Ecological impacts of acid sulfate soils on river biota in Finnish rivers

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Introduction

- The characteristics of river are determined by the nature of the catchment
-Land use in a river catchment has large influence on the riverine ecosystem
-As a consequence of land use various substances like nutrients, solid matter, metals and acidifying substances leach into rivers
-These substances cause changes in the physicochemical aquatic environment and also change the species distribution and abundance of aquatic organisms

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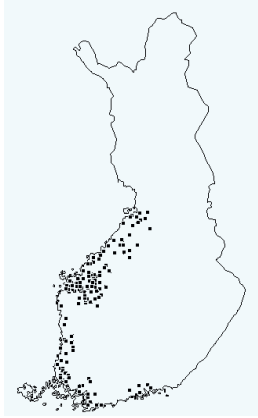
Acid sulfate soils (ASS)

- ASS are often found in coastal environments, but also further inland along former coastlines

-Finland has the largest area of AS-soils in Europe

-Due to the isostatic land rise and drainage for agriculture use , the sulfide-bearing sediments have emerged above water-level and exposed to oxygen, thus producing sulfuric acid.

-At the same time, large quantities of metals restored in the soil are mobilized.



Occurrence of AS-soils in the Finnish cultivated areas.

Global distribution of AS-soils (Ljung et al. 2009)

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CATERMASS -Climate Change Adaptation Tools for Environmental Risk Mitigation of Acid Sulfate Soils

Life+-project 2010-2012

CATERMASS consists of five substance actions:

1. Mapping and risk classification of acid sulphate soils
2. Environmental impact assessment and risk scenarios
3. Mitigation methods and their adaptation to the changing climate
4. Socio-economic impacts and analysis of adaptation tools
5. Dissemination of the best environmental practices for AS-soils

Potential AS-soil not yet exposed to oxygen is black or dark blue

Actual oxygenized AS-soil has gray color (pH 2.5–3).

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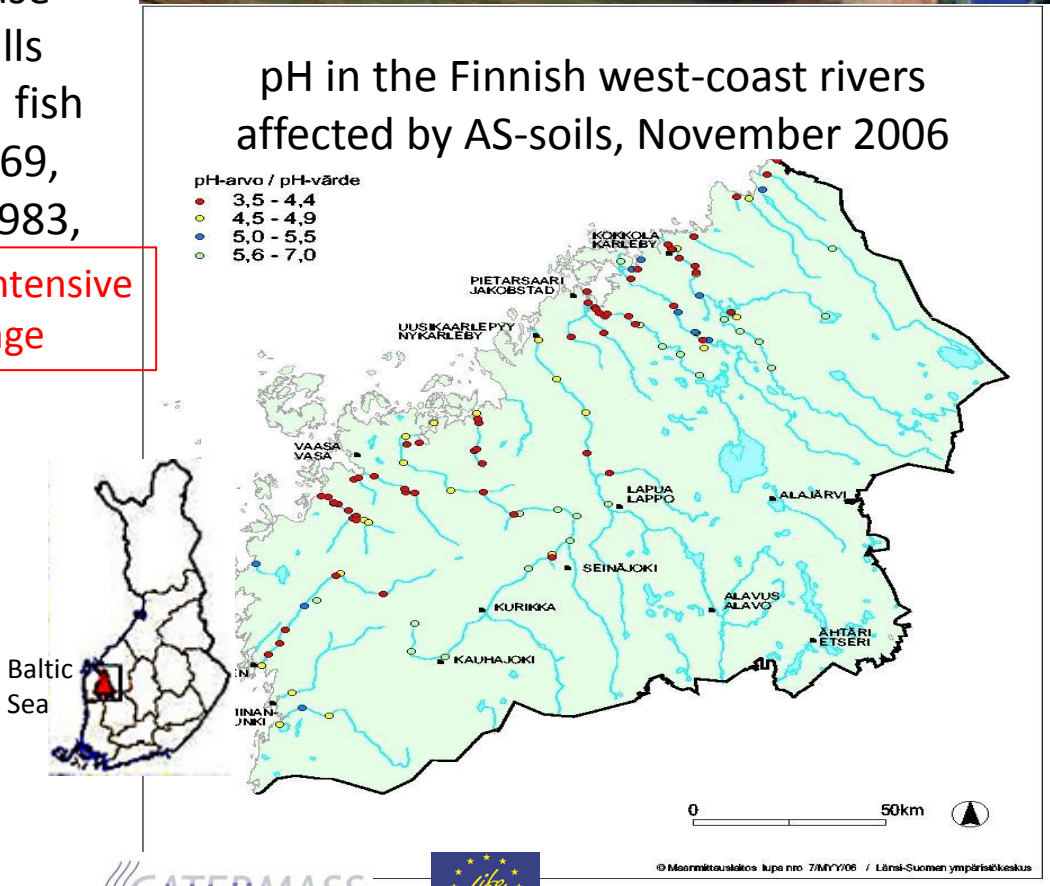
Environmental effects of ASS, Fish

Fish kills

-The acidic leaks from AS-soils time to time generate fish kills in the rivers of the area due to low pH peaks.

