Regional assessment of current extent of acidification of surface waters in Europe and North America

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Aims

- Assess the current extent of surface water acidification in Europe and North America
  - Overview of where surface water acidification is observed and how severe it is
  - Identifying potentially acidified regions where the available data are insufficient
- Inform policy processes
  - The need for further emission reduction
  - The need for monitoring of effects of air pollution

Outline

- Acid sensitivity and regions with potentially acidified surface waters
- Acidification status overview from
  - National data, Water Framework Directive
- National chapters
- Discussion
  - Current extent of acidification
  - Do we have sufficient information?
    - Role of NEC Directive monitoring
  - The future of acidified surface waters

National contributions

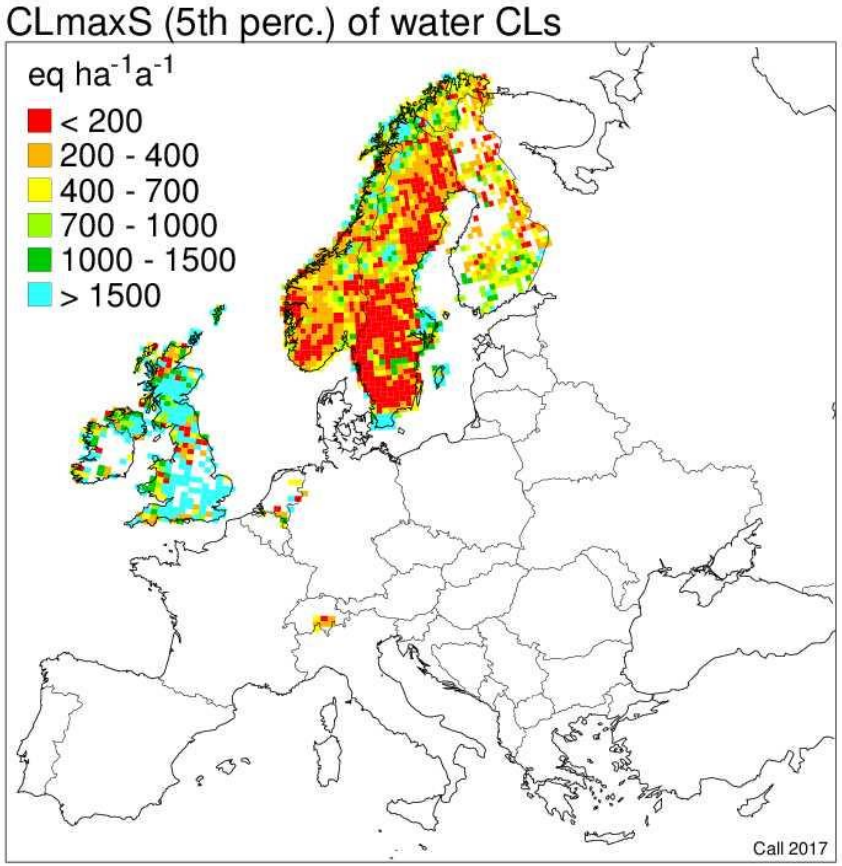
- National chapters
  - Acid sensitivity, acidification status and monitoring
  - CH, CZ, DE, FI, IT, LV, NO, PL, SE, UK, US (CA, IE in the pipeline)
- Data
  - From sensitive regions; large-scale surveys, not only ICP W sites; recent average data – current situation
  - CA, CH, CZ, DE, FI, IE, IT, NO, PL, SE, UK, US

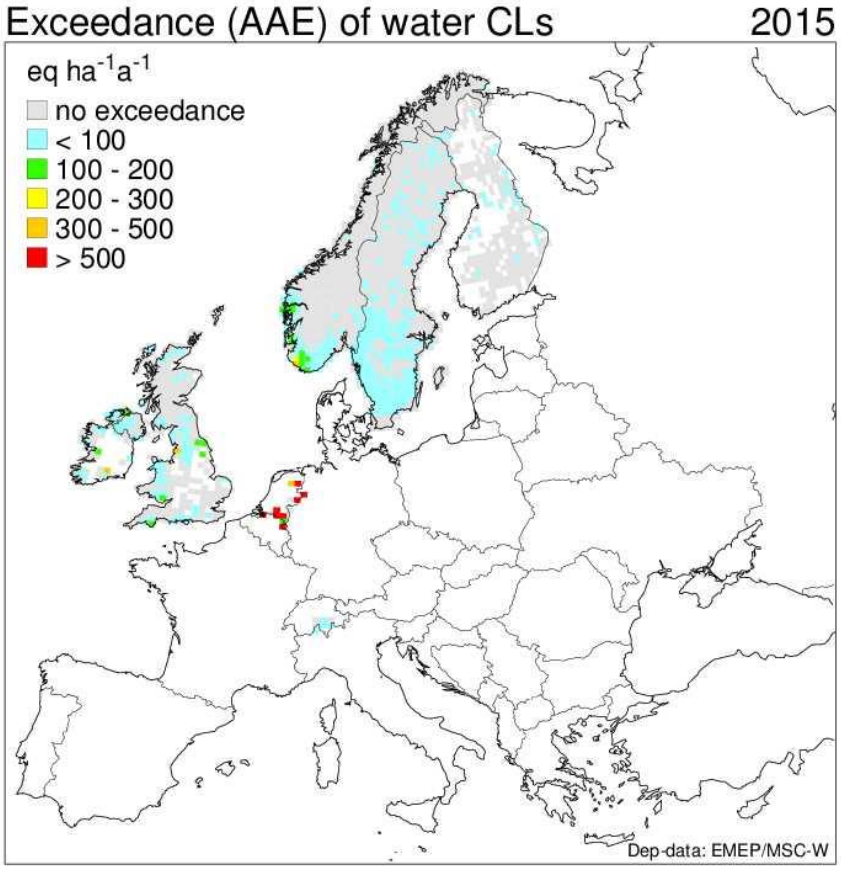
Potentially acidified surface waters

- Requires
  - High sensitivity
    - Slowly weathering bedrock
    - Thin soils and/or soils with a low cation exchange capacity
    - Climate, slope etc
  - Sufficiently high deposition
- Relation to critical loads
  - Low critical loads = high sensitivity
  - Exceedance of critical loads = acidification likely
  - But – No longer exceedance ≠ no longer acidified

