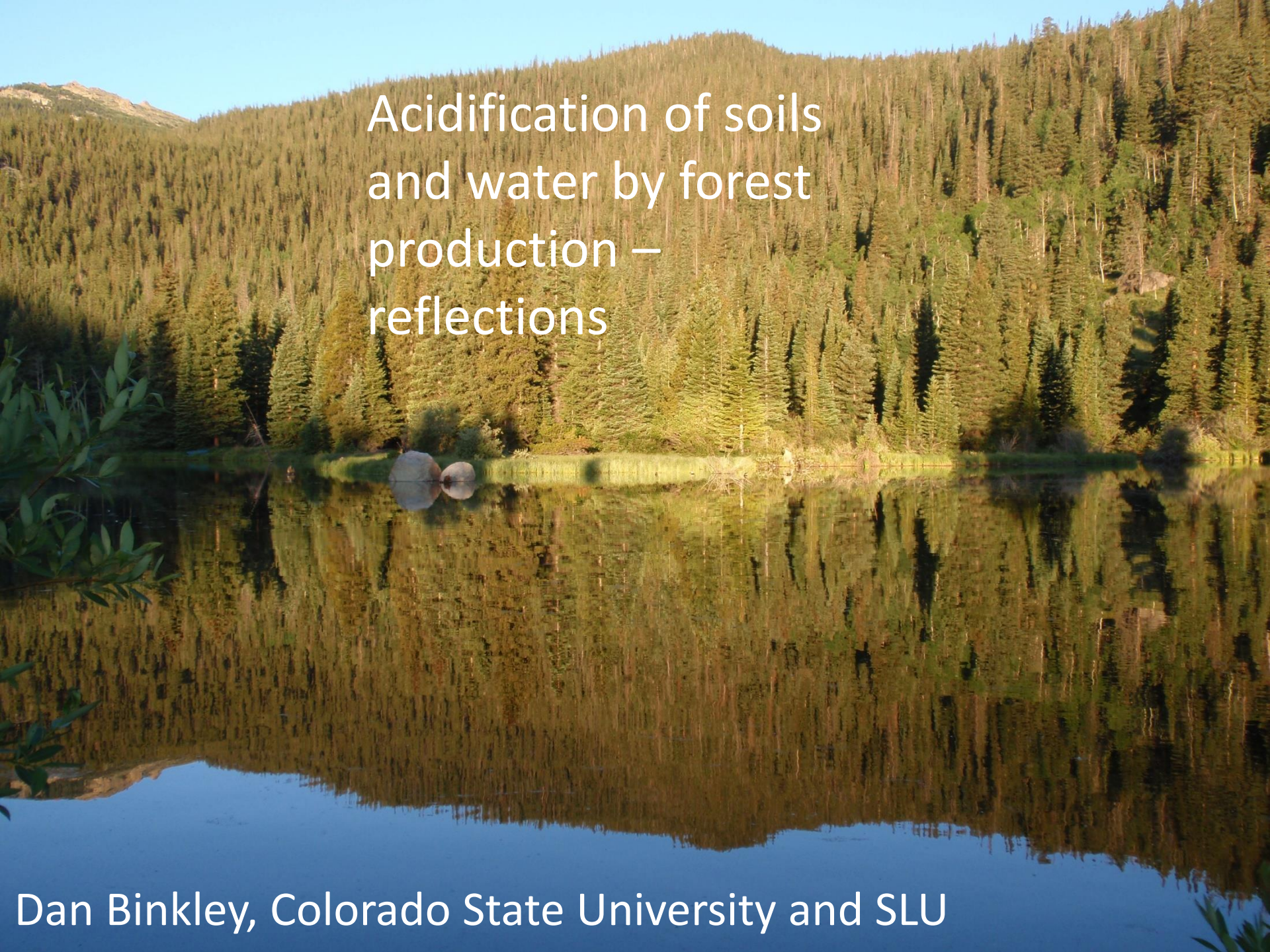
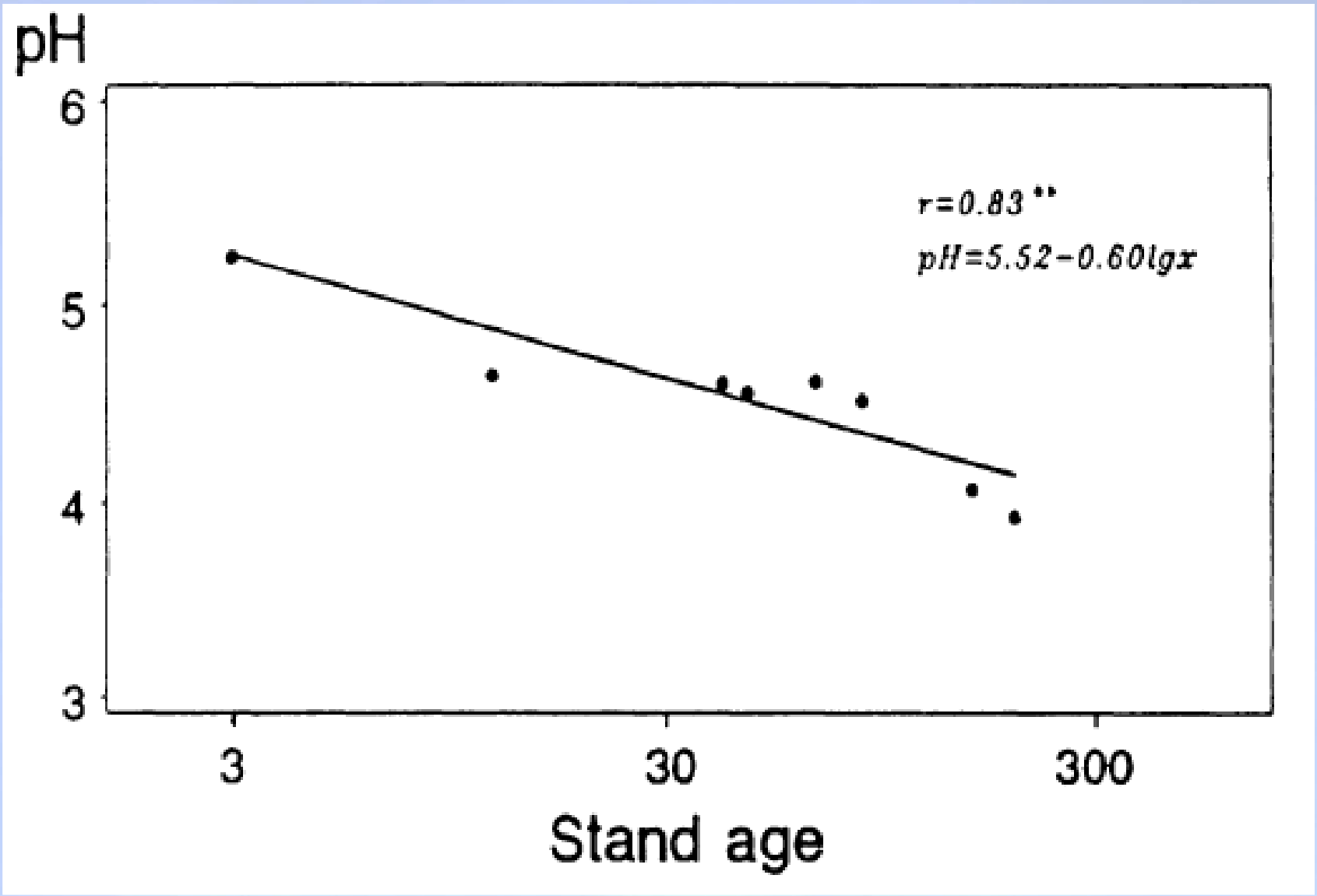
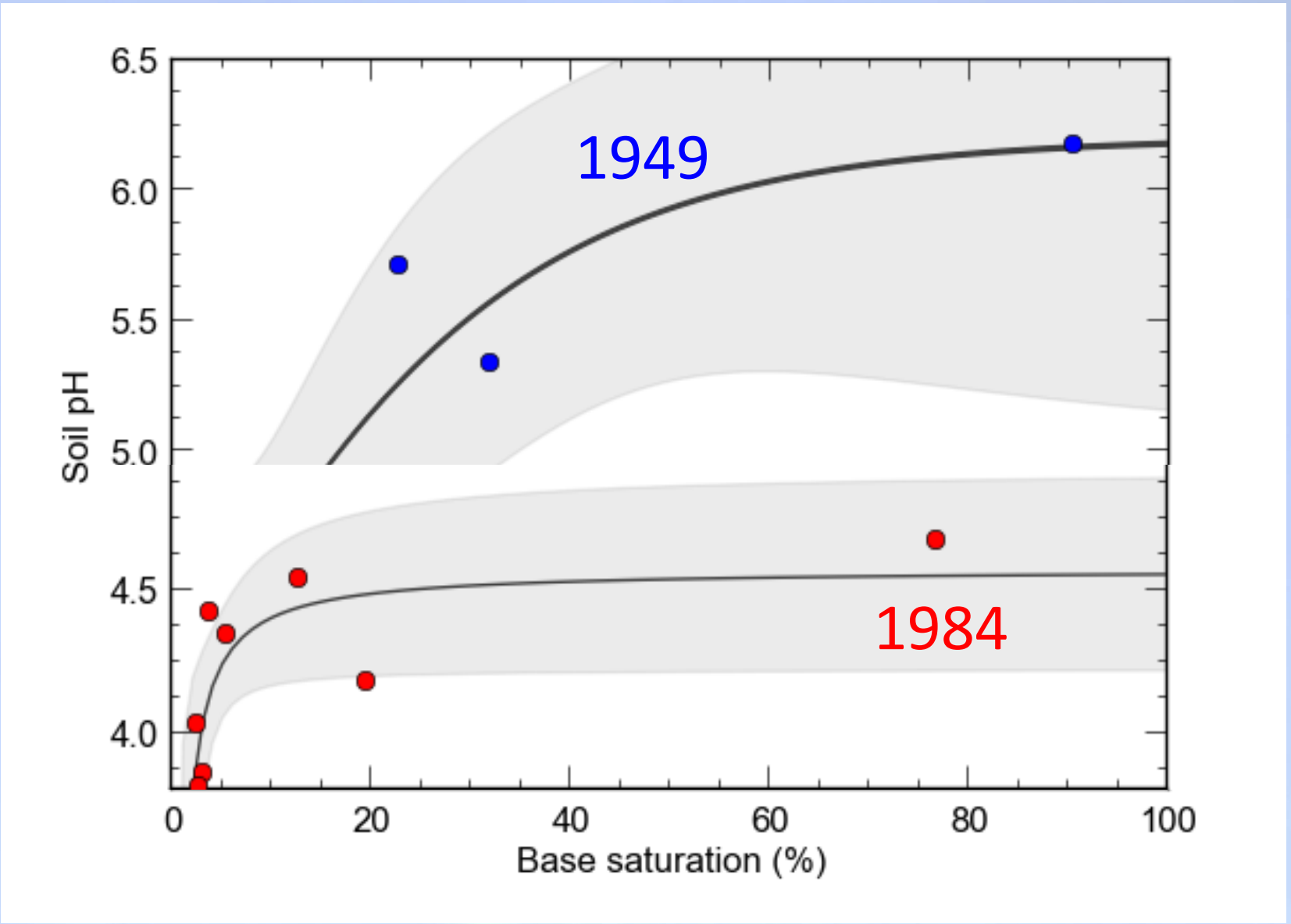