-For example in River Kyrönjoki, land use intensified in 1700-century. First fish kills reported 1834. During recent decades fish kills have been reported from years 1969, 1970, 1971, 1972, 1976, 1977, 1979, 1983, 1984, 1996 and 2006.

Period of intensive land drainage



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Environmental effects of ASS

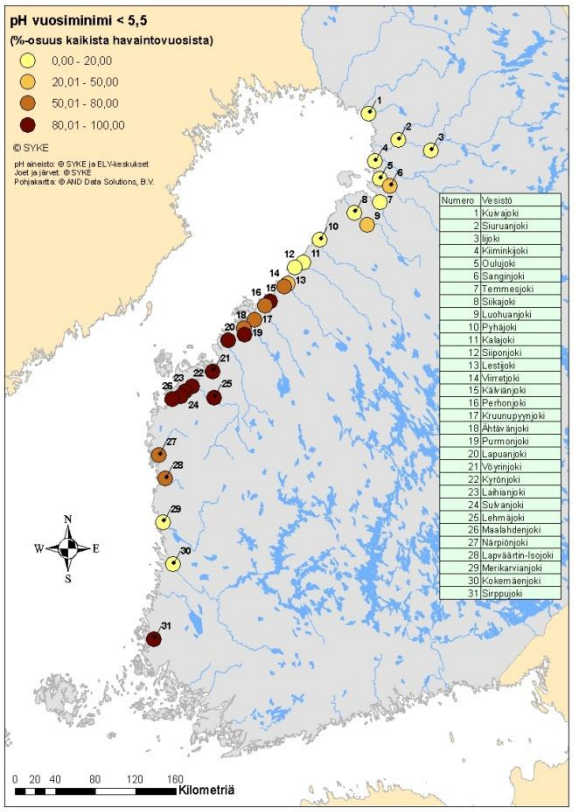
Fish assemblage

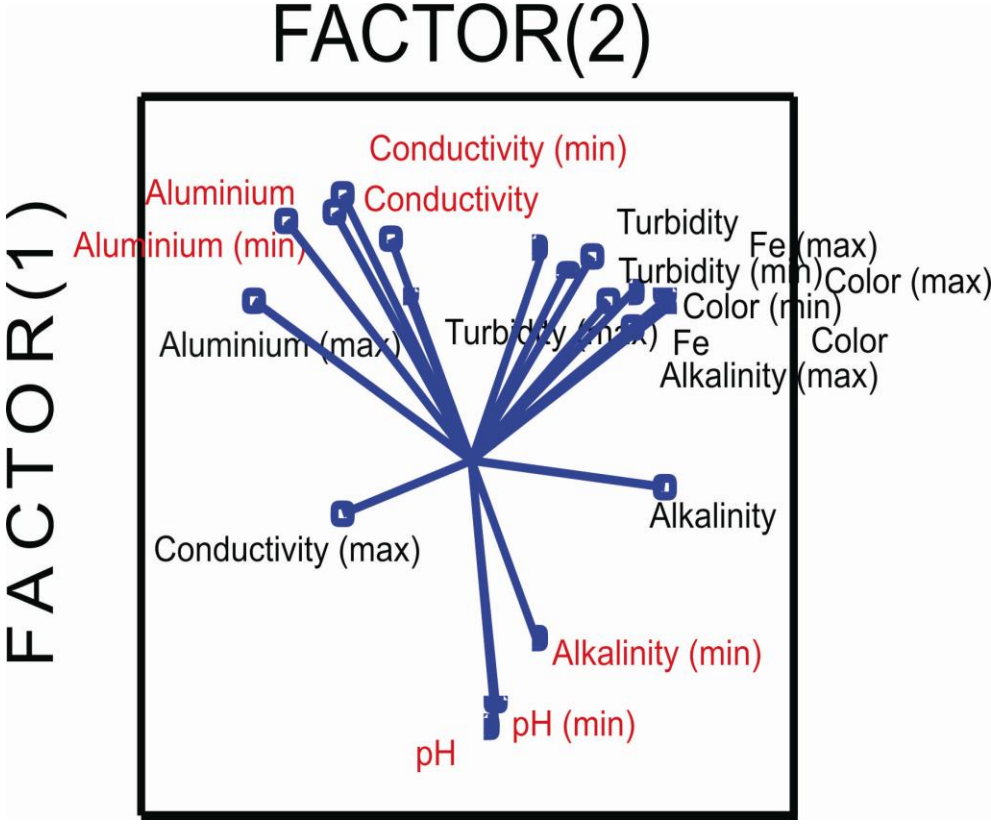
-32 rivers from the AS-soils area, range from "low" to "high" risk of AS-soil acidic loads