Critical loads and exceedance - Europe

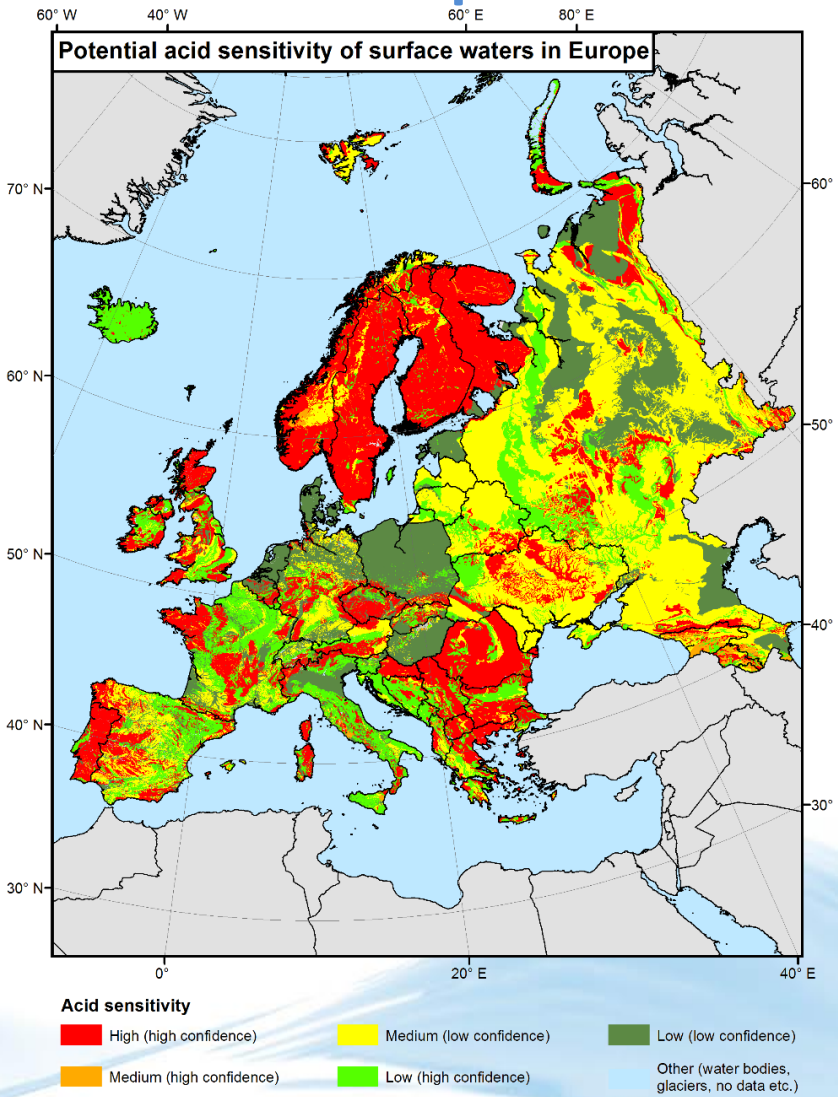
- Available for seven countries only for water





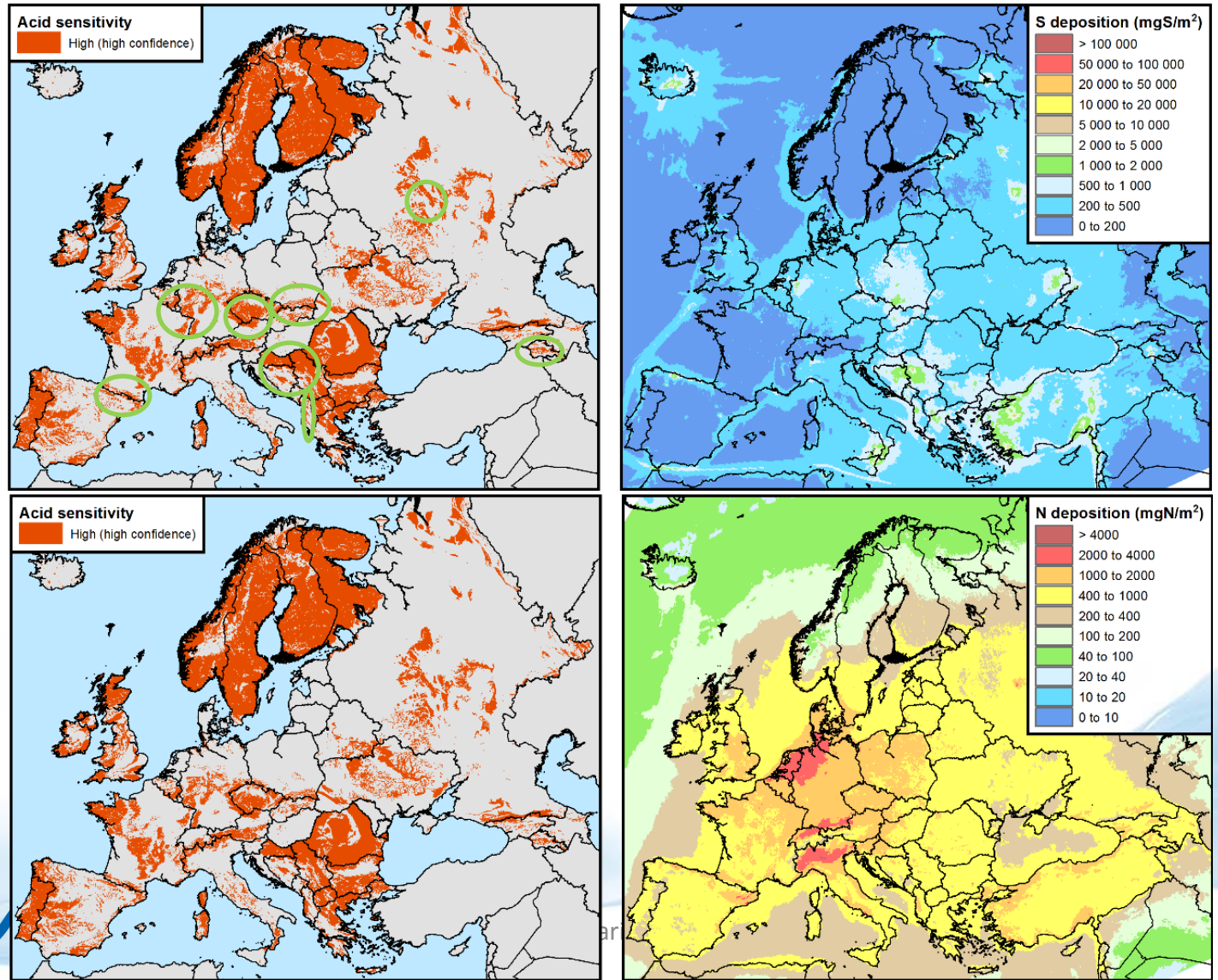
Acid sensitivity from bedrock maps

- Identify regions with high sensitivity
- Only bedrock = uncertain
  - But reasonable correspondence with critical loads map