Acidification of soils and water by forest production – reflections
Dan Binkley, Colorado State University and SLU



Why did soil pH decline? Easy explanation is tree accumulation of “base” cations lowered soil “base” saturation

Hesselman 1937

Not all easy expectations are supported by evidence:



pH change could *not* be explained by BS change

Falkengren-Grerup et al. 1987

pH of soil water solutions goes down if:

Salt concentration goes up

Base saturation goes down

(= acid dissociation increases)

Carbon (organic acids) goes up

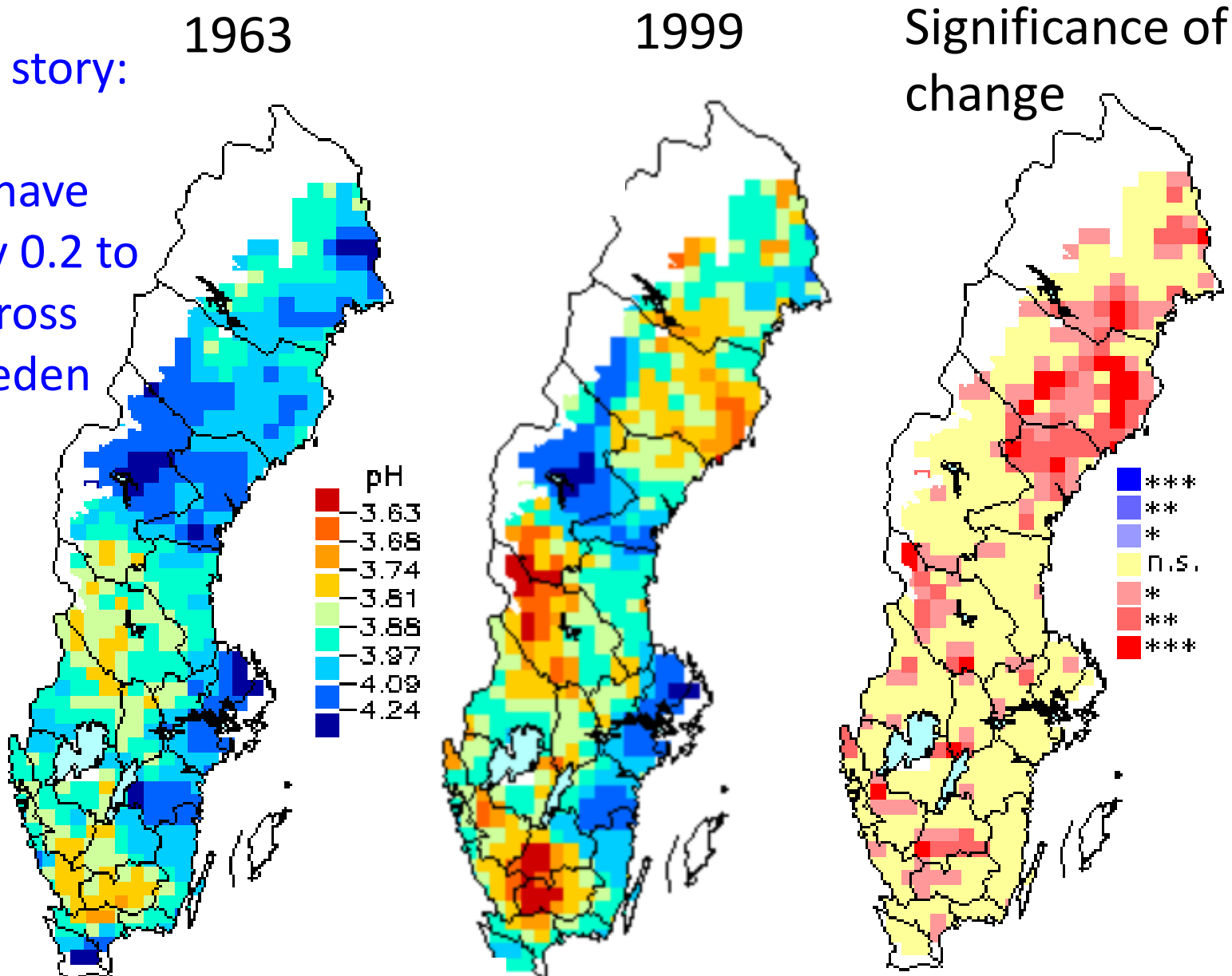
Carbon acid strength increases

Acidification of Swedish Forest Soils:

Trends across the decades, across Sweden

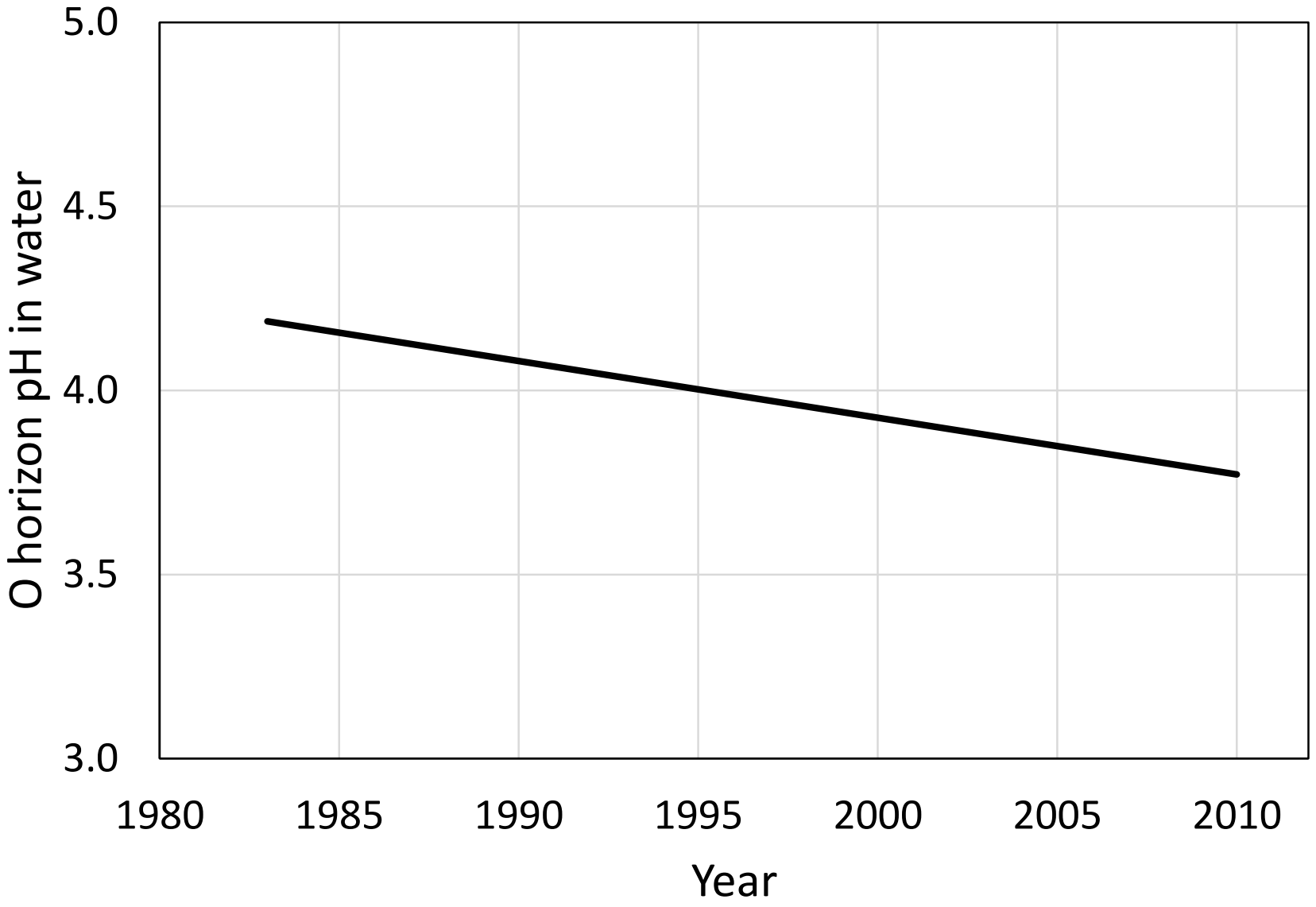
The current story:

O horizons have acidified, by 0.2 to 0.4 units across most of Sweden



Acidification of Swedish Forest Soils:

Trends across the decades, across Sweden

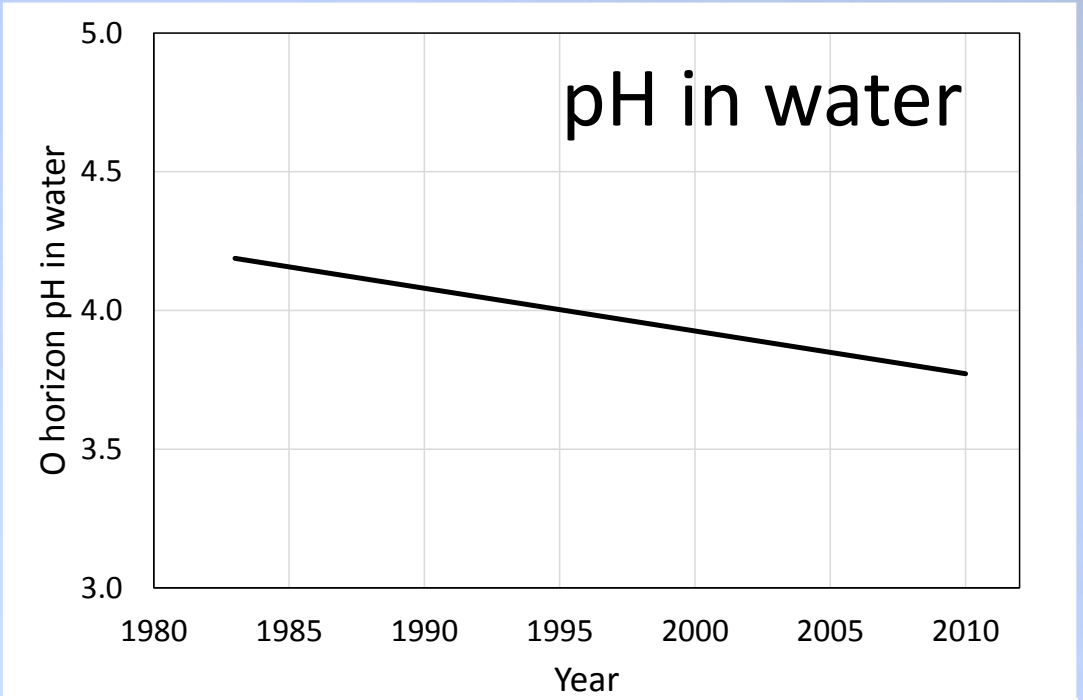


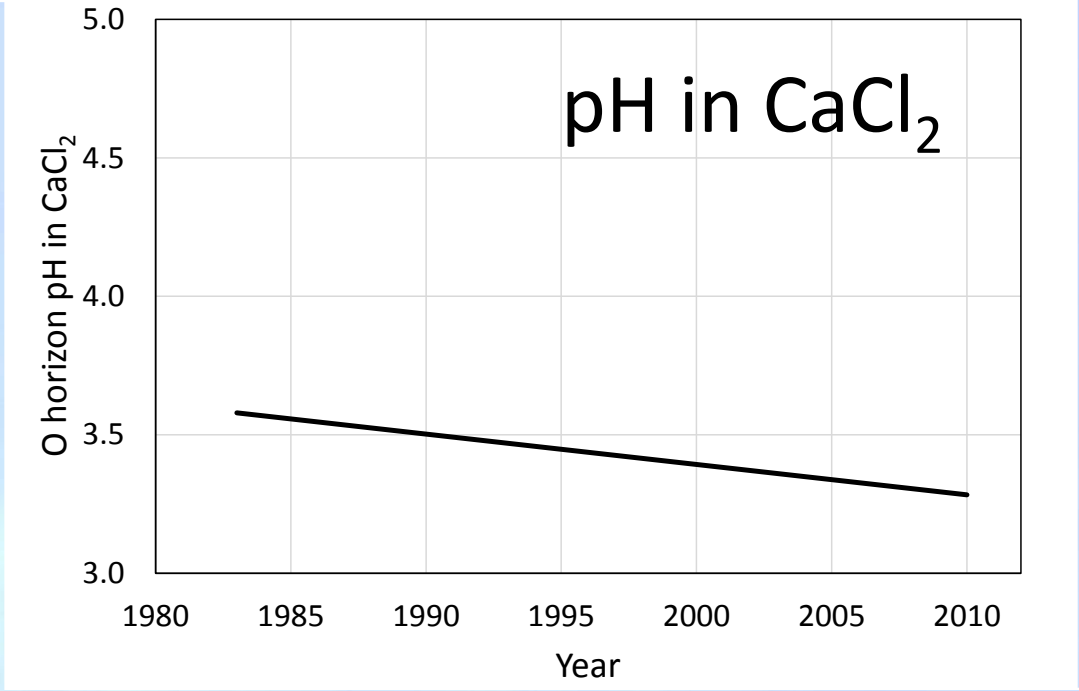
Preliminary analysis

Why? Salt effect?

pH of soil water solutions goes down if salt concentration goes up

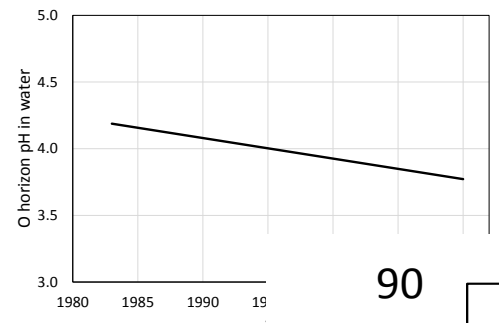
…but pH declined even when measured in salt solution