-Historic data, risk that yearly minimum pH falls below 5.5

-Water quality sampling, 2005-2011,

-Principal component analysis (PCA) to summarize the variance





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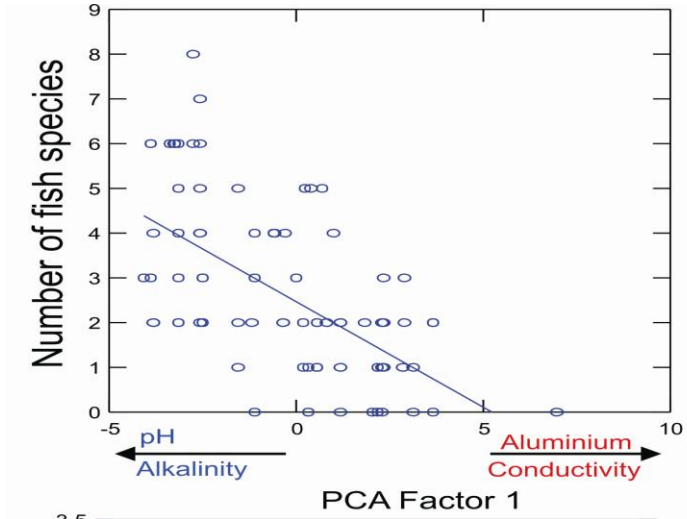
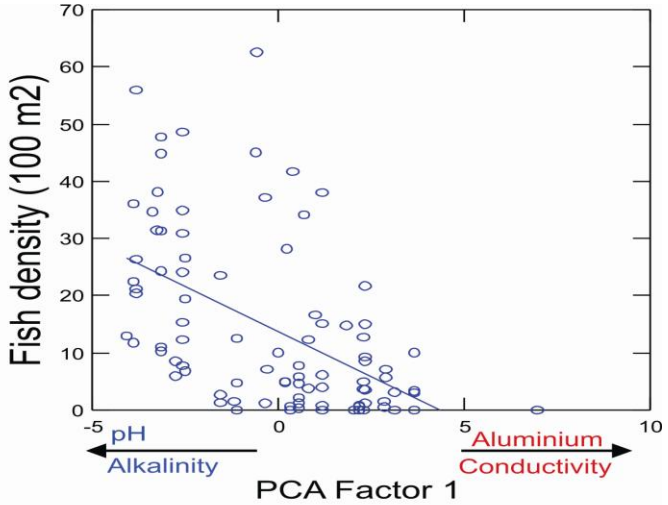
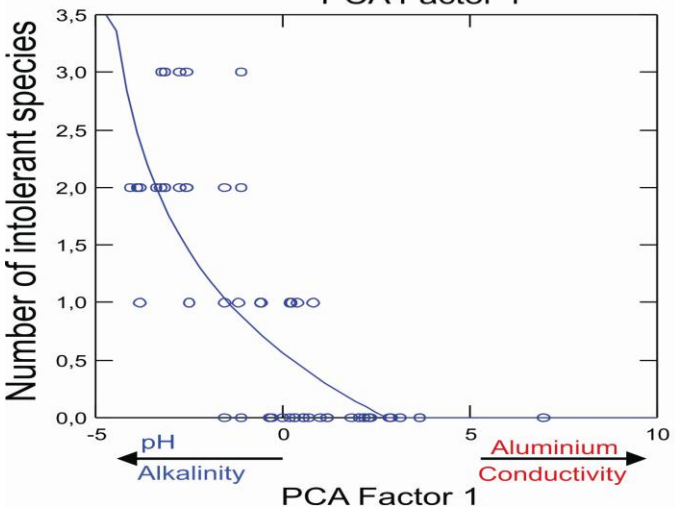
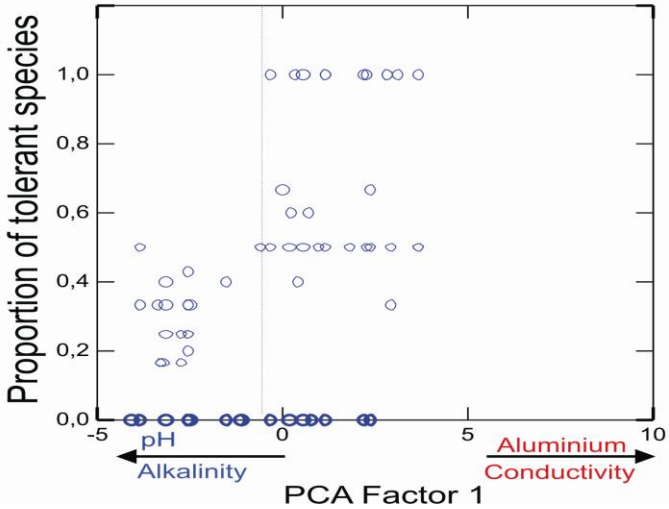
Environmental effects of ASS, Fish

