Effects of bark beetle disturbance on soil nutrient retention and lake chemistry in glacial catchment

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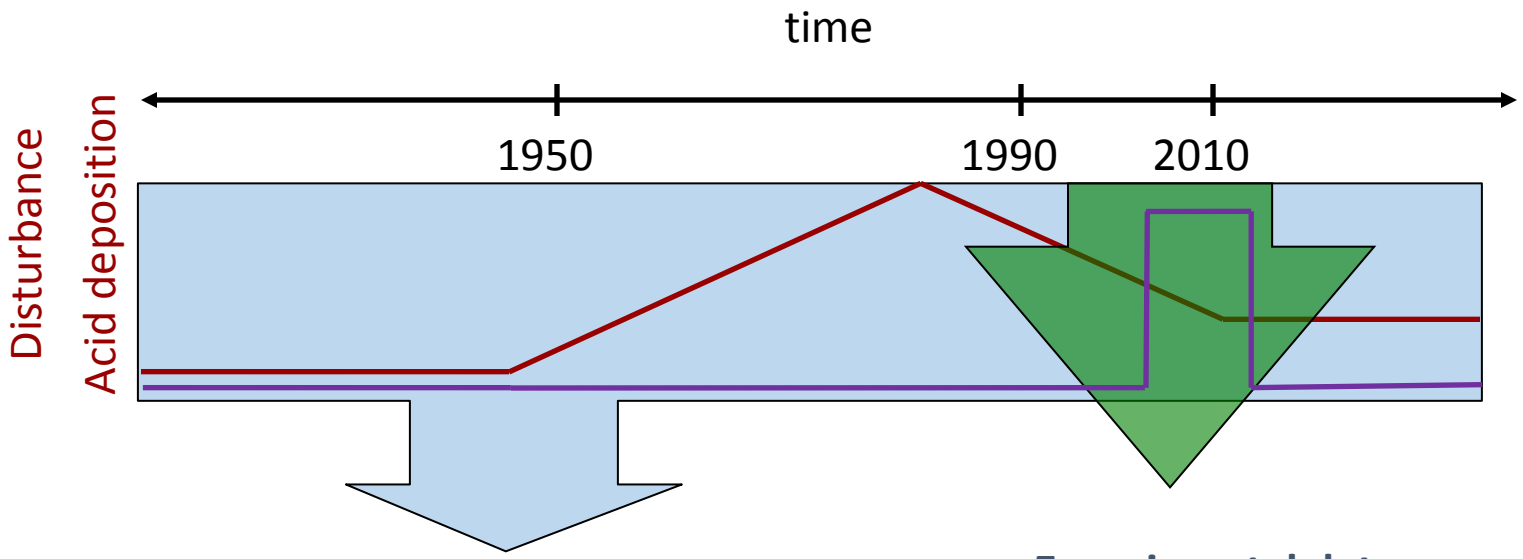
Four things that I am going to talk about:

- The Lake
- Nutrients
- Acid Rain
- Bark Beetle

Biogeochemical modelling



Biogeochemical modelling

MAGIC

Model of **A**cidification of **G**roundwater **I**n **C**atchments

Experimental data

Precipitation
Soil
Vegetation
Surface water

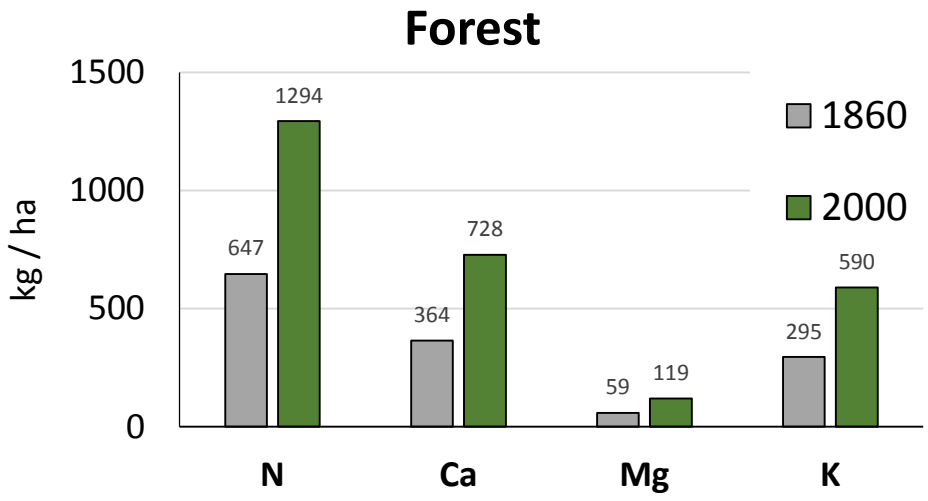
2000

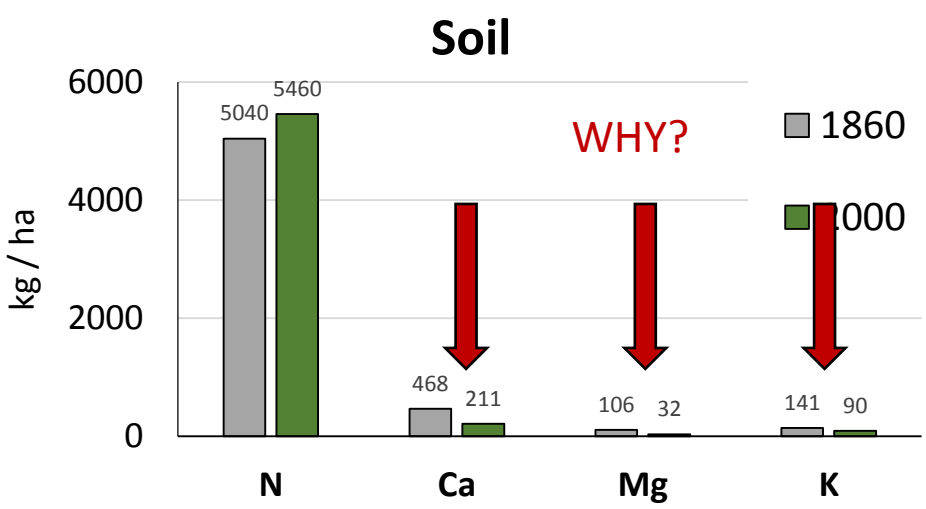
Estimated forest biomass (year 1860)

280 t / ha

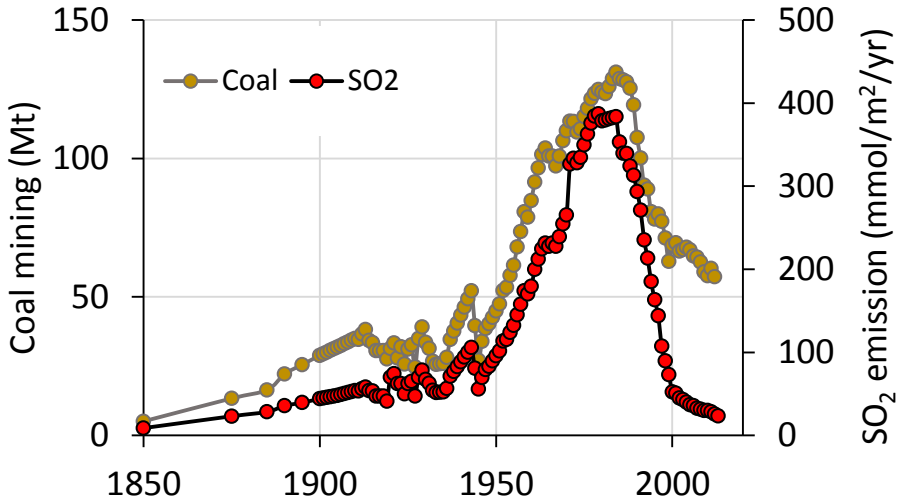
Measured forest biomass (year 2000)