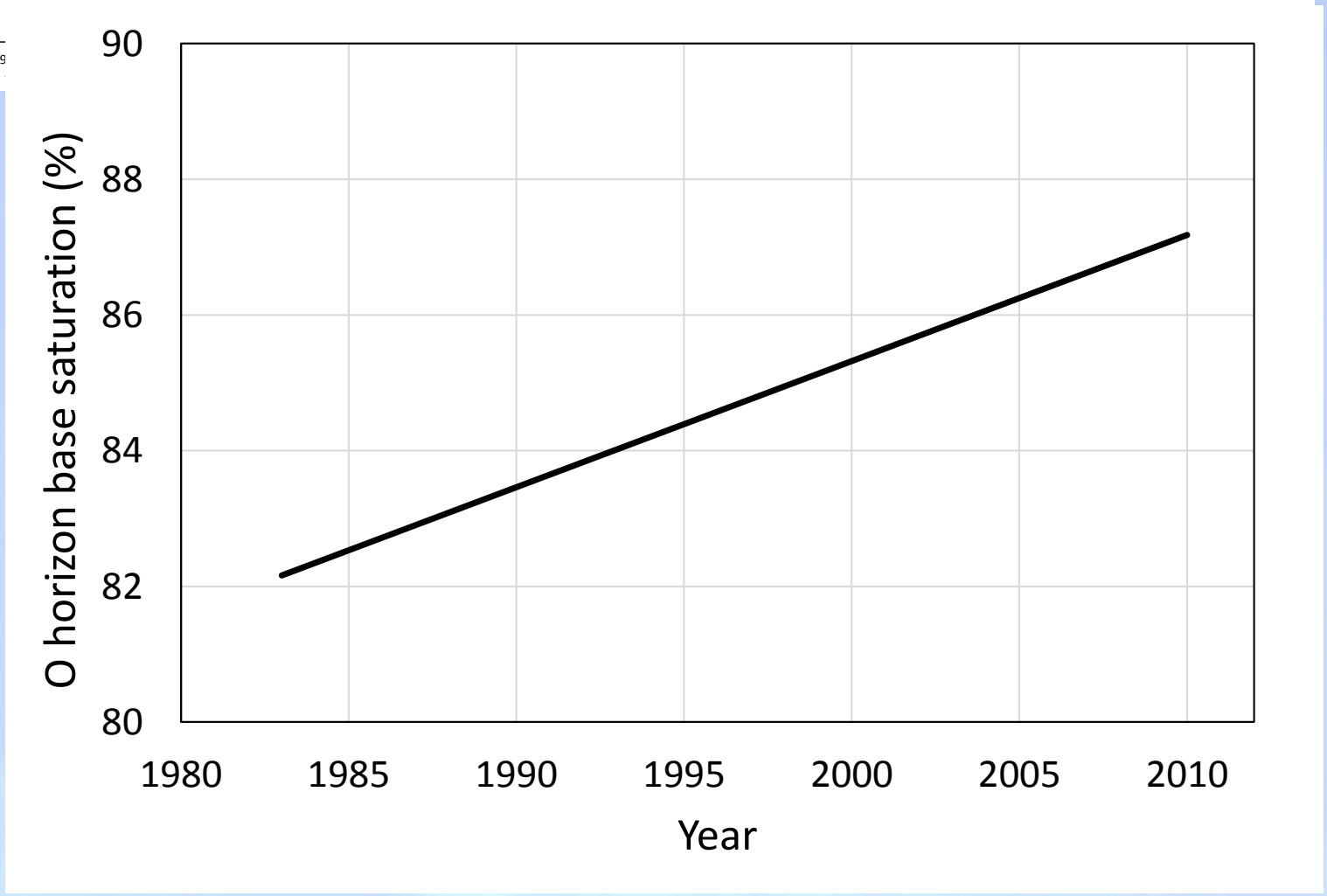


Preliminary analysis

Why? Acid dissociation increases (= Base saturation drops)

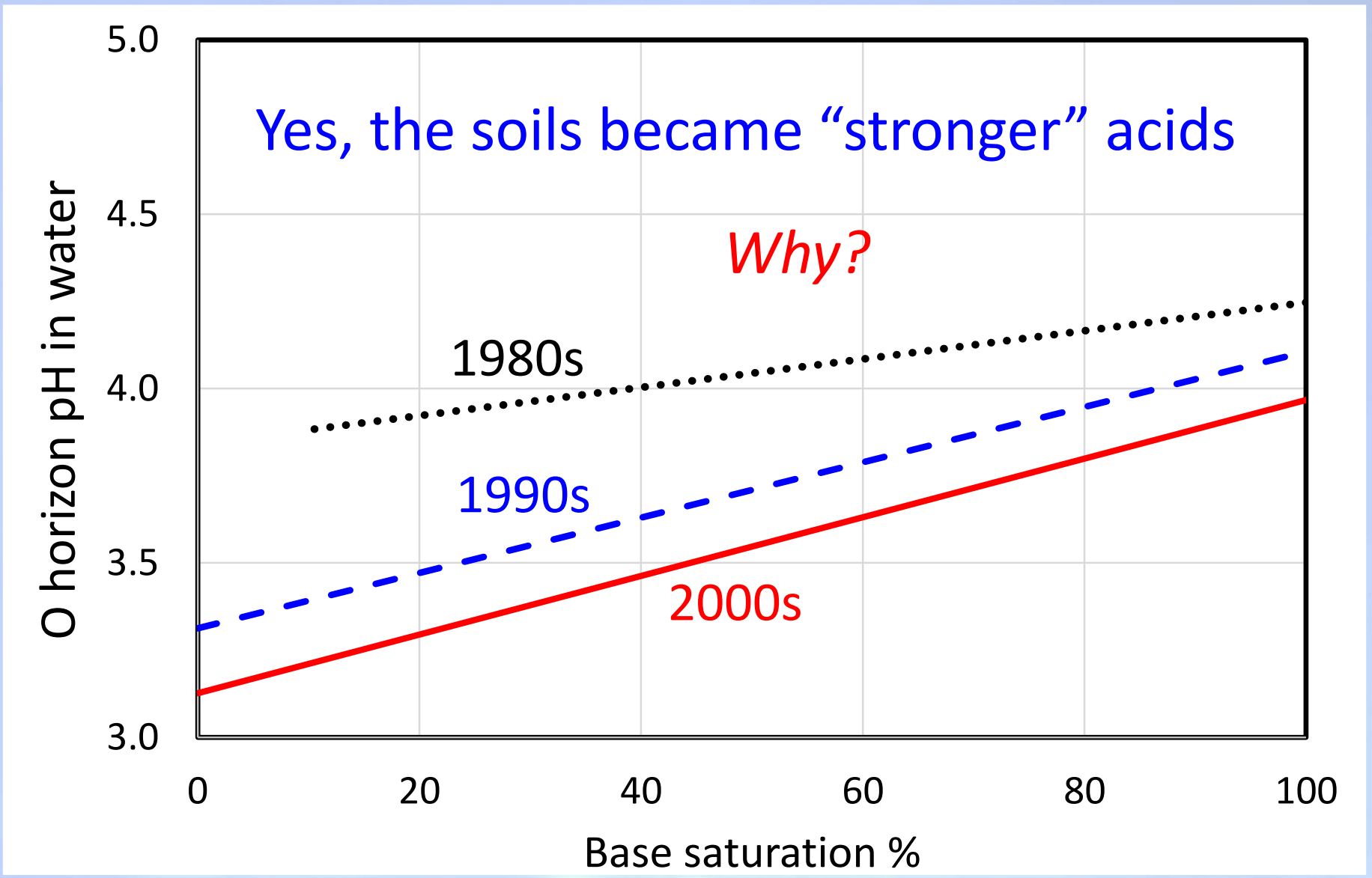


The database's decline in pH was *not* driven by declining base saturation



Preliminary analysis

Why? Change in the "quality" of the soil acid complex?



Preliminary analysis

Soil acid-strength increased as %C increased:

Did the O horizon %C *really* go up, or did sampling change?