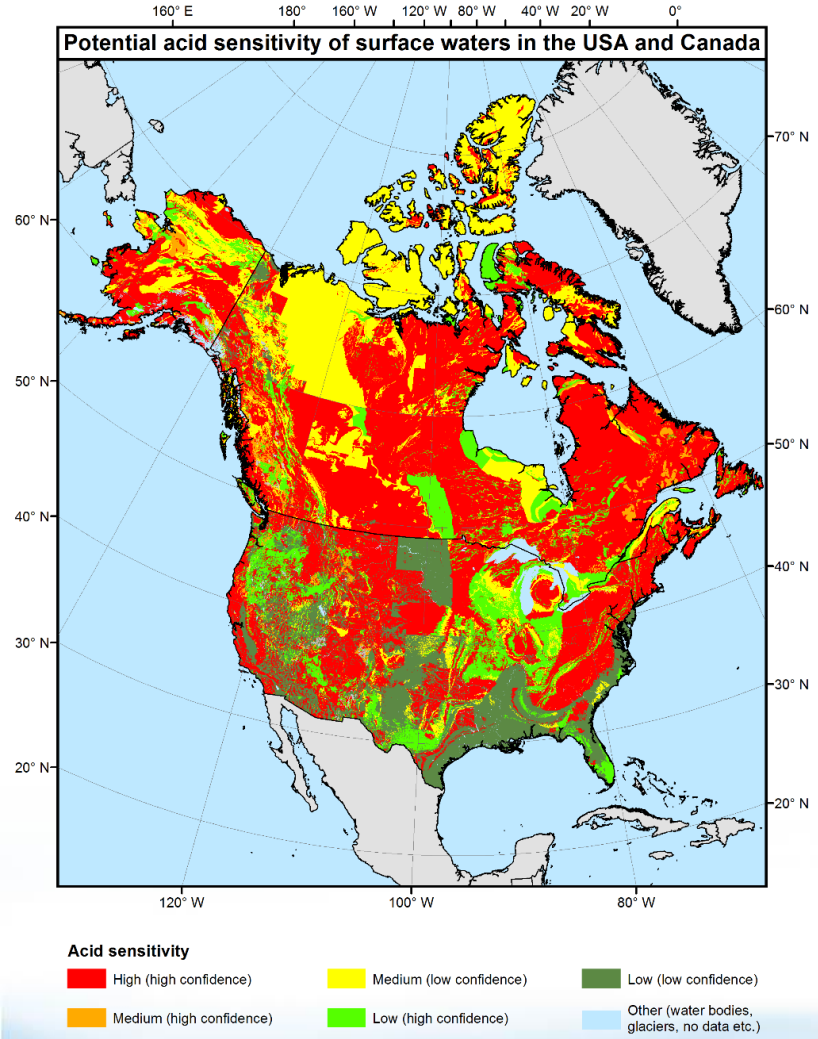


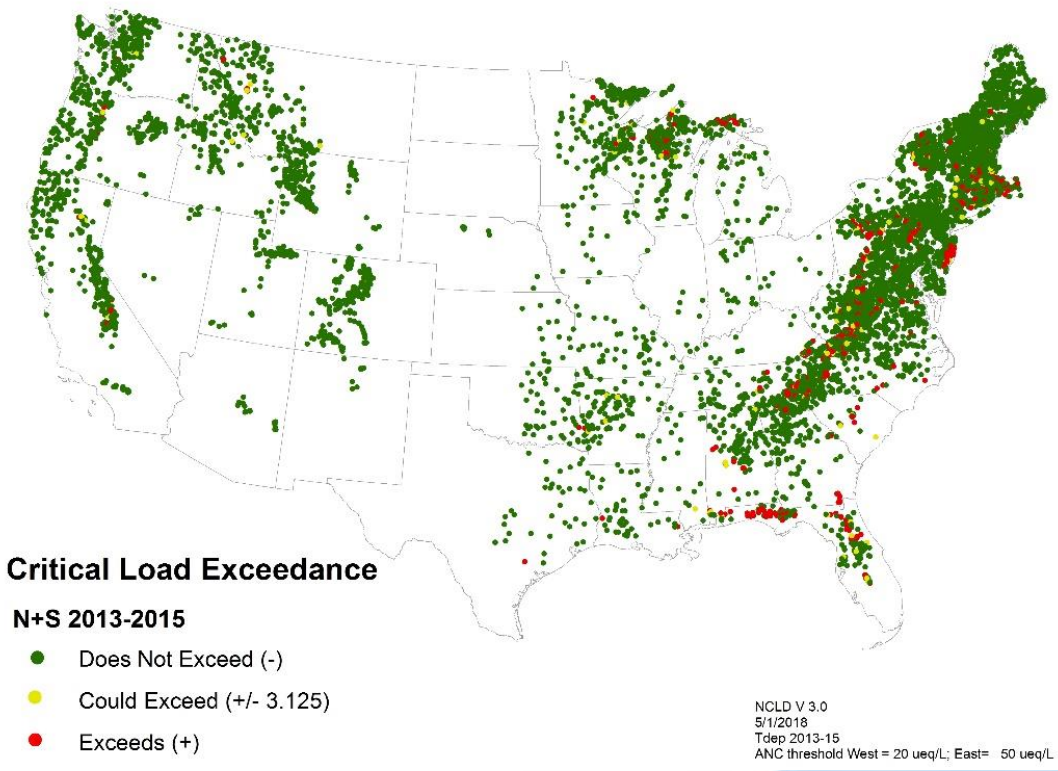
Based on lithological classifications from Hartmann J & Moosdorf N. 2012. *The new global lithological map database GLiM: a representation of rock properties at the Earth surface*. Geochemistry, Geophysics, Geosystems **13**, 12. DOI: 10.1029/2012GC004370.

Sensitivity + deposition - Europe



Potential acidification North America





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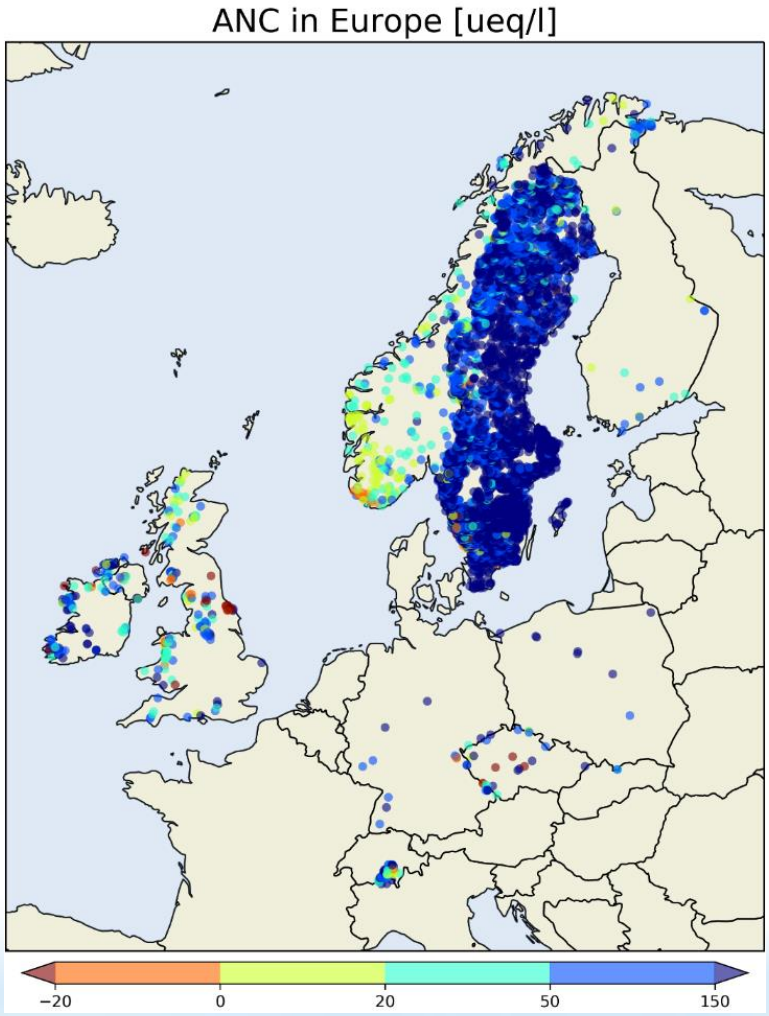
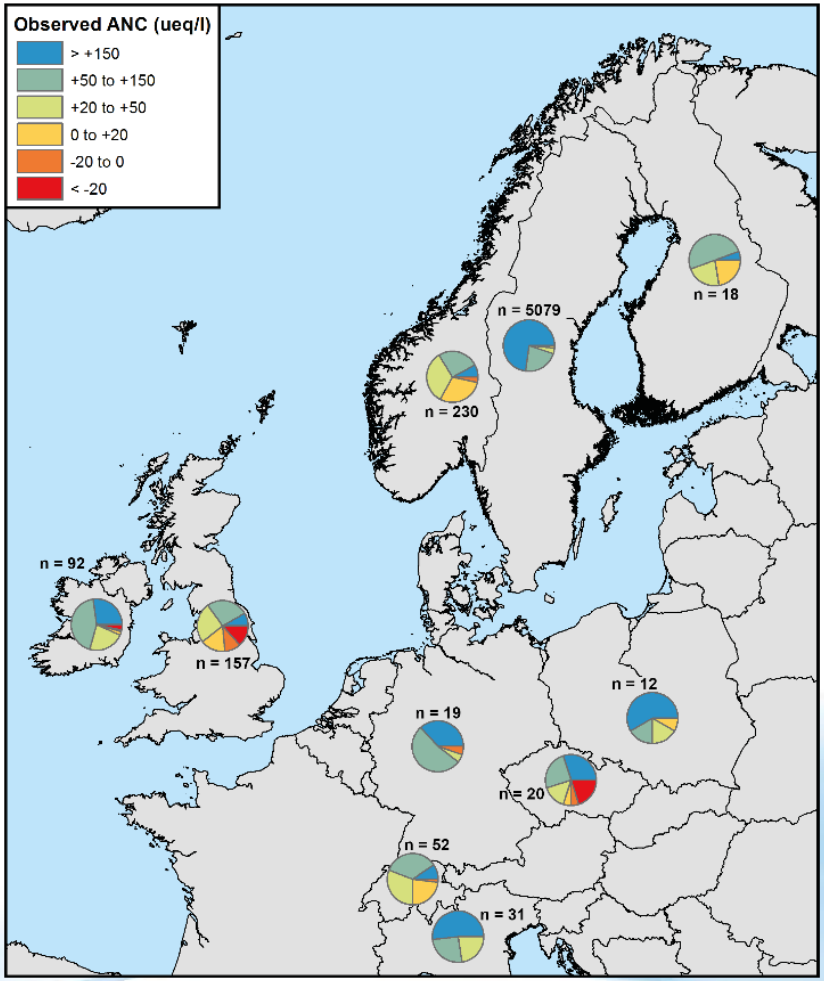
National data