420 t / ha



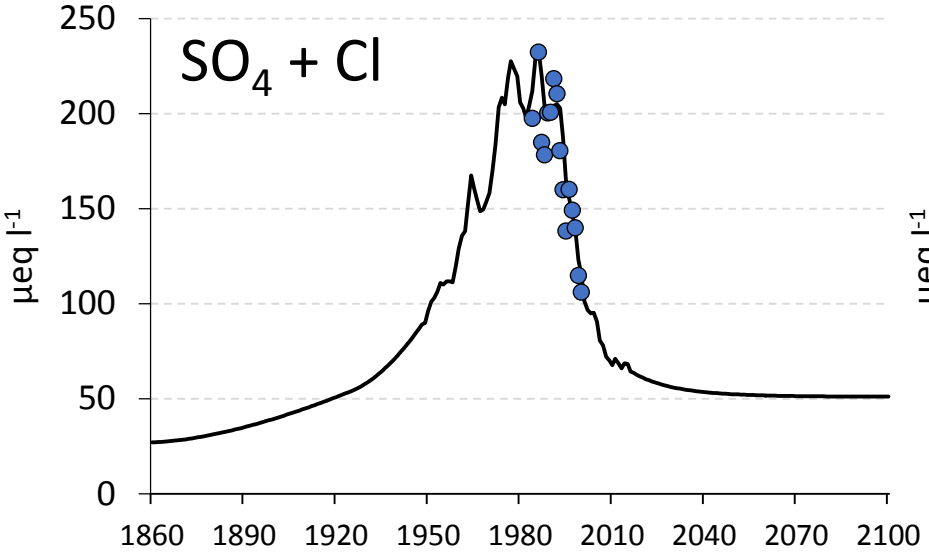


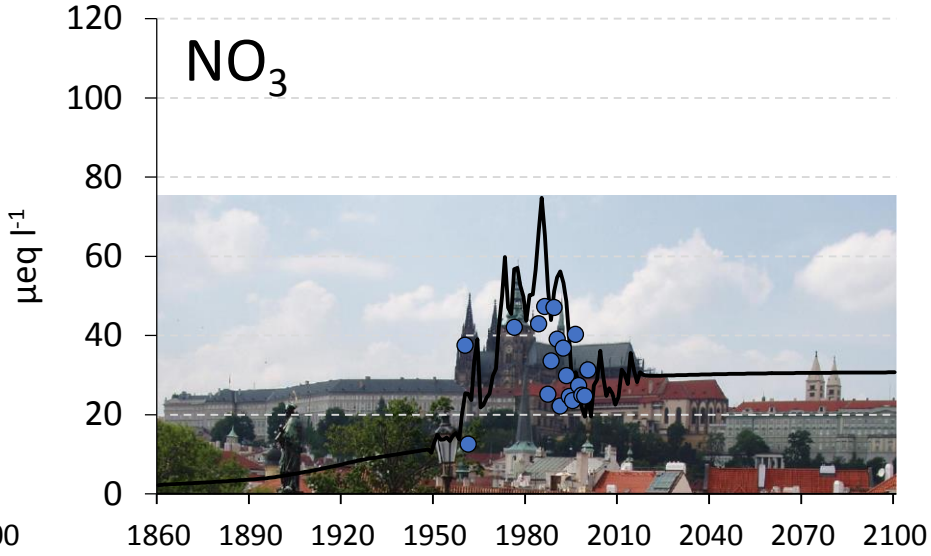
Acid rain

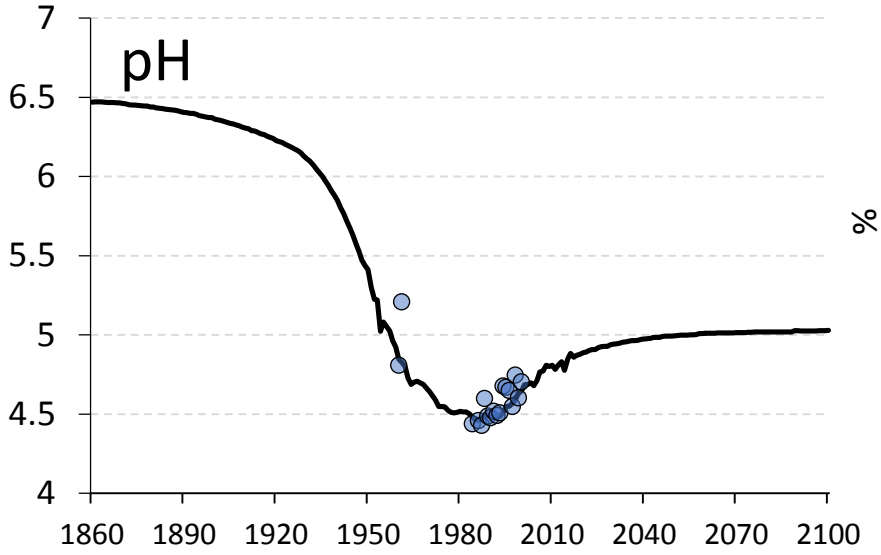


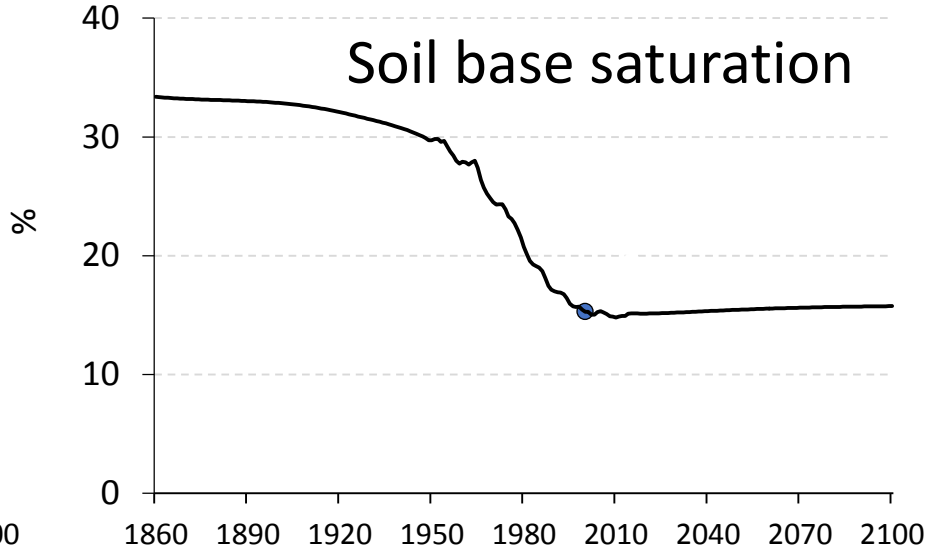
Acidification of lake water and soil

Acid rain

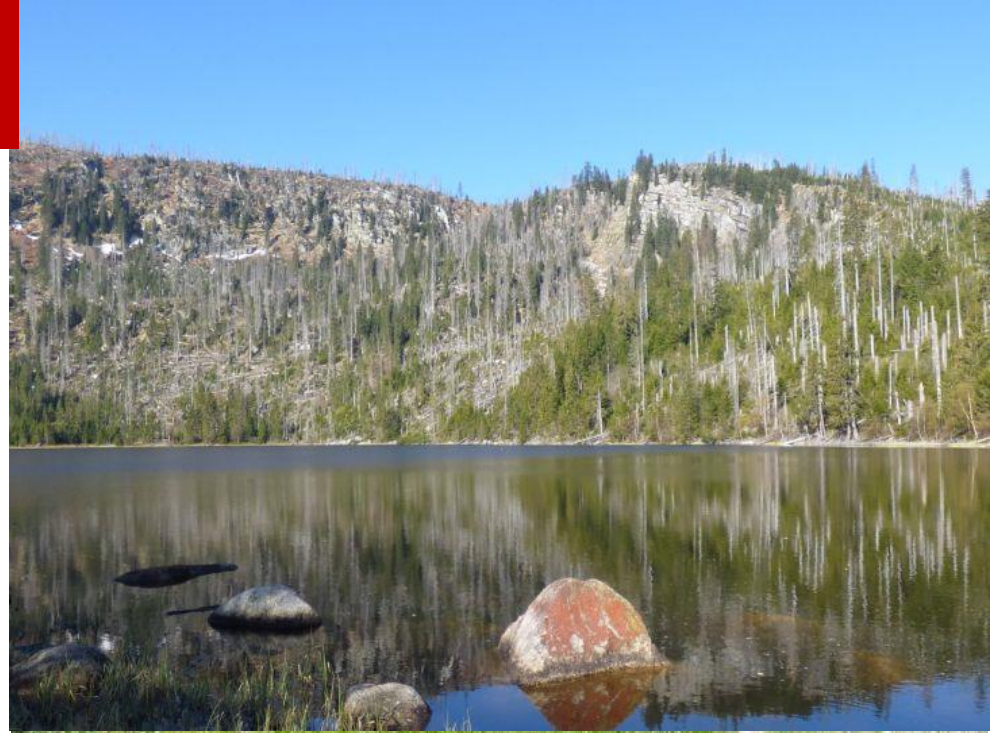

SO_4 + Cl
µeq l-1
250
200
150
100
50
0
1860
1890
1920
1950
1980
2010
2040
2070
2100


NO_3
µeq l-1
120
100
80
60
40
20
0
1860
1890
1920
1950
1980
2010
2040
2070
2100


pH
7
6.5
6
5.5
5
4.5
4
1860
1890
1920
1950
1980
2010
2040
2070
2100


Soil base saturation
%
40
30
20
10
0
1860
1890
1920
1950
1980
2010
2040
2070
2100