Preliminary analysis

Challenges to predict, and understand, the future:

- Chemistry of most Swedish soils is strongly influenced by organic matter (solid and dissolved)
- Soil organic matter contains more base cations than the exchange complex (mostly…)
- Changes in soil organic matter change base saturation in 3 ways:
    1) lowering BS without removing cations
    2) adding or removing cations as organic matter content changes
    3) changing stoichiometry of C:base cations
- Weather rates are highly variable – and influenced by organic compounds, microbes and plants

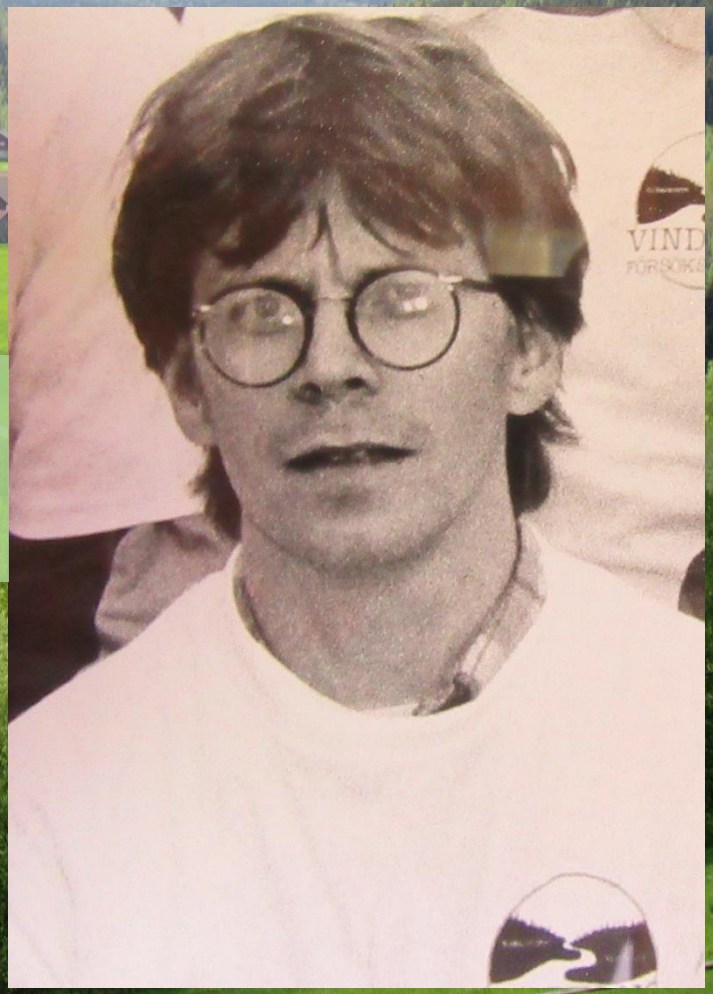
Challenges to predict, and understand, the future:

- Soils are very challenging to resample over time (especially if rocks or fuzzy horizon boundaries)
- Analytical methods are a challenge for quality assurance over long time spans
- Productivity of most (not all) Swedish forests is limited by low soil N
- Few Swedish forests are limited by cation nutrients, even when fertilized with N and P (though some do exist, esp. peat soils)
- So there is little opportunity for collecting evidence to falsify or support ideas about base cations and soil fertility in Sweden.

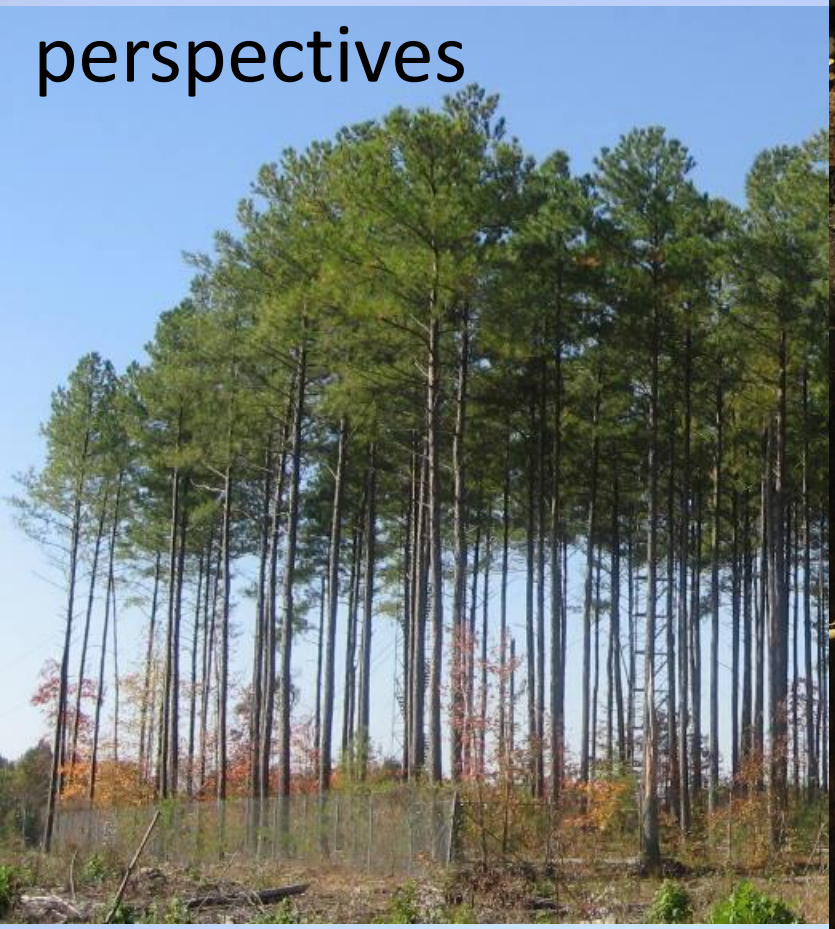
Challenges to predict, and understand, the future:

- Landscapes, soils, and land use have huge diversity within watersheds – connections to aquatic systems are rarely simple in time and space

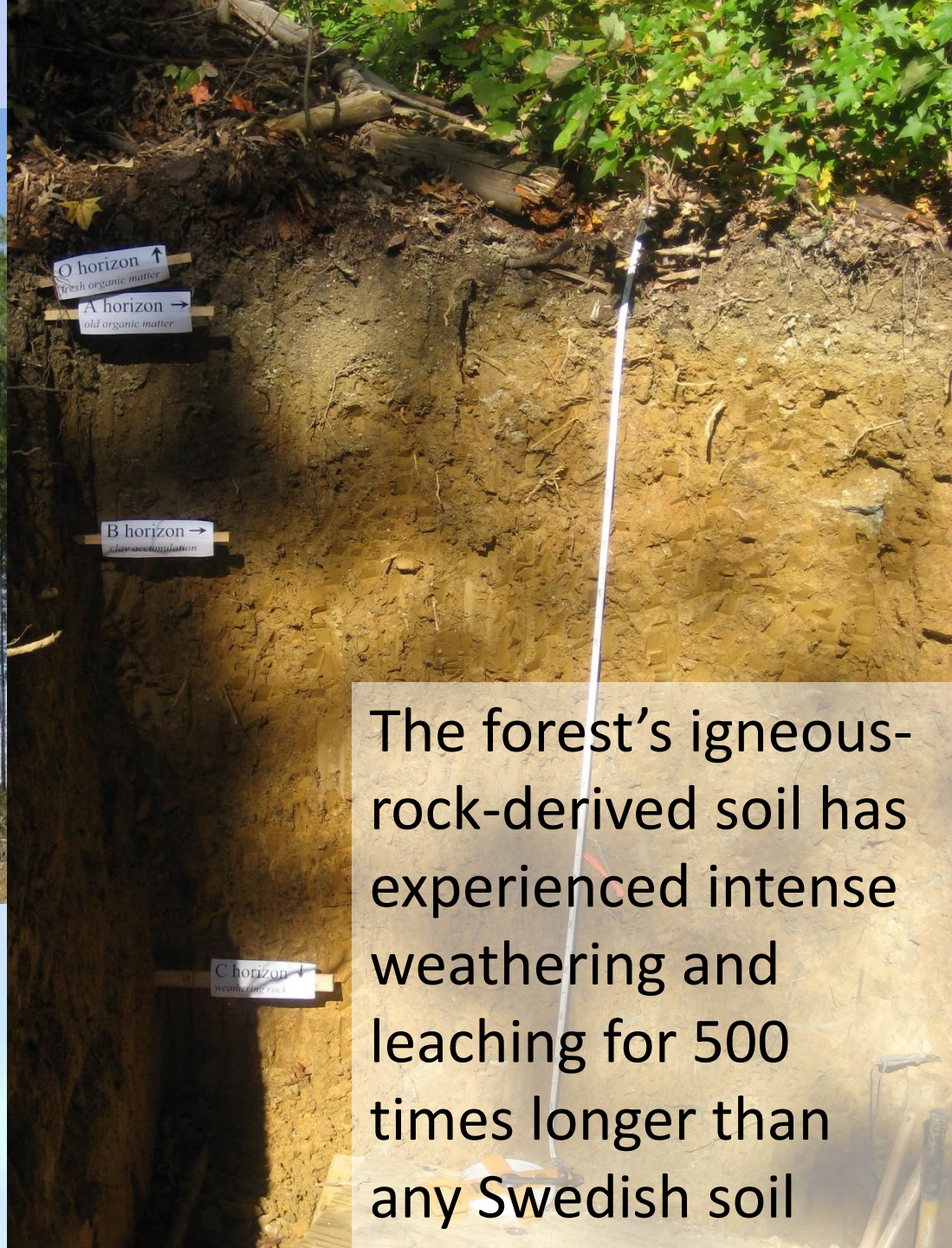
Great opportunities for young scientists!