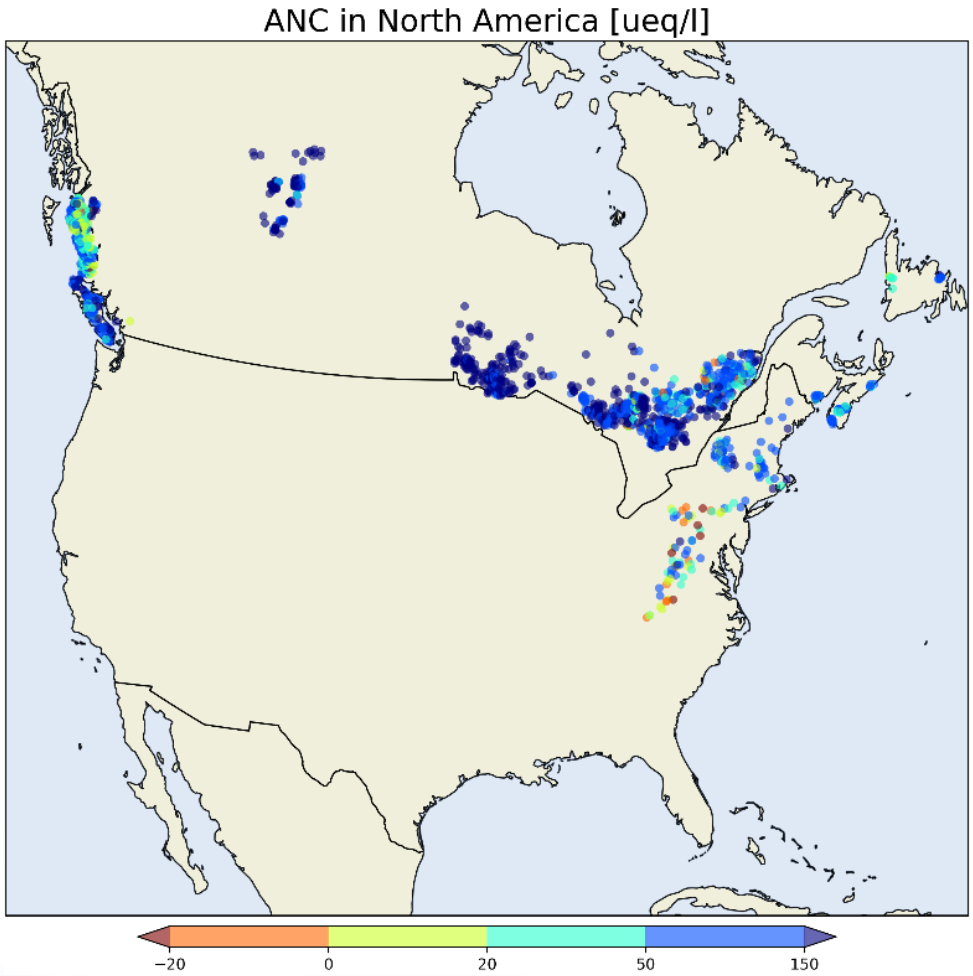
- Large scale surveys or regular monitoring sites
- Mainly from sensitive areas, but not always
- Variable representativity must be taken into account when comparing the data
- Threshold/critical limit
  - In reality water body/type specific
  - Different national systems
  - Used the «traditional» critical limits 20 µeq/l ANC or 8 µeq/l ANCoaa

