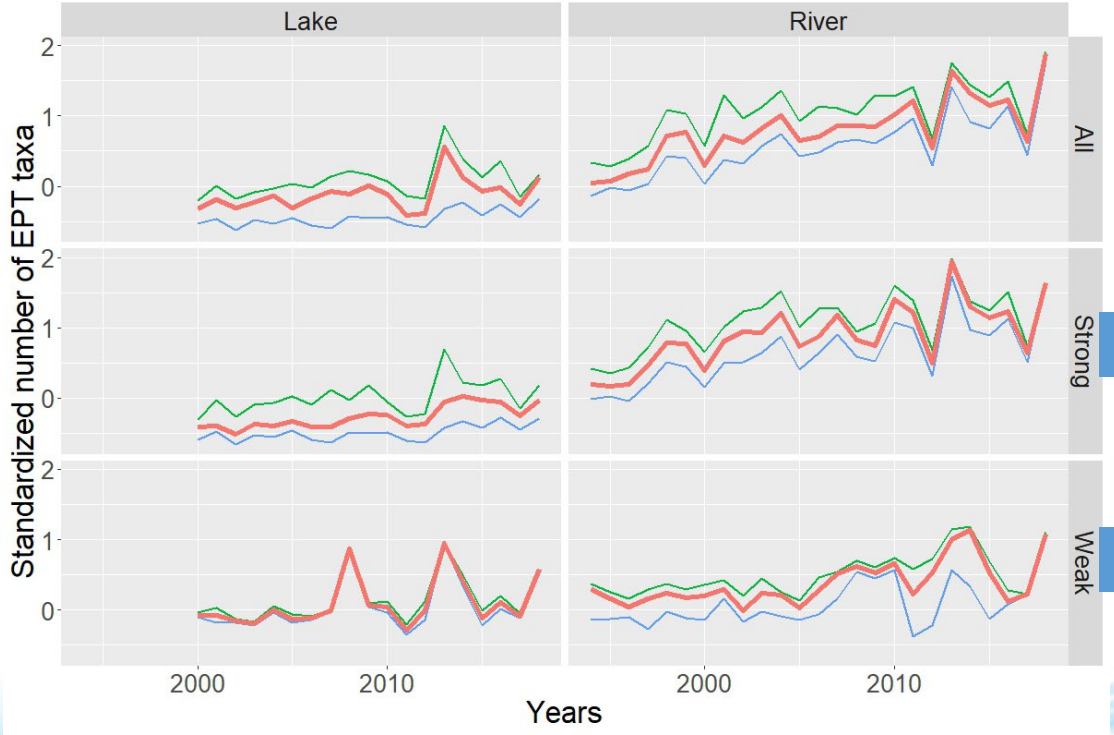
Trends in species richness (number of species)

- 53% of rivers with increased number of species

- **Temporal correlation to richness**
- ANC: 21% of rivers
- pH: 16 % of rivers
- SO_4: 16% of rivers



Increases in species richness



Strong chemical recovery

Weak chemical recovery

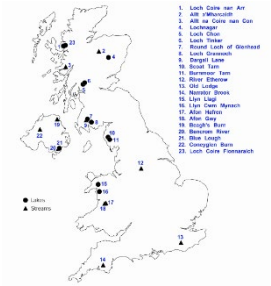
Conclusions – species richness

1. Richness has increased in about 45% of the sites
2. The increase in richness is more pronounced in rivers than in lakes
   - Shorter time series in lakes
3. Richness over time is more often correlated to ANC than to SO_4 and pH
   - More pronounced change in sites with strong chemical recovery