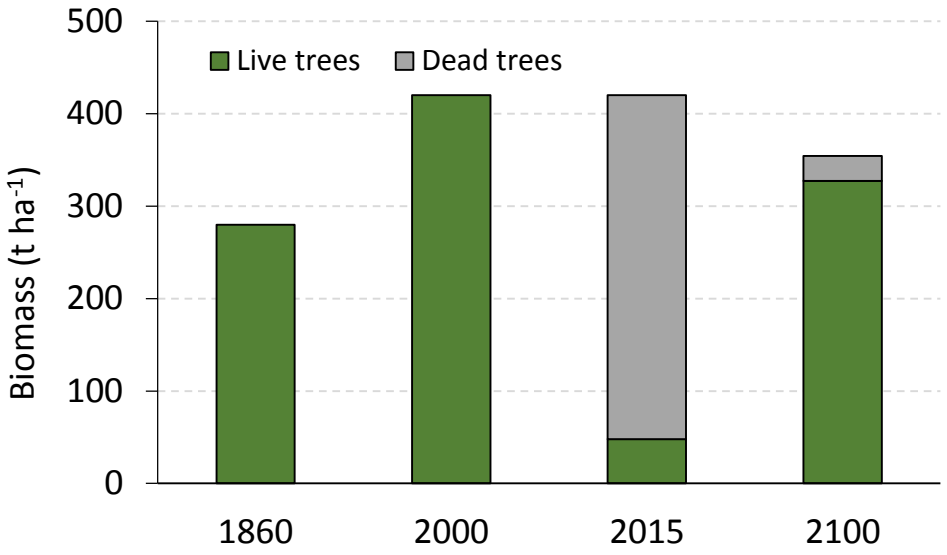
2016



Cycling of nutrients driven by:

1) Dead biomass decomposition/mineralization

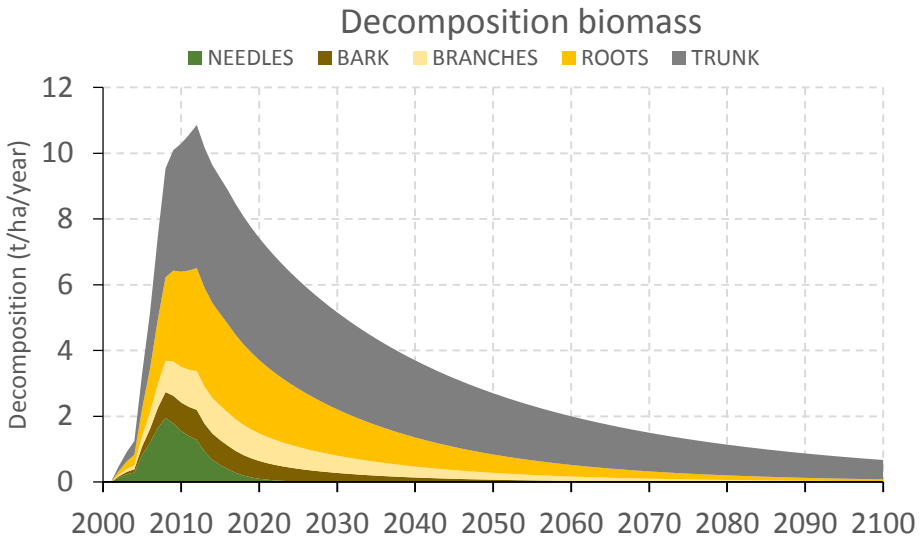
2) Immobilization in regrown vegetation (trees + understory vegetation)