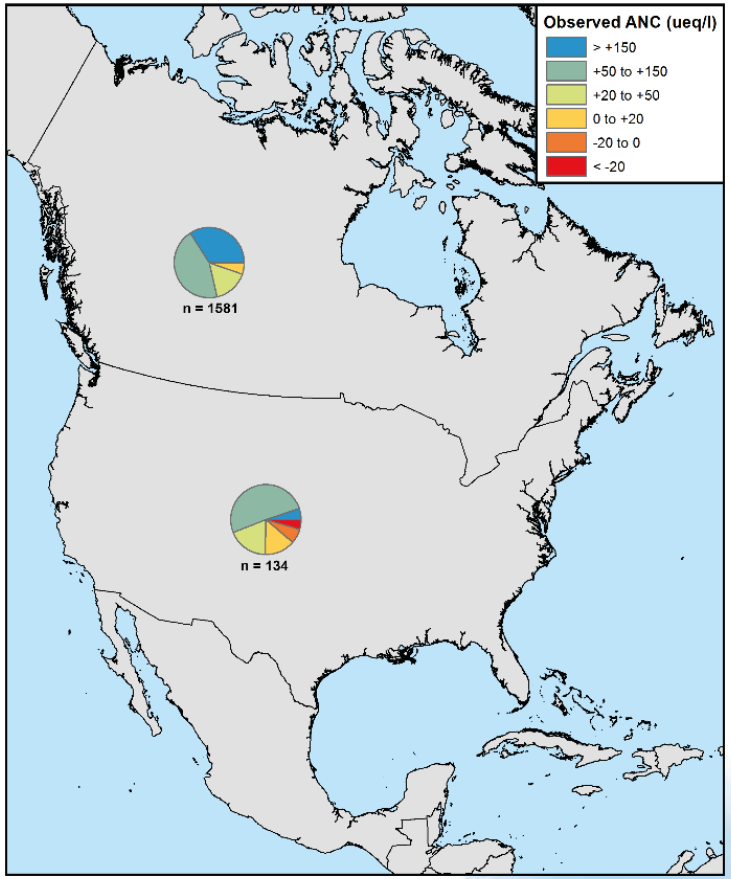
National data - Europe





National data – North America

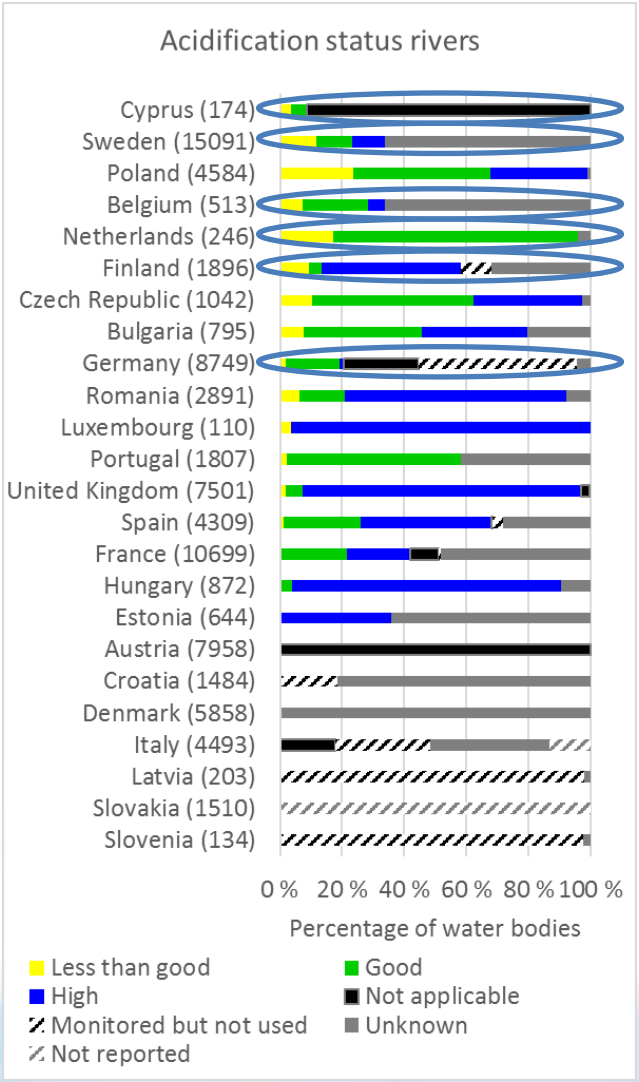


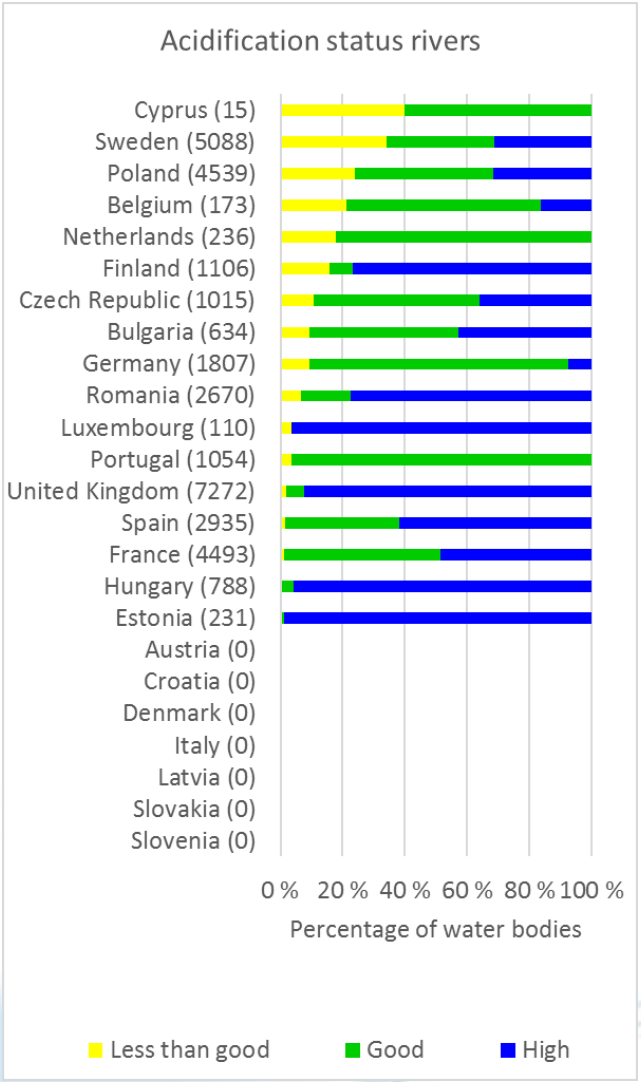


Water Framework Directive

- Ecological status reported for (nearly) all water bodies
  - Lakes >0.5 km^2, rivers with catchment >10 km^2
- Acidification status one of several quality elements
  - Can downgrade the ecological status based on biology
- Should be classified when relevant
  - Classified: High, good, less than good
  - Otherwise: Not applicable, monitored but not used, unknown (and sometimes just not reported)
- Not necessarily acidification caused by deposition

Water Framework Directive data



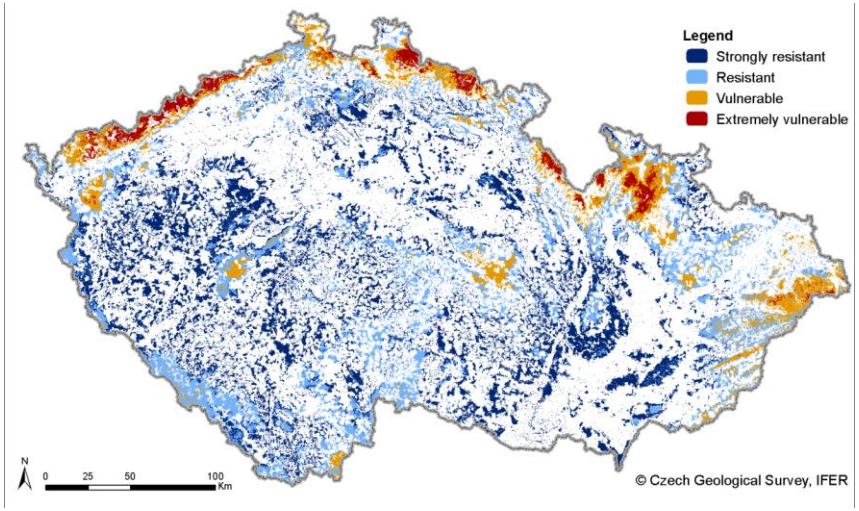


Pressure reporting

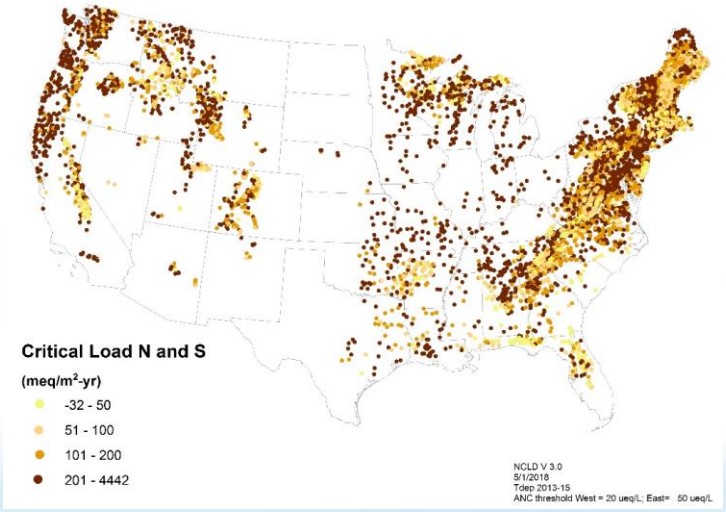
Country	< good	% atm. dep.
Belgium	37	43
Bulgaria	60	0
Cyprus	6	0
Czech Republic	109	27
Estonia	1	0
Finland	176	77
France	52	0
Germany	168	98
Hungary	4	25
Luxembourg	4	100
Netherlands	42	21
Poland	1087	1
Portugal	37	0
Romania	179	0
Spain	48	0
Sweden	1744	100
United Kingdom	141	36