-32 rivers, 128 electro fishing's 2010-2011 (2012 to be sampled..)



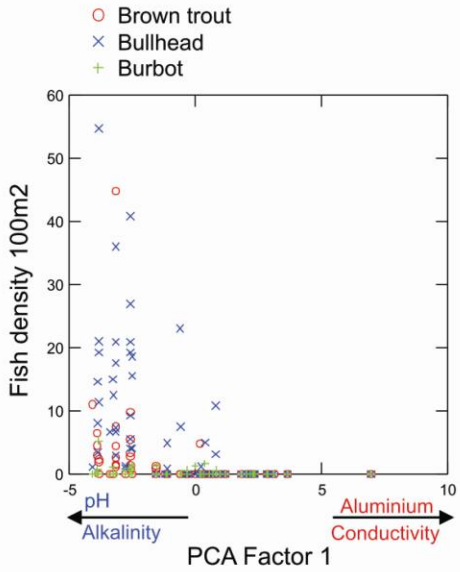


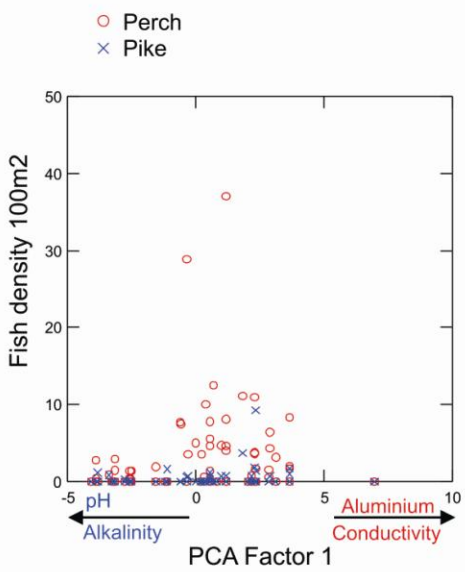




Environmental effects of ASS, Fish

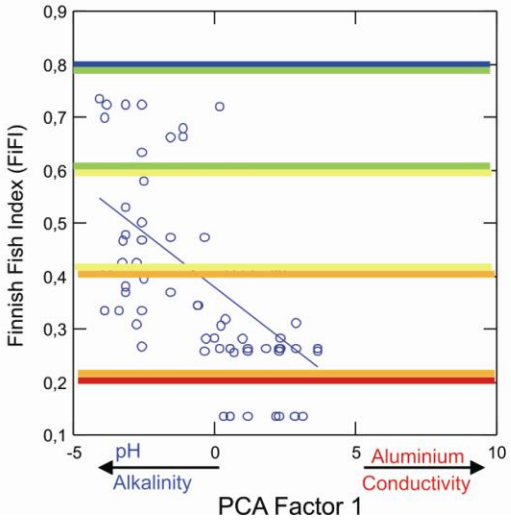
Species composition along water quality gradient





Ecological cassification

Finnish Fish Index (proportion of intolerant and tolerant species, density of 0+ salmonids, number of fish species)