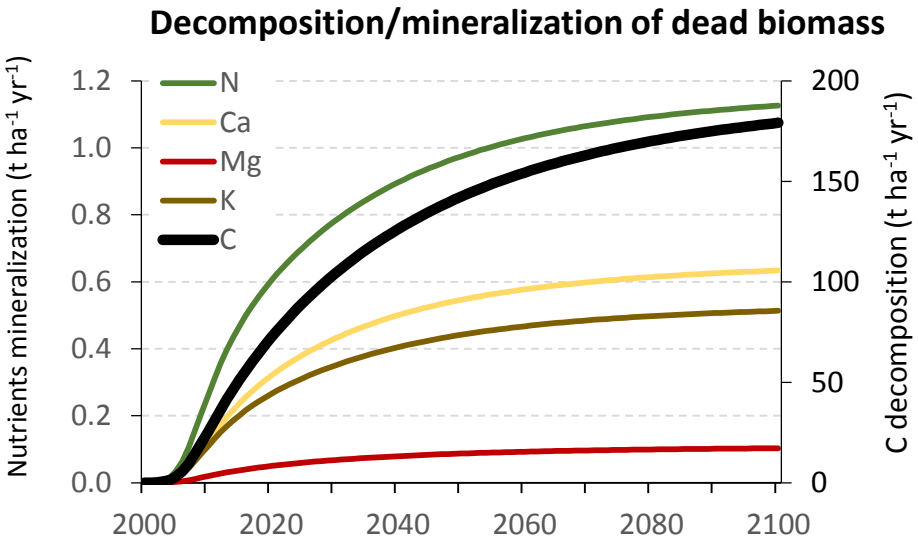


1) decomposition/mineralization

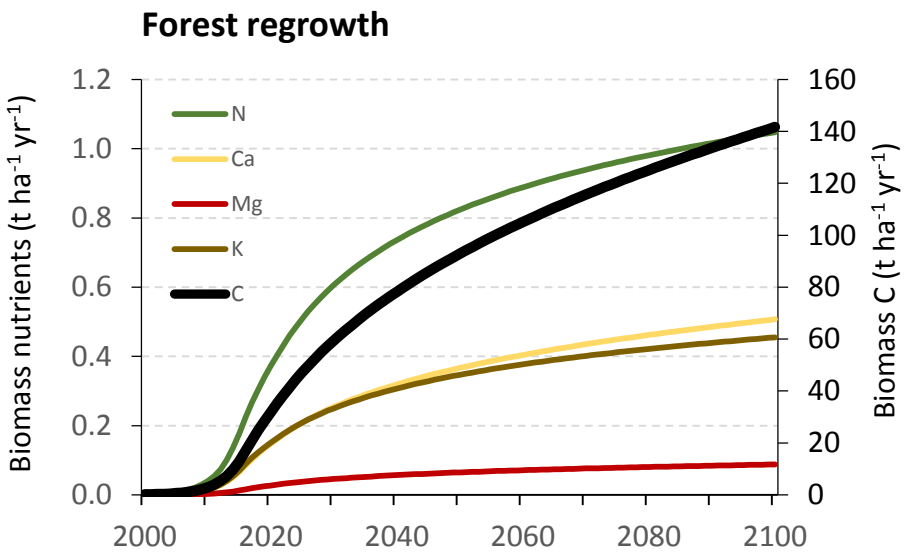
$$AML_t = 1 - e^{-kt}$$

	needles	bark	branches + roots	trunk
k	0.35	0.069	0.046	0.023
$t_{50\%}$	2	10	15	30
$t_{90\%}$	7	33	50	100