National chapters

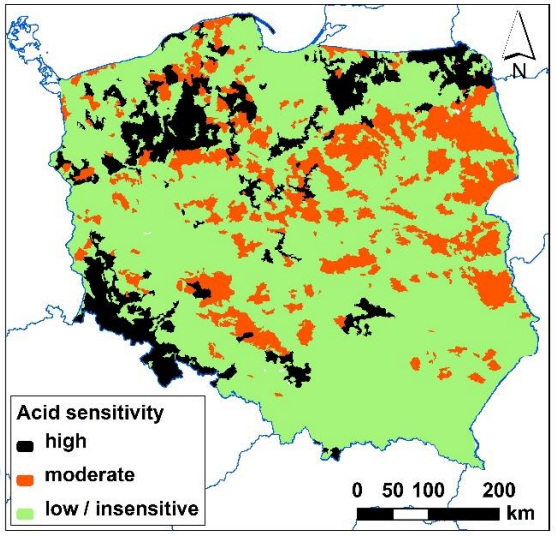
- Acid sensitivity
- Monitoring
- Acidification status
- Case studies, trends, outlook



Czech Republic

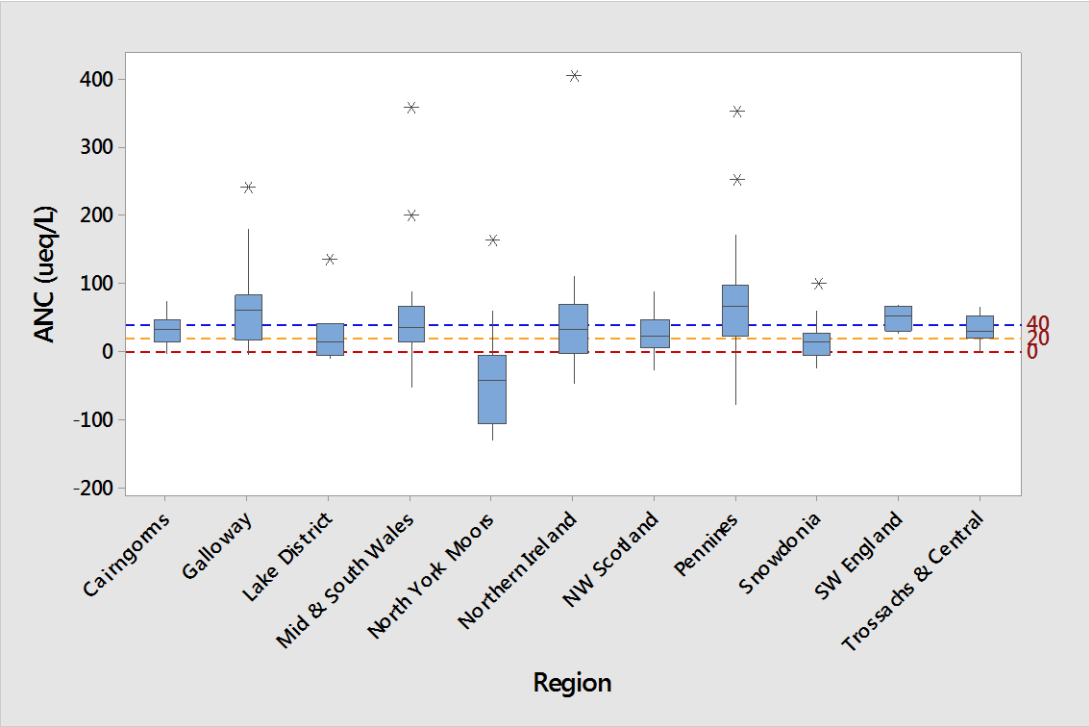


United States



Poland

Acidification status



United Kingdom

Sweden

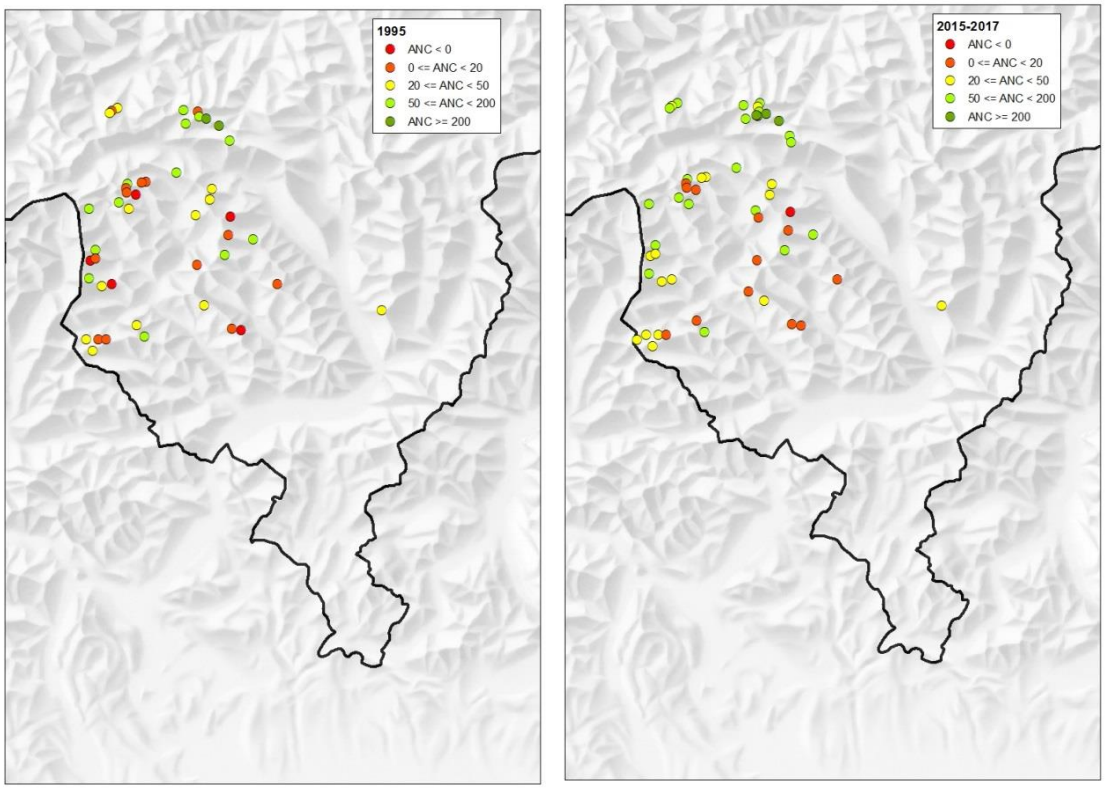
10% of lakes acidified

7% of area has acidified lakes

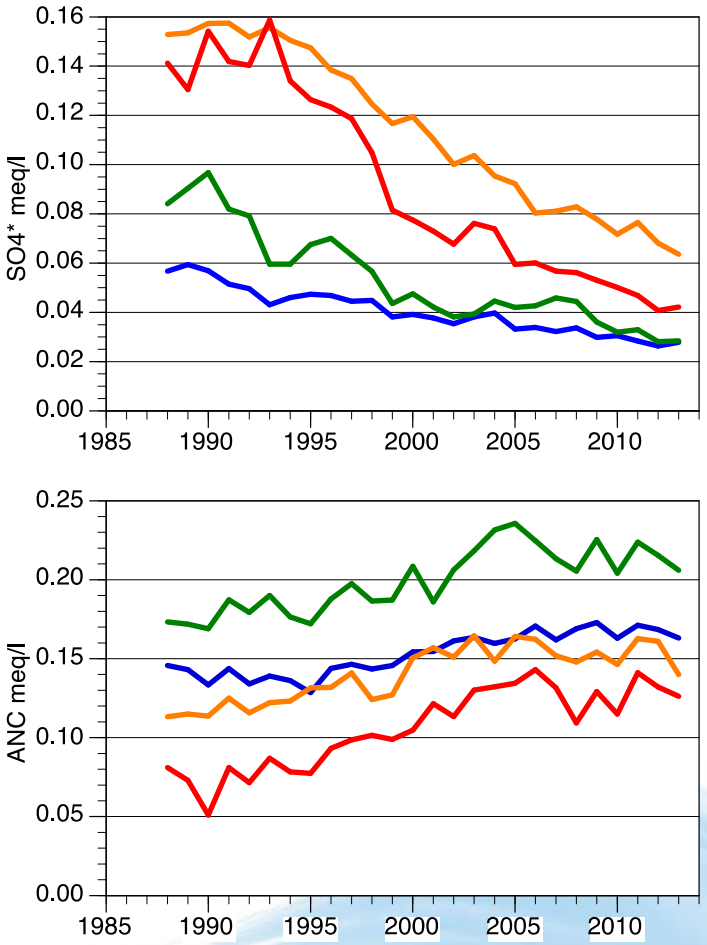
Classification 2015
Ca 1880, TOC 2015
High
Good
Moderate
Poor
Bad

Norway

Acidification status/trend

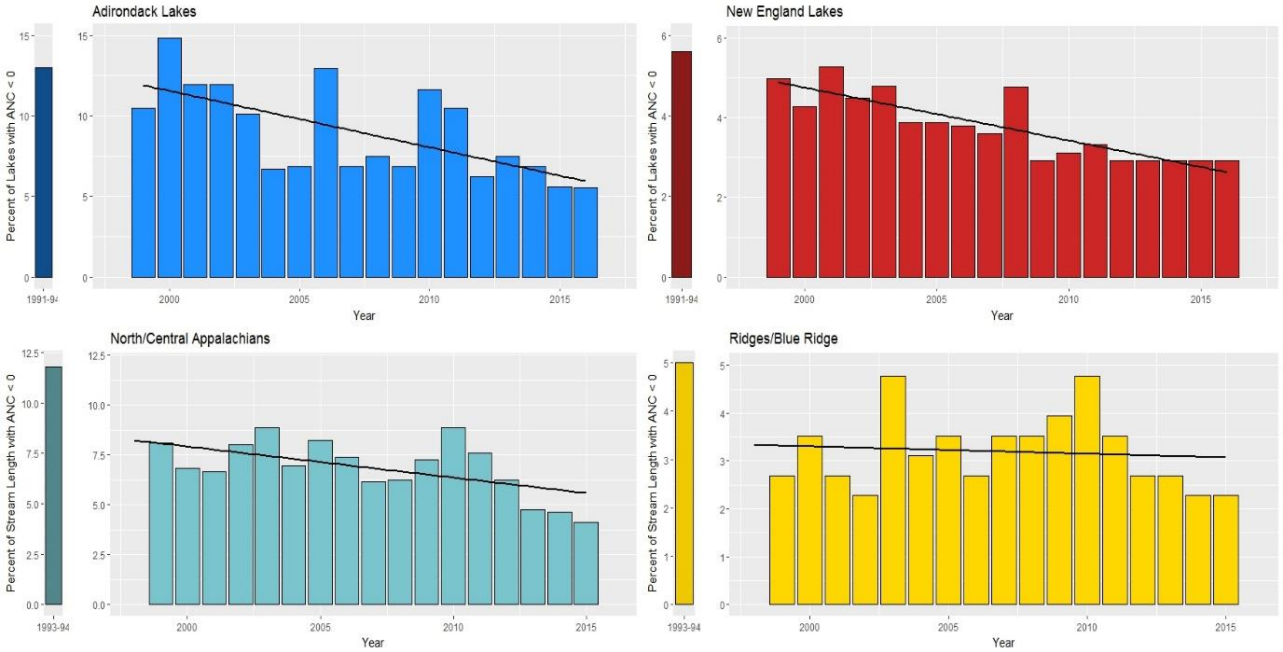


Switzerland



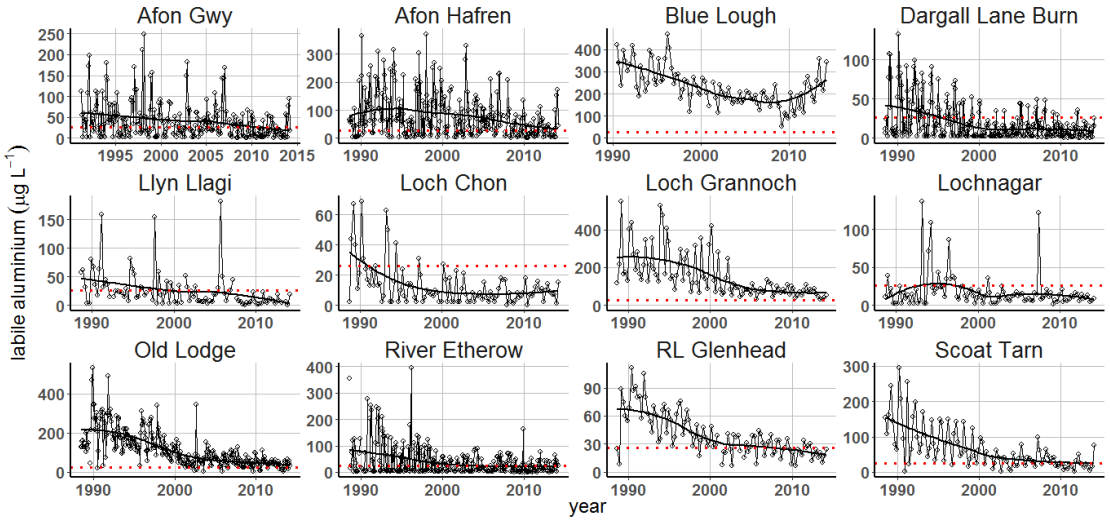