Final thoughts/ perspectives



This 40-year-old pine plantation in North Carolina grew faster than any forest in Sweden

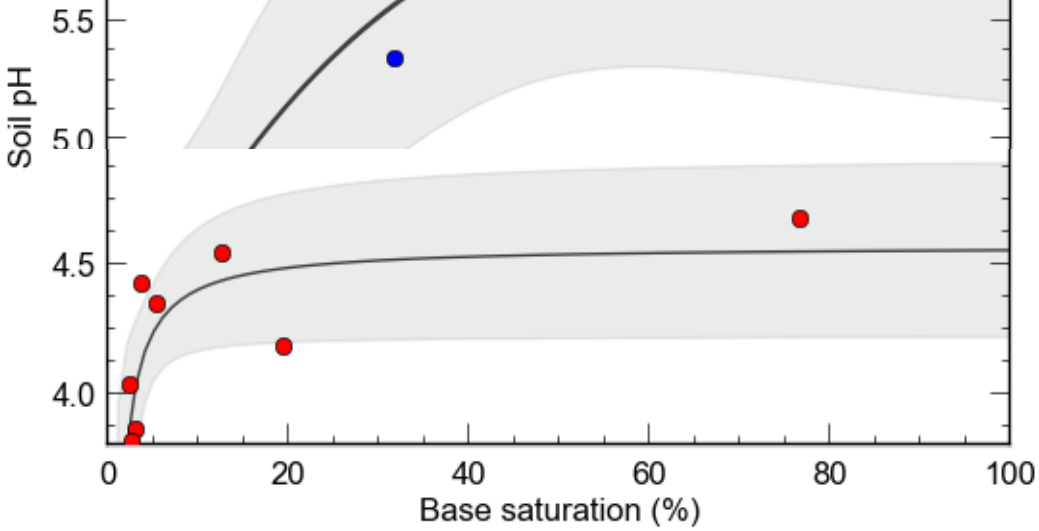


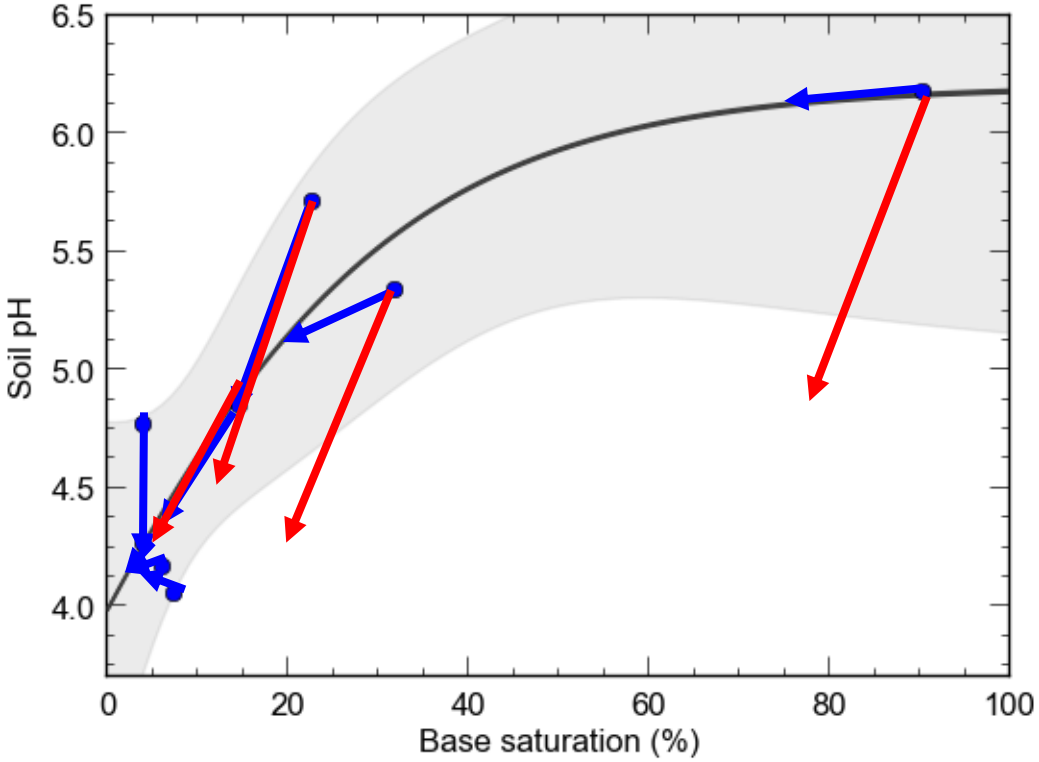
The forest's igneous-rock-derived soil has experienced intense weathering and leaching for 500 times longer than any Swedish soil

This is a Swedish soil in a dynamic, biotic forest:

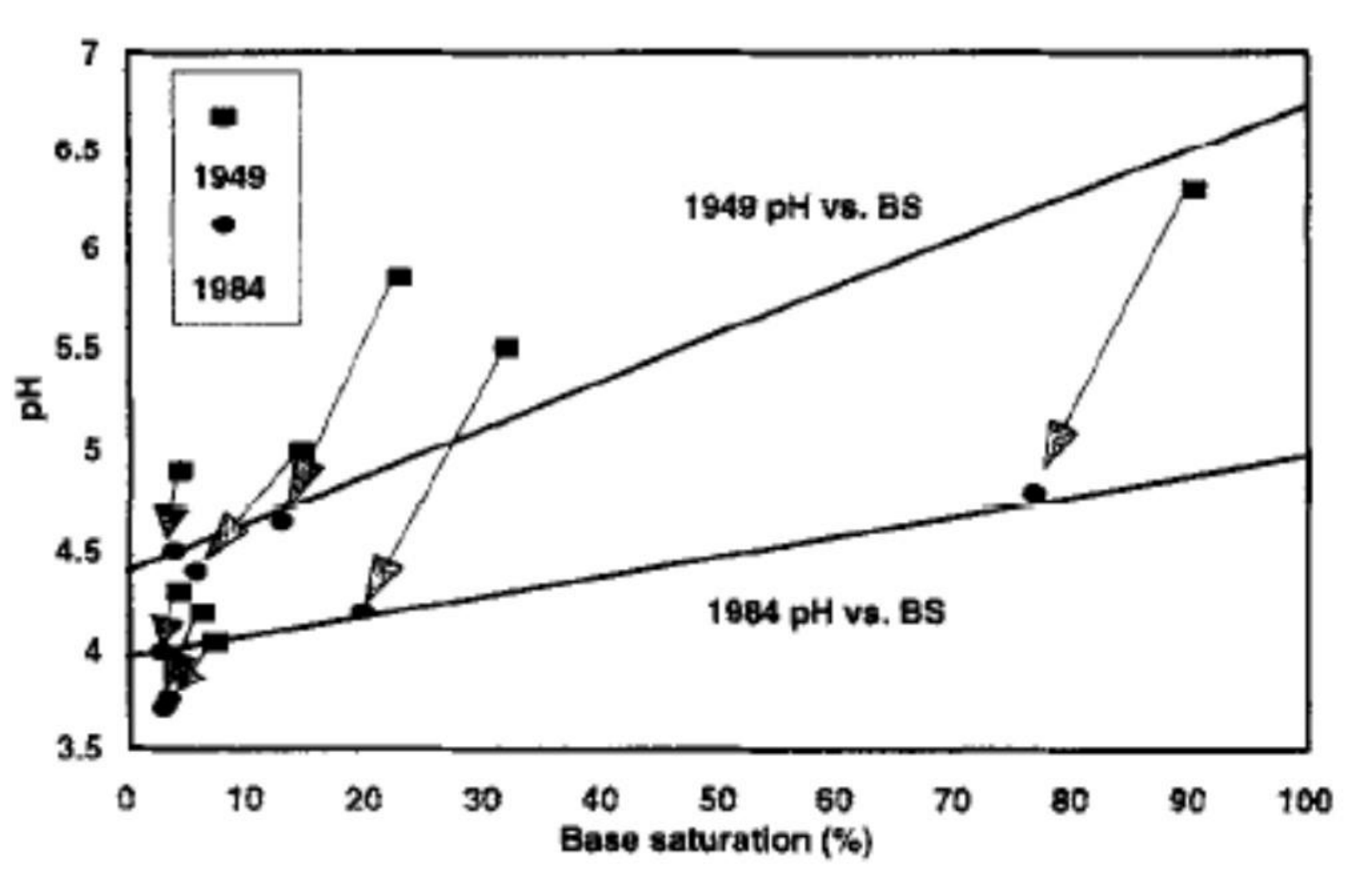
This geochemical clay is neither:

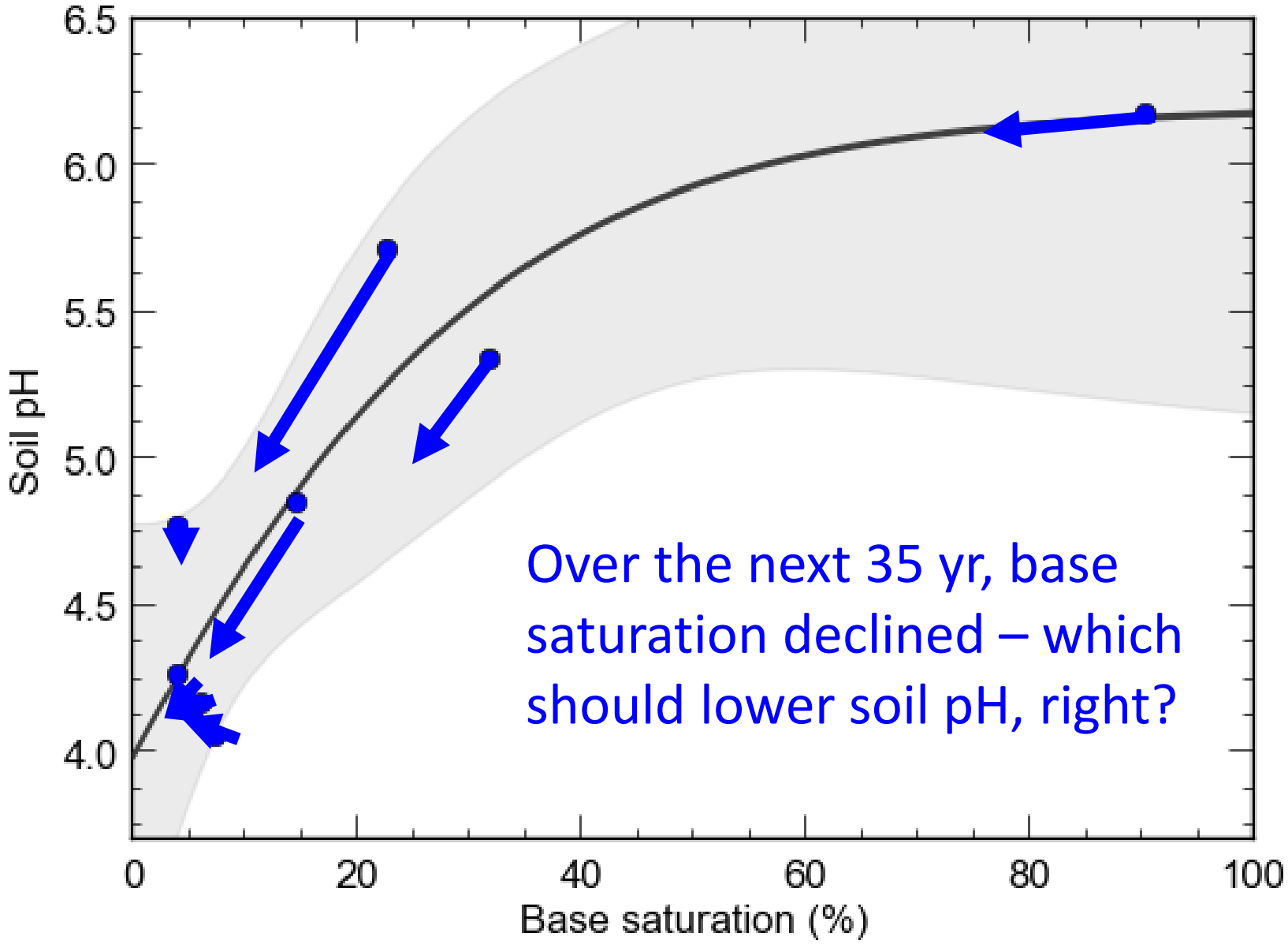

On to the discussions!

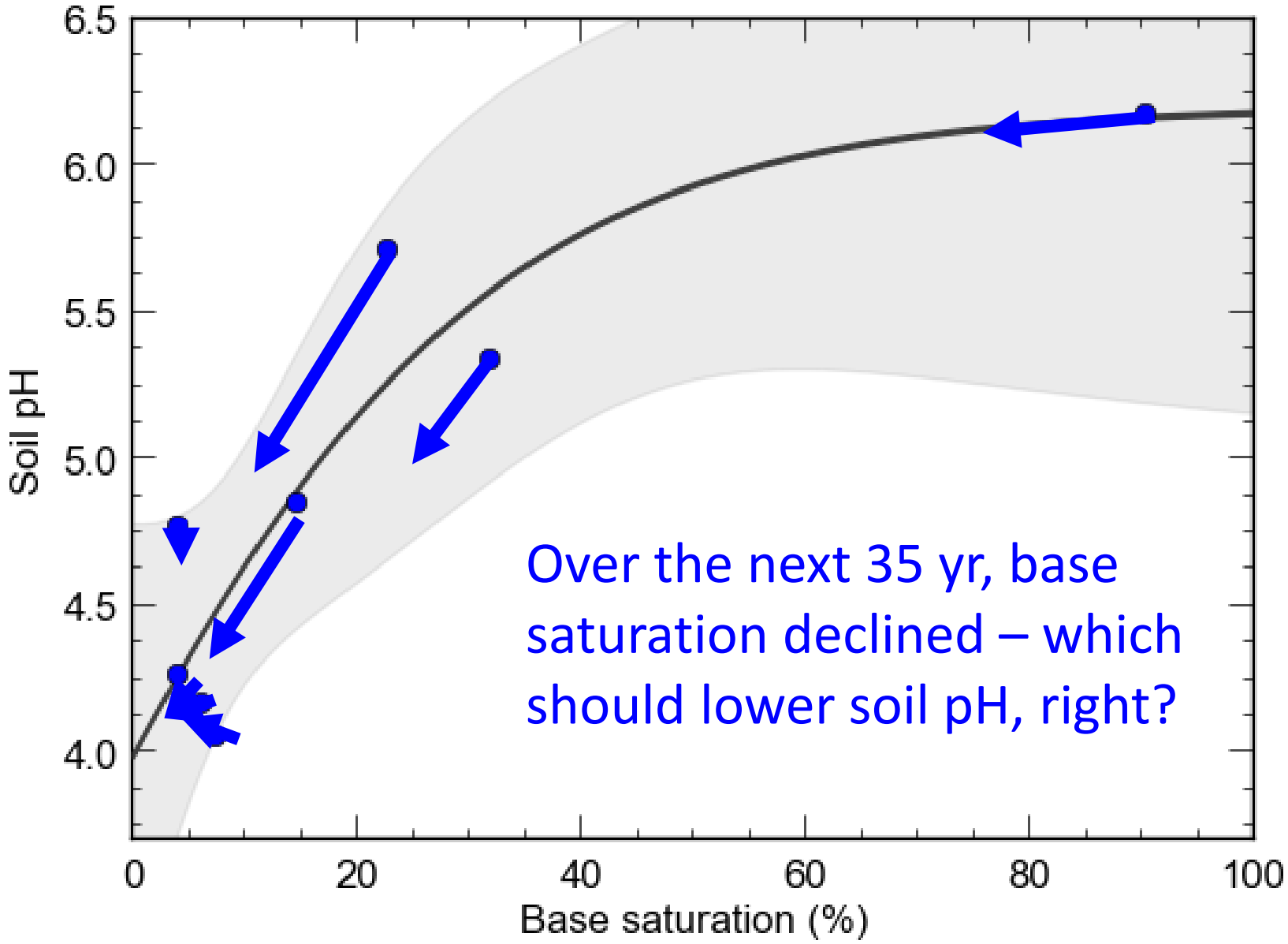




These files are saved a .png
In the 2015/Sweden folder, so
Photoshop can work


7
6.5
6
5.5
5
4.5
4
3.5
pH
1949
1984
1949 pH vs. BS
1984 pH vs. BS
0
10
20
30
40
50
60
70
80
90
100
Base saturation (%)


6.5
6.0
5.5
5.0
4.5
4.0
Soil pH
0
20
40
60
80
100
Base saturation (%)
Over the next 35 yr, base saturation declined – which should lower soil pH, right?