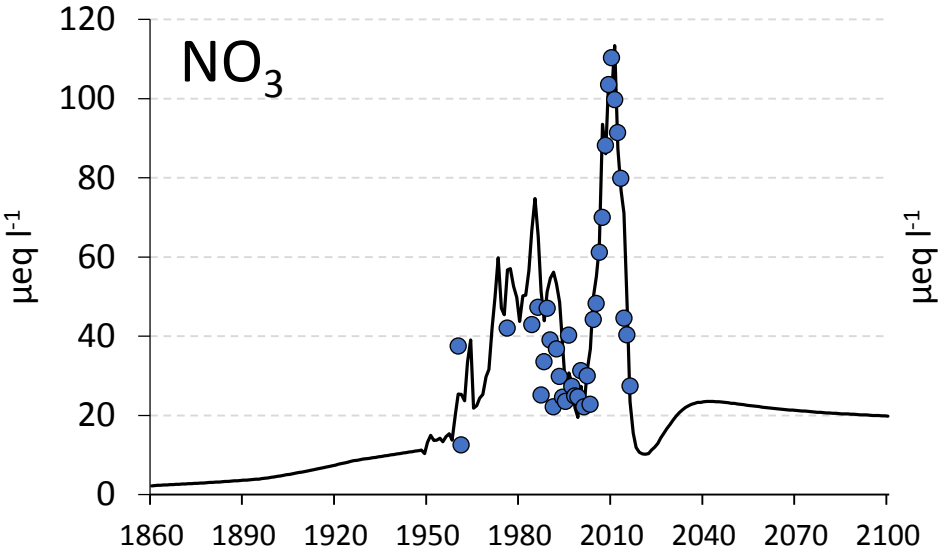


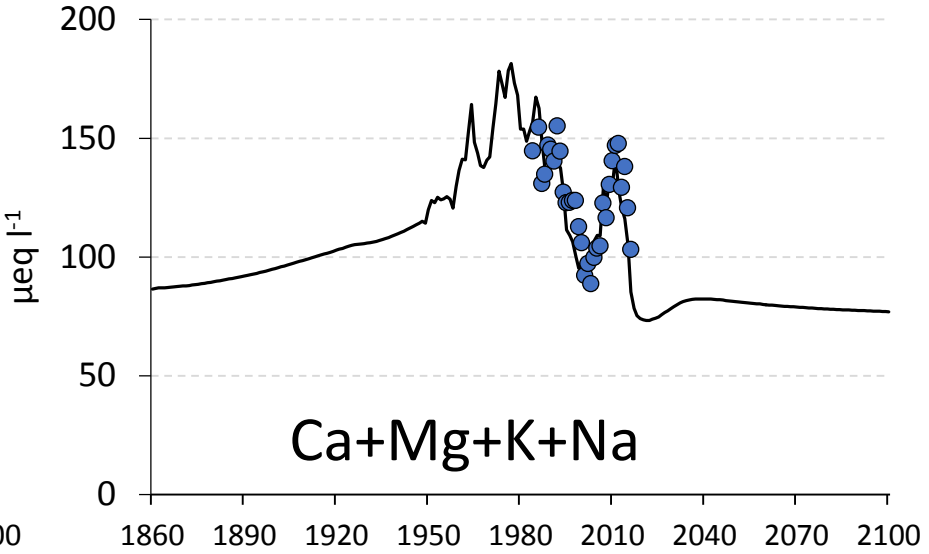


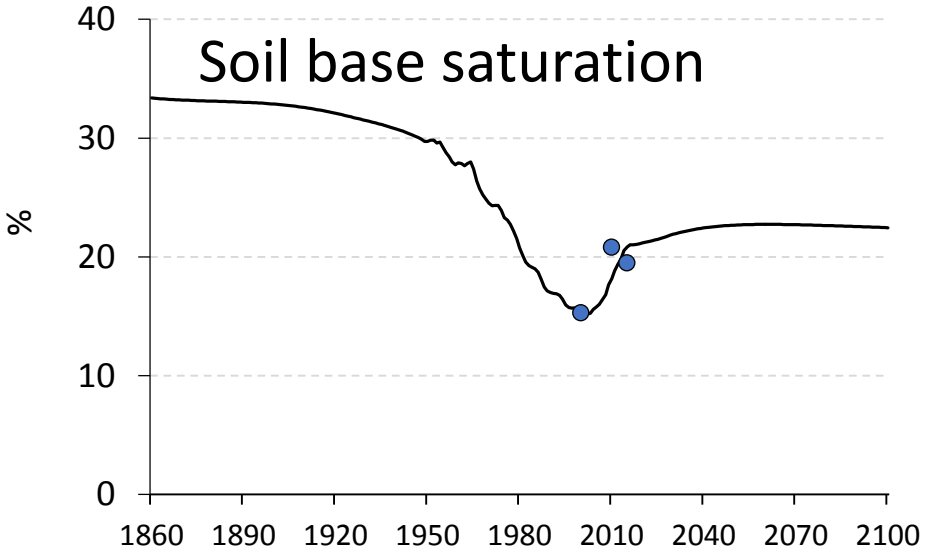
1) Vegetation regrowth

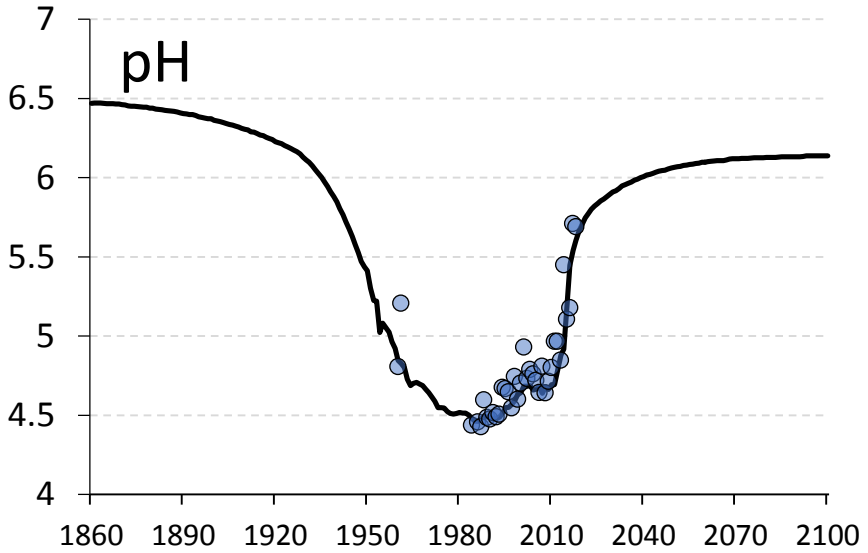


Effects on lake ecosystem









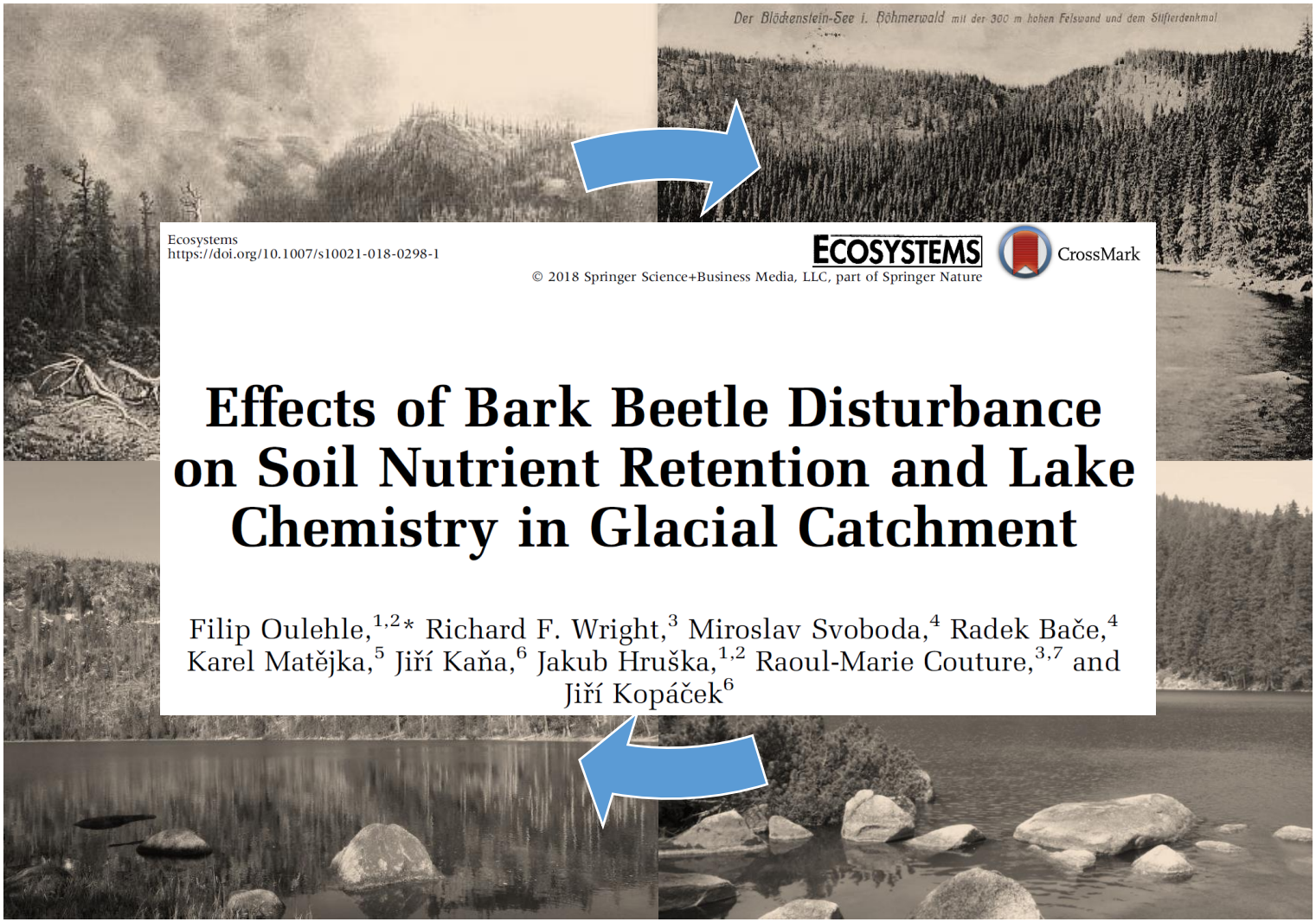
Take home message

- Mountain forests (especially on poor bedrock) have naturally constrained nutrient budget
  - Soils are shalow and poor in soil fine fraction
  - High precip and runoff, low weathering rates

- Acidification led to the loss of base cations from soils (Ca by 55%; Mg by 70%)
  - Soils and surface waters acidified, low pH, high Al
  - Lake ecosystem diversity declined

- Bark beetle = decline of mature trees (90 % of catchment area)
  - Mineralization/mobilization of nutrients from dead trees – N, Ca, Mg, K
  - In the early stage connected to losses out of catchment (leaching of NO_3)
  - Vegetation succesion not affected by salvage logging
    - Uptake of nutrients by regrown vegetation (N, Ca, Mg, K)
    - Decline of NO_3 leaching » base cations remained in the soil (increase of base saturtion)

- Bark beetle = accelerated recovery of whole lake ecosystem from acidification
  - Positive impact on soil chemistry
  - Positive impact on lake chemistry – biological recovery also accelerated



Ecosystems
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