Sweden

Acidification status/trend



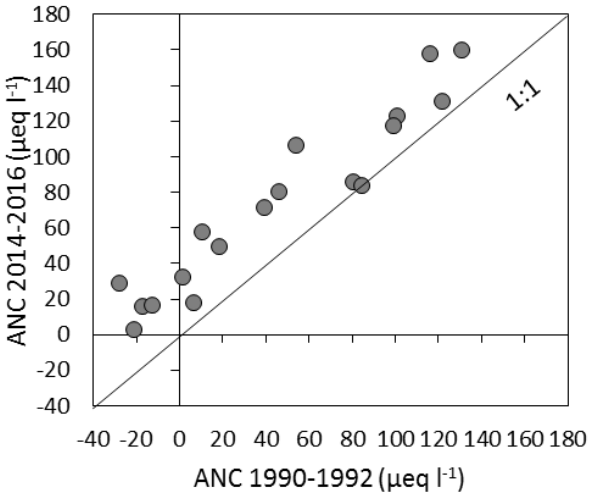
United States

< 1% acidified overall



UK

Finland



Extent - countries with national chapters

- Large regions with acidification
  - Sweden, Norway, the UK, the US, Canada
  - Still most of the country area is not acidified
- Scattered acidification in larger parts of the country
  - Finland, Germany
- Acidification limited to smaller regions
  - Czech Republic, Switzerland, Ireland
  - Acidification can still be severe where it occurs
- Hardly any acidification
  - Poland, Italy, Latvia (not at all)