High

Good

Multiple pressures but AS-soils are important pressure

Moderate

Poor

Bad

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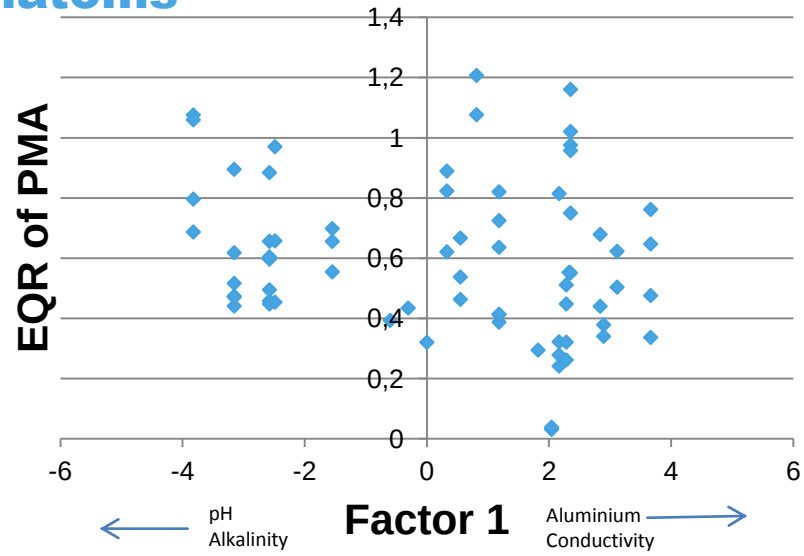
Environmental effects of ASS, Diatoms

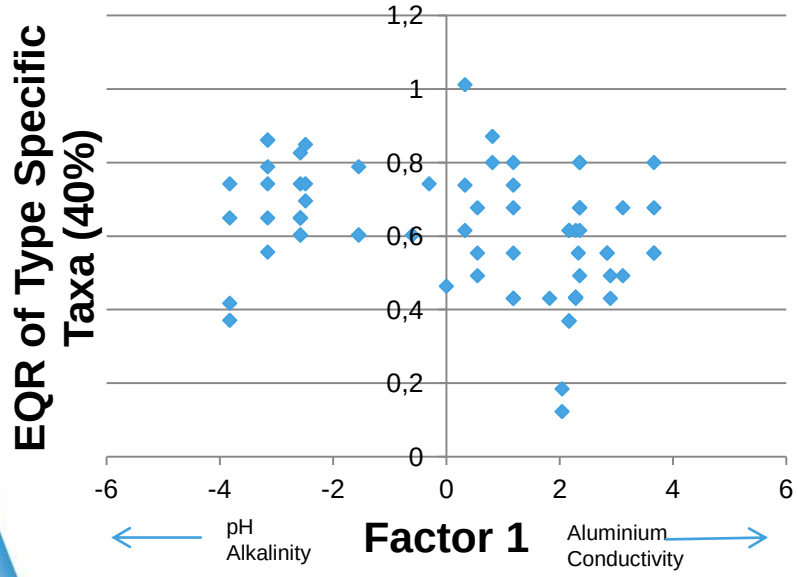
- Benthic algae are important primary producers in stream
- Studied with
  - Type specific species and PMA (*Percent Model Affinity*) used in classification in Finland
  - ACID index by Andrén and Jarlman (2008)
    - Indicates acidity in rivers
    - Based on indicator species

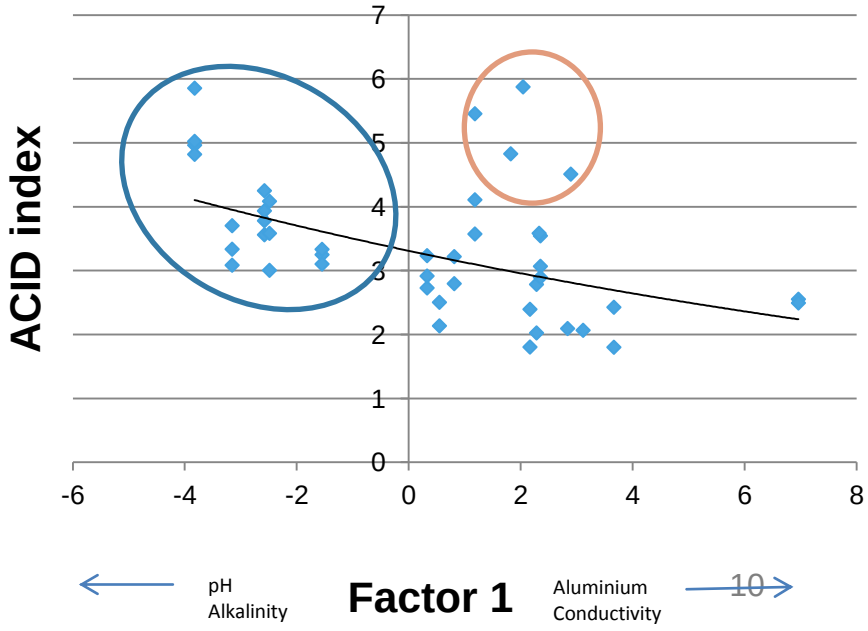
Diatom group	
Acidobiontic	optimal occurrence at pH < 5,5
Acidophilous	mainly occurring at pH < 7
Circumneutral	mainly occurring at pH-values about 7
Alkaliphilous	mainly occurring at pH > 7
Alkalibiontic	exclusively occurring at pH > 7