6.5
6.0
5.5
5.0
4.5
4.0
Soil pH
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40
60
80
100
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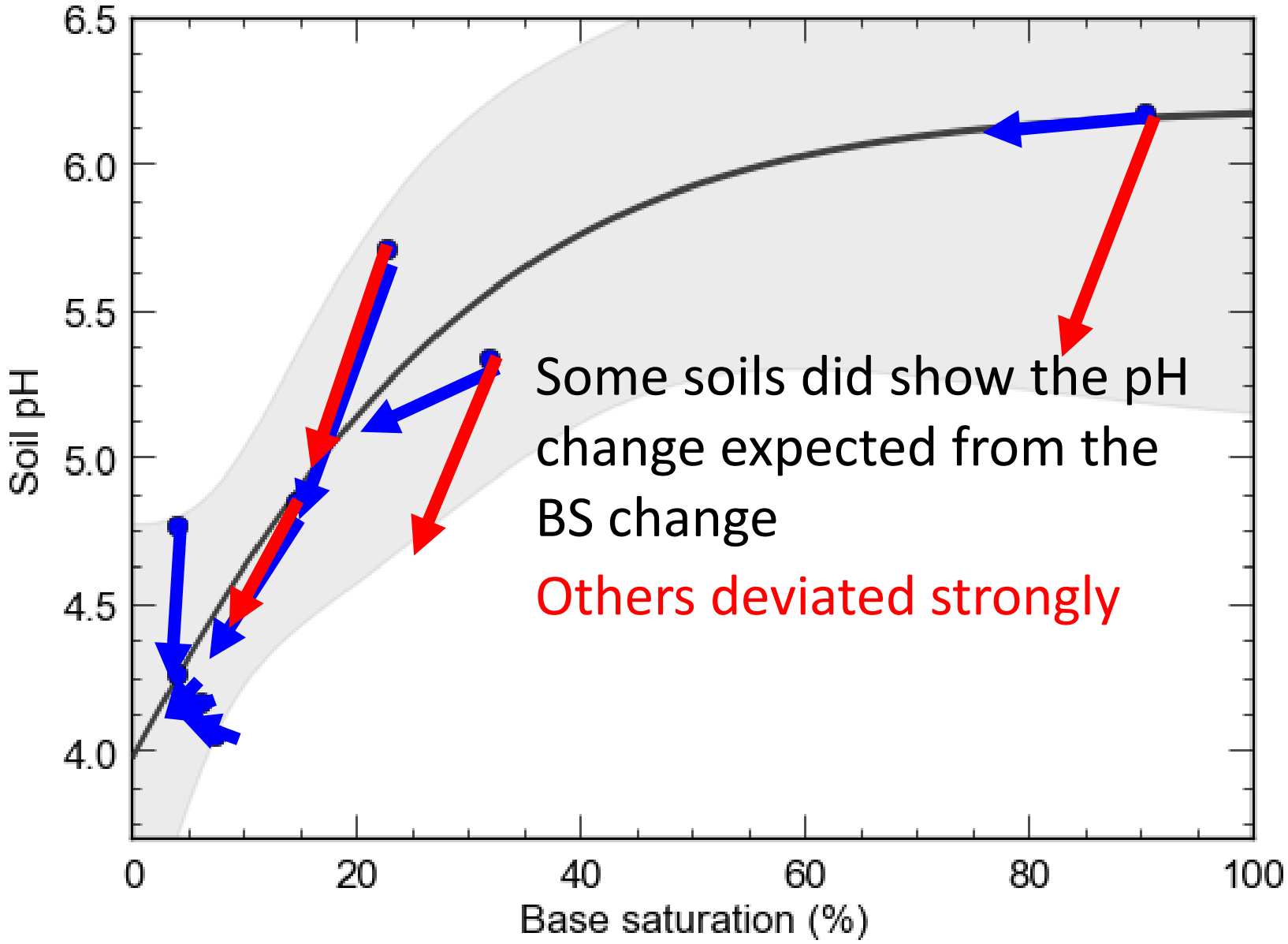
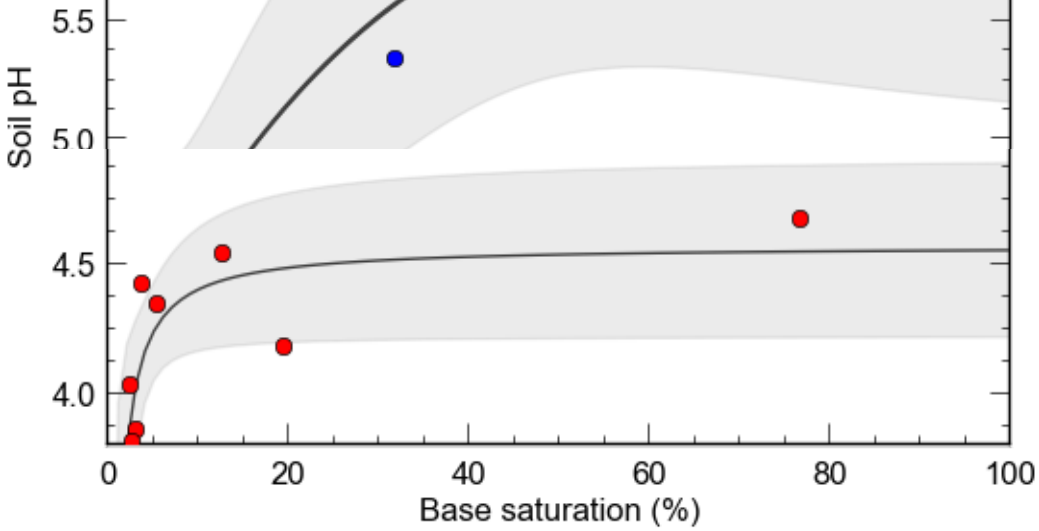
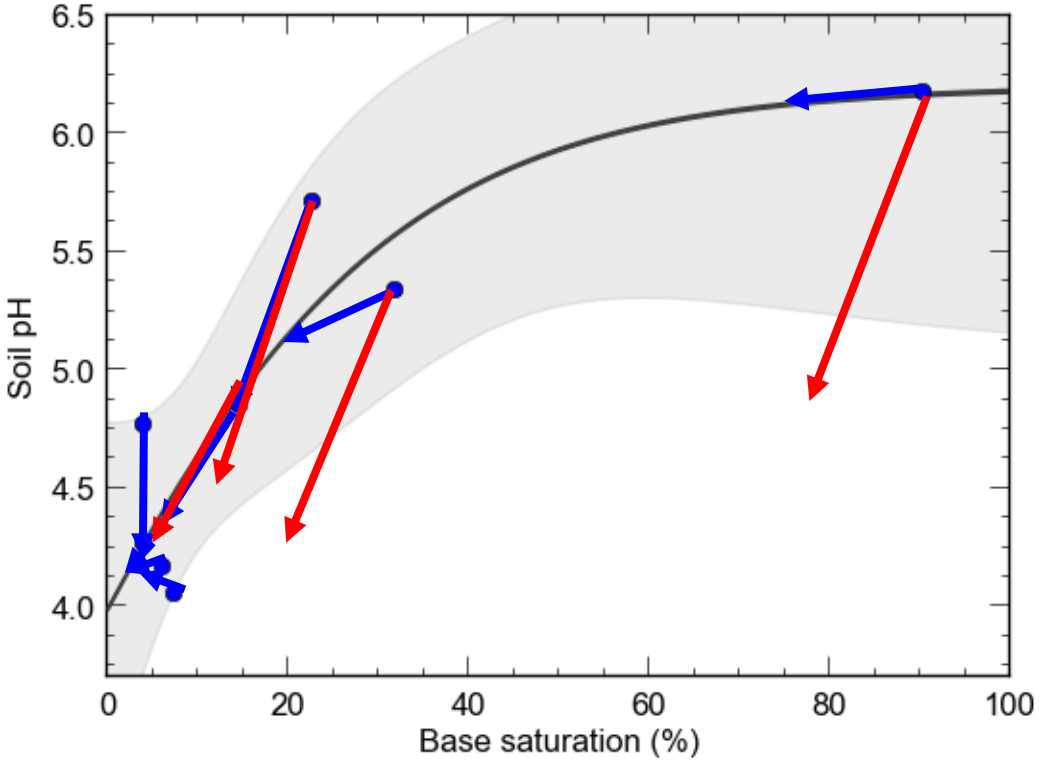

6.5
6.0
5.5
5.0
4.5
4.0
Soil pH
0
20
40
60
80
100
Base saturation (%)
Some soils did show the pH change expected from the BS change
Others deviated strongly





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