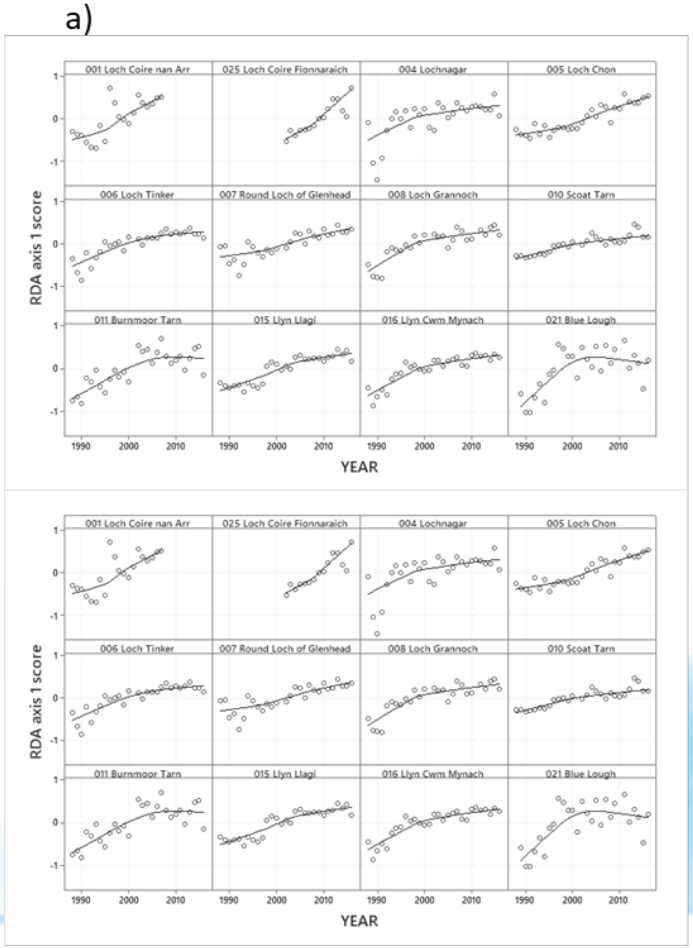
National analyses

- Longer time-series than in joint analysis
- More variation in monitoring approach, targeted species and methods for data analysis

UK
1990-2015



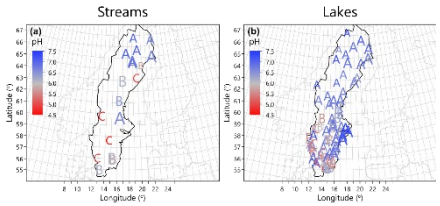
Widespread evidence for improvements in epilithic diatom and macroinvertebrate communities that are consistent with partial recovery from the effects of chronic acidification.



Don Monteith[1], John Murphy[2], Steve Juggins[3], Ewan Shilland[2,4,5] and Iwan Jones[2]

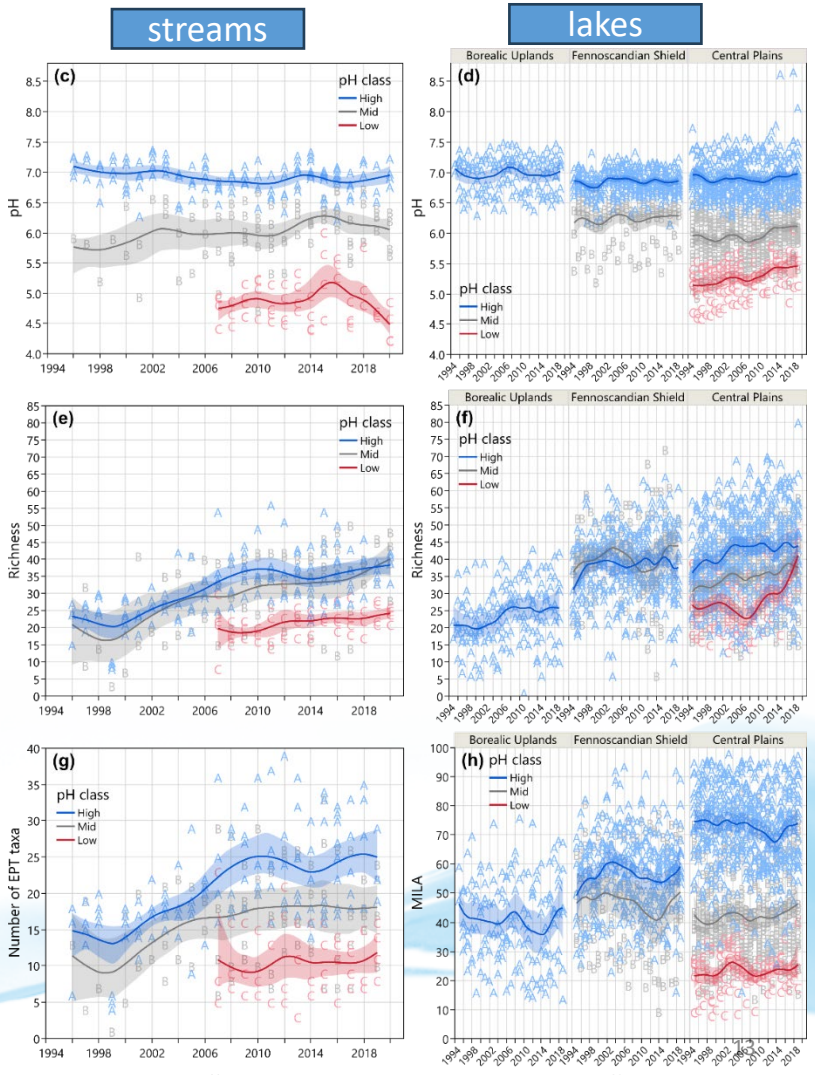
[1]UK Centre for Ecology & Hydrology, Lancaster UK., [2]Queen Mary University of London, [3]University of Newcastle, [4]University College London, [5]Natural History Museum, London

Sweden – 1995-2020



Limited increases of species diversity (all species and only EPT taxa) in strongly acidified water bodies

Increases in species diversity in less acid-sensitive and acidified water bodies – climate change response?