Environmental effects of ASS, Diatoms

- From Factor 1 pH and alkalinity respond best to ACID index, then PMA
- Type specific taxa used in classification does not respond to pH as the species can be the same in reference conditions

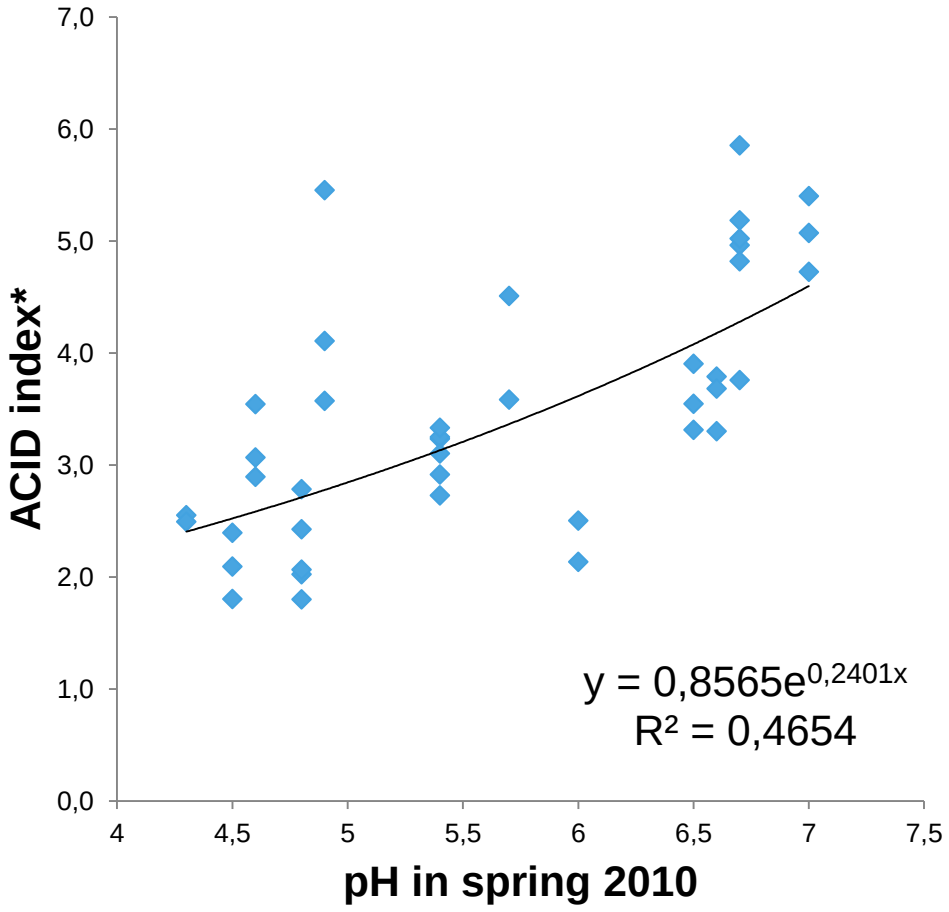






Environmental effects of ASS, Diatoms

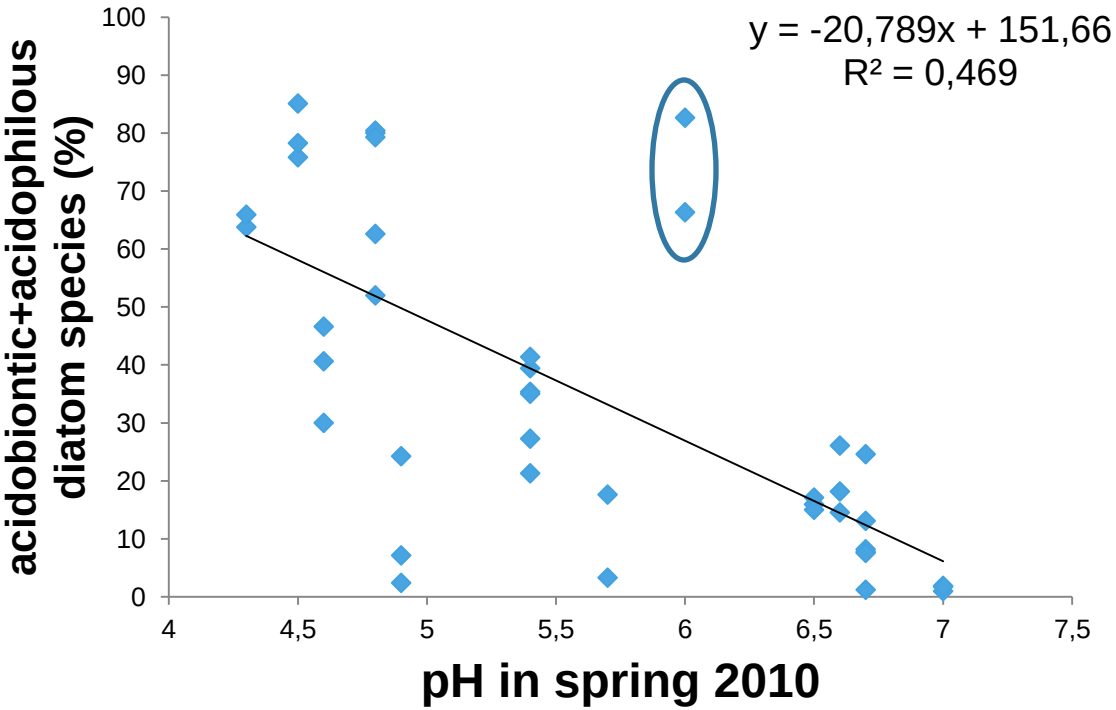
- ACID index had best relation with the previous spring pH measurement