Regions not covered by national chapters

- Belgium, the Netherlands, Luxembourg
  - CL exceedance + WFD + high dep indicate acidification
  - Reports on acidified small lakes from the 1980s
- Pyrenees
  - Low dep, reports from 1990s suggest no acidification
- Vosges mountains, France
  - Acidified streams reported in the 1990s
  - WFD: 52 acidified rivers, but apparently not due to dep
- Tatra mountains, Slovakia
  - Recovering, but many lakes still acidified

Regions not covered by national chapters

- Rila mountains, Bulgaria; Retezat mountains, Romania
  - Indications of acidification early 2000s
  - WFD: Some acidified water bodies, but apparently not due to dep
- Austria
  - Acidification from acid deposition no longer an issue
- Other regions
  - Croatia, Bosnia, Serbia, Albania: No information, to be explored
  - Russia, Armenia: Data/literature from NFCs

Do we have sufficient information?

- Limited reporting of critical loads for water
  - Limited issue or limited data/resources/focus?
  - Overall CL/exceedance maps do not fully reflect water
- Low/reduced regular monitoring, few large surveys
  - Low representativity – difficult to upscale
- Regions with sparse/no recent information
- WFD data insufficient and ambiguous
  - Large water bodies
  - Many «unknowns» – is acidification relevant or not?
  - Is the acidification due to acid deposition?

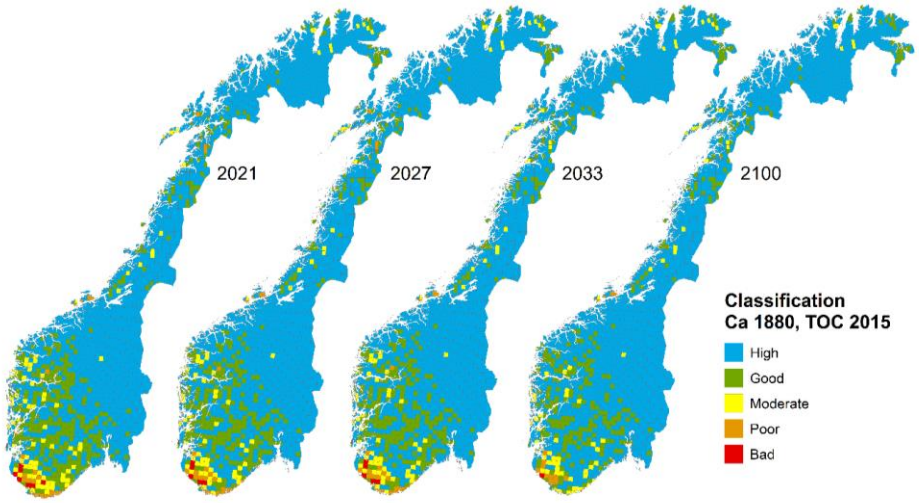
NEC directive monitoring essential

- Representative
  - Should be possible to upscale
  - Should result in increased monitoring in some countries
- Targeted
  - Relevant sites and parameters
- Wider coverage
  - Obligation for all EU countries (with sensitive areas)
- Contribute to review of critical loads and levels
  - Important for further emission reductions

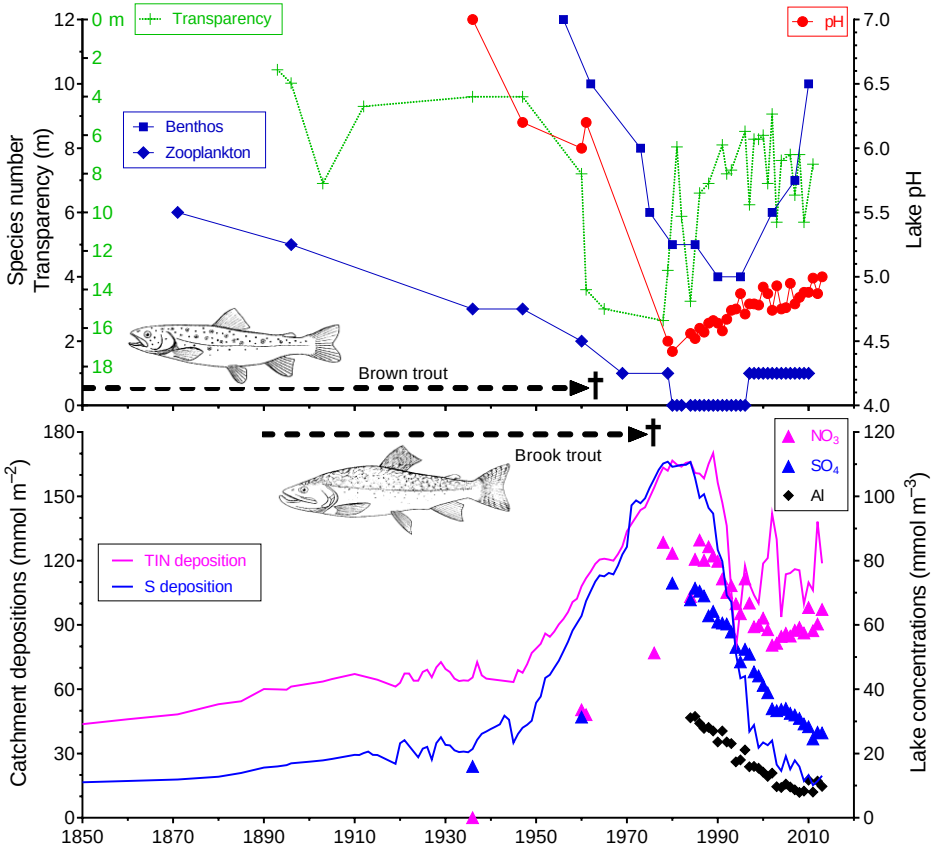
Outlook

- Recovery is going on, but far from complete
  - Replenishment of base cations slow process
  - Biological recovery: Stable chemistry above critical limits, dispersal
- Climate change and intensified forestry may counteract recovery
- Further emission reductions will speed up recovery
  - Including reducing deposition below the critical load

Recovery – national examples



Norway – MAGIC+revised Gothenburg



Černé Lake, Czech Republic

Conclusions

- Surface water acidification is still an issue in Europe and North America
- Acidification is likely to occur also in countries not covered by the national chapters
- WFD data can assist in assessing acidification status, but can never fully replace other monitoring data
- NEC Directive monitoring can address some of the current shortcomings of the monitoring programmes
- Further emission reductions are needed to speed up recovery

Comments/input welcome

- At the meeting or to kari.austnes@niva.no
- Further discussion at the separate ICP Waters meeting on Wednesday
- Final report early autumn – deadline for comments June 1st

- And thanks
  - To all authors/contributors
  - And the Norwegian Environment Agency and national sources for funding