Danny C. P. Lau, Willem Goedkoop, Jens Fölster

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Norway (1981-2021)

Significant upward trends in species diversity (EPT taxa) in acidified rivers that have recovered strongly from acid deposition

Gaute Velle [1,2] and Christian Lucien Bodin [2]

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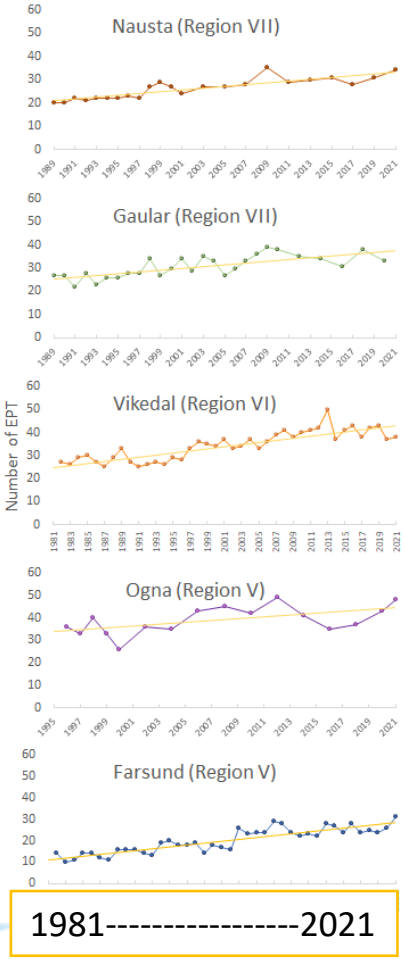
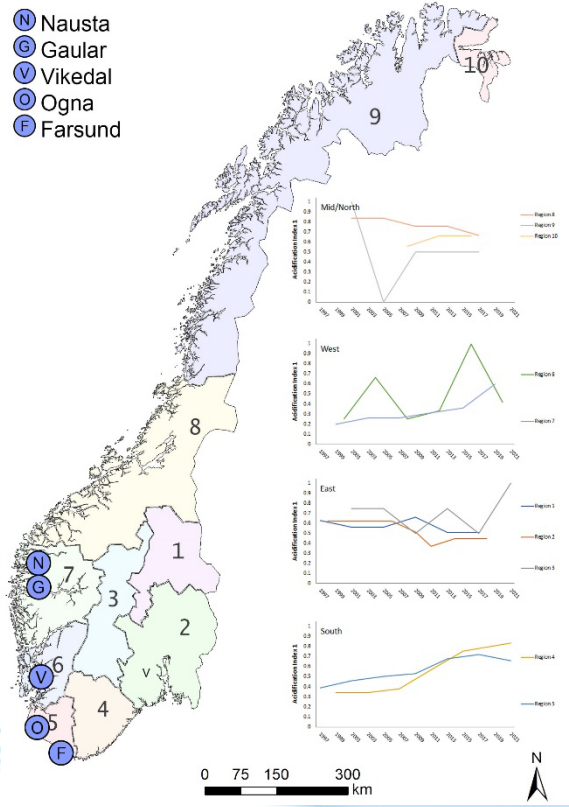
[2] Department of Biosciences, University of Bergen, Bergen

Trends in EPT species in Norwegian rivers





1981----------2021

Aquatic biodiversity - conclusions

- Widespread evidence for increases in species diversity of EPT taxa (and other groups of species) from the 1990s onwards, significantly related to chemical recovery
  - Interpreted as biological response to reduced acid deposition
- Results from joint ICP Waters analysis and national contribution point in the same direction, but are not always consistent
  - Also increases in species diversity in relatively in-sensitive areas, little impacted by acid deposition
  - Climate can also impact changes in species richness
- Integrated biological and water chemical monitoring programs are essential for documentation of biological responses to air pollution

Thanks to co-authors of report

Gaute Velle, Christian Lucien Bodin, Jens Arle, Kari Austnes, Angela Boggero, Jindriska Bojkova, Riccardo Fornaroli, Jens Fölster, Willem Goedkoop, Iwan Jones, Steve Juggins, Danny C. P. Lau, Don Monteith, John Murphy, Simona Musazzi, Ewan Shilland, Sandra Steingruber,Magda-Lena Wiklund, Heleen de Wit