***Andrén, C. & Jarlman, A. 2008. Benthic diatoms as indicators of acidity in streams. Fundam. Appl. Limnol. 173: 237–253.**

Environmental effects of ASS, Diatoms

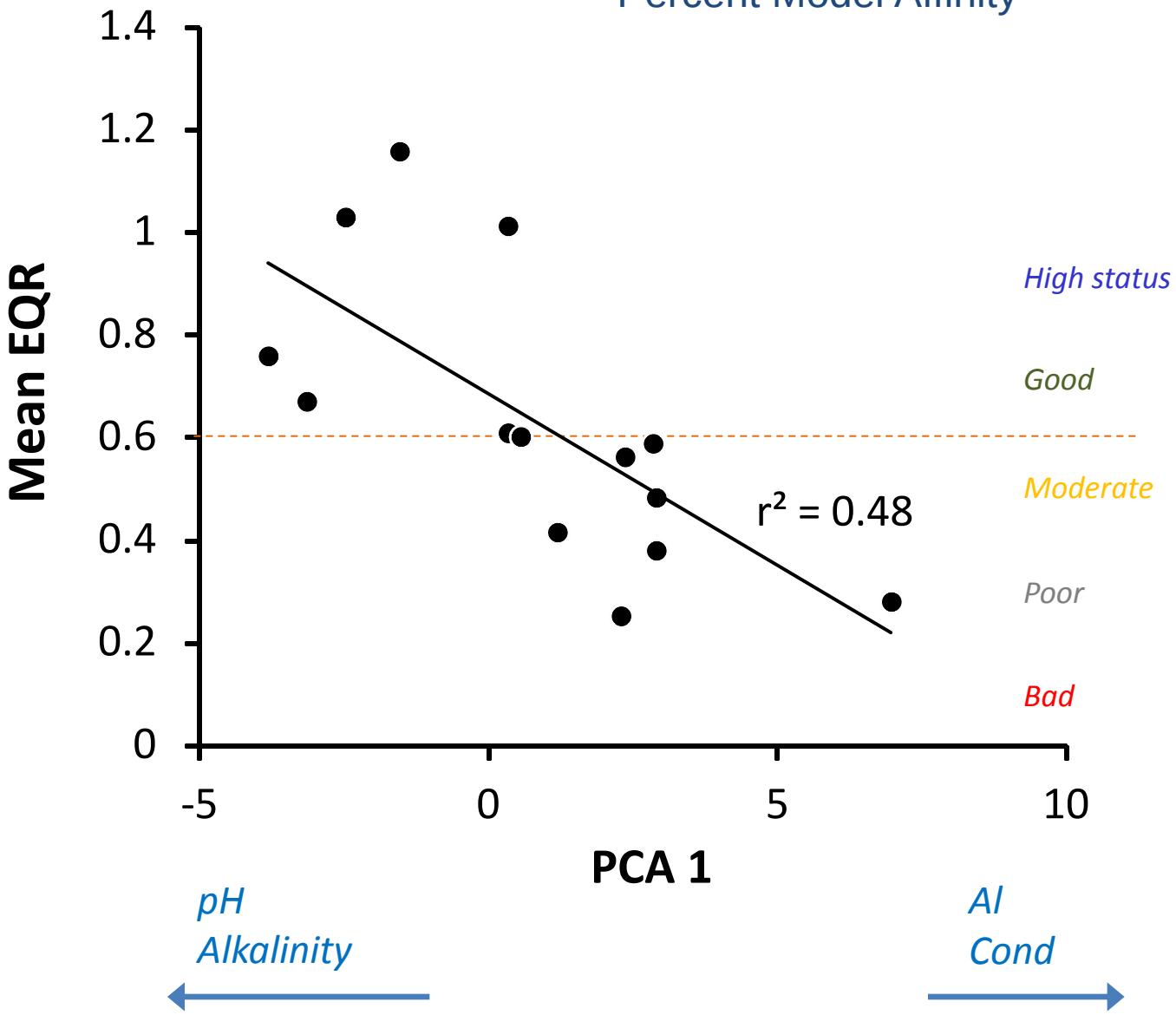
- Proportion of acidobiontic and acidophilous species is high if the river water has been acidic in some period previous to sampling (eg. in spring or some other period as those circled)



Benthic invertebrates

(2010 samples)

Mean EQR over rescaled EQRs of 3 metrics (occurrence of type-specific taxa, occurrence of type-specific families, Percent Model Affinity

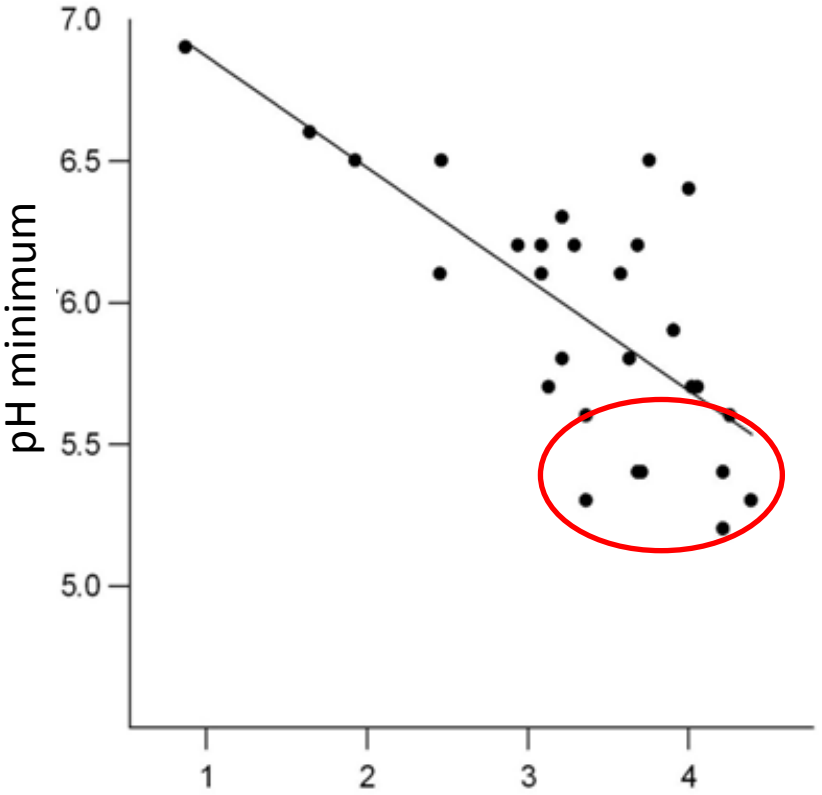


Mitigation of the effects

-Acid leaks from AS-soils are related to dry-wet periods, especially to maximum discharges during autumn – early winter

-Resent climate change scenarios indicate the an increase in high precipitation periods during winter flows thus increasing winter flooding in Scandinavia

-The ecotoxicological risks of acid sulphate soils increases in the future



(Redrawn from Saarinen et al. 2010)

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Conclusions

-The acidity has strongly affected the biota; fish, invertebrates and diatoms, in the area

-As a result (WFD) ecological status has declined

-For example, most impacted sites were classified to “poor” or “bad” ecological class by the Finnish Fish Index (FiFI) and “moderate” to “poor” by invertebrate classification

Monitoring:

-Diatoms: Acidity index (ACID) was the most promising metrics responding to acidity

-Fish: Modified Finnish Fish Index (without density of cyprinid-group) responded adequately to acidity

- Invertebrates: the current national assessment system for invertebrates (EQR over 3 metrics) also responded adequately to acidity

--We need to develop new and take into use existing techniques capable to mitigate the effects acidic loads to improve the ecological status of the rivers in the area

The results are preliminary. More data is beeing collected and and large part of the data is still under analysis.

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Project partners

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Thank you for listening!