Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences
Sötvattenslaboratoriet

Contribution to:
***Acid Rain 2015**, Rochester, New York, USA,*
October 19-23, 2015

Long term effects of liming on fish in Swedish streams and lakes

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Financial supporter

Swedish Agency for Marine and Water Management

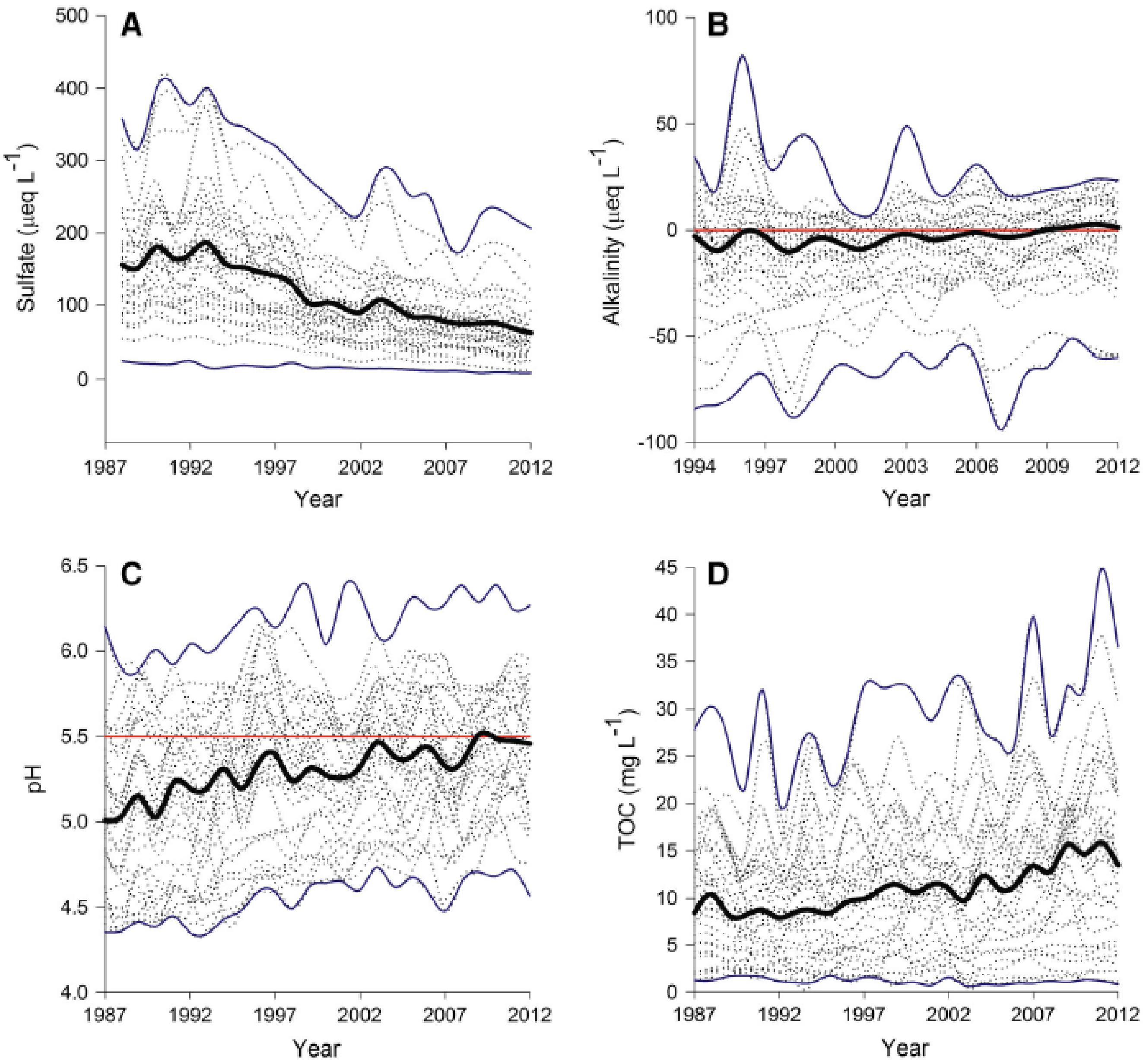
Long term monitoring in a few well studied sites

→ Large national fish databases

Outline:

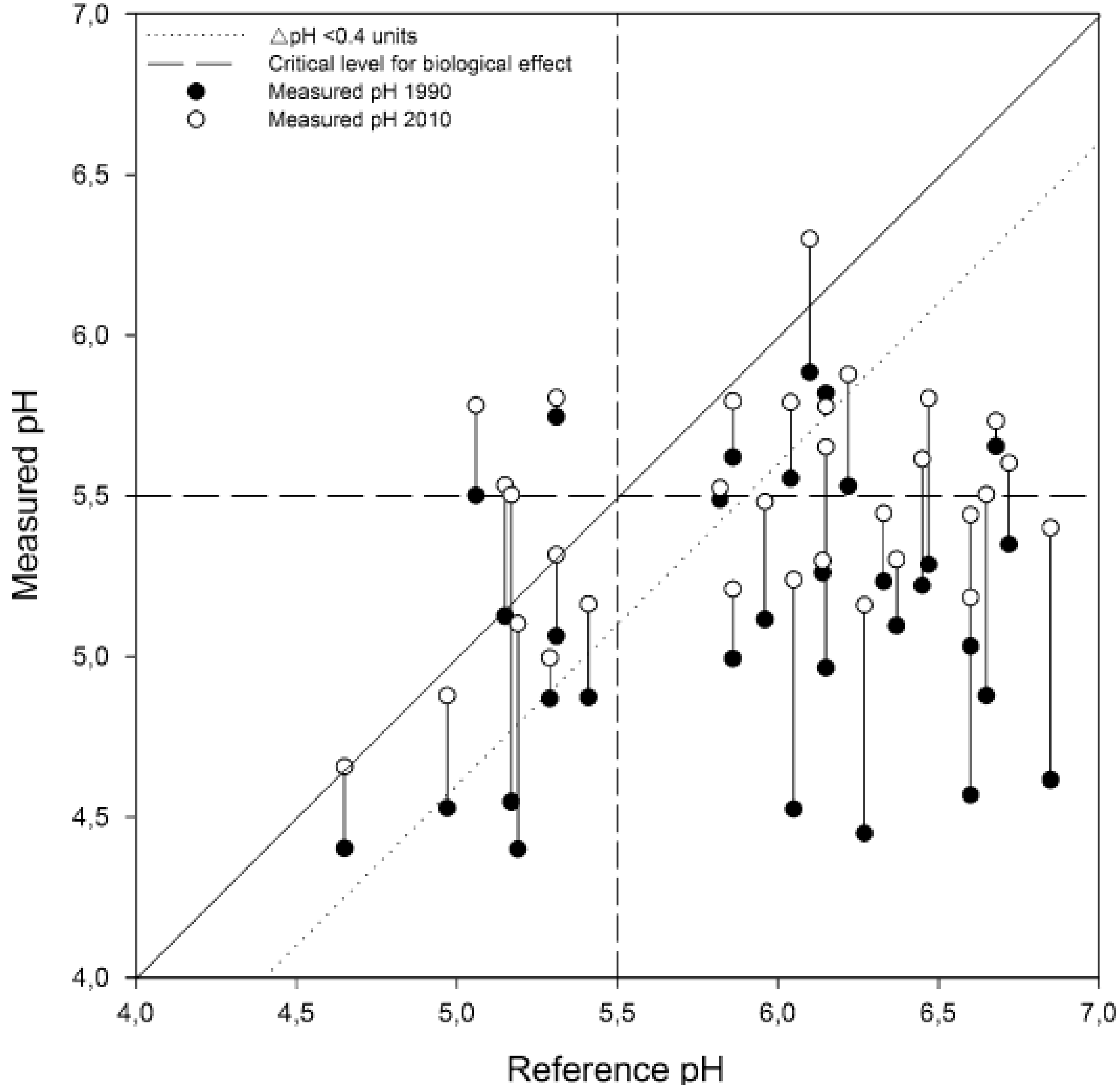
- Acidification and liming in Sweden
- Expected effects of liming/recovery
- Fish databases SERS and NORS
- Fish sites with data on liming and acidity
- Long term effects on stream fish
- Long term effects on lake fish?
- Take home messages

Slow recovery from historic acidification



From: Futter et al. 2014

Slow recovery from historic acidification



MAGIC-estimated for year 1860

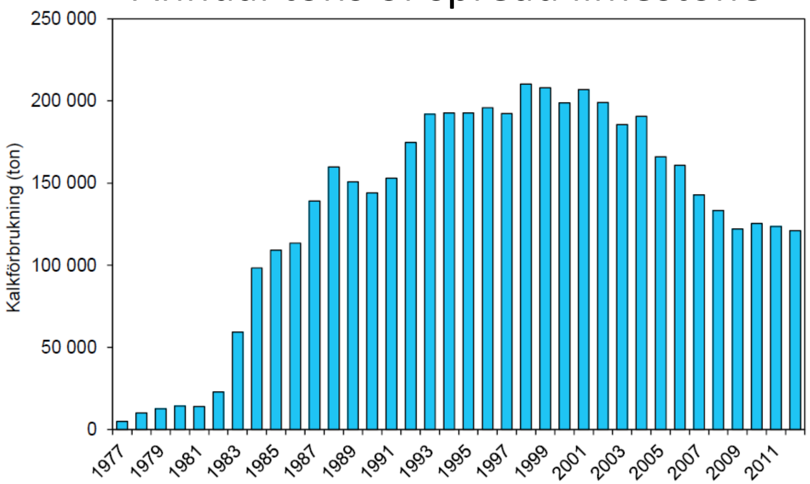
From: Futter et al. 2014

Adaptive liming to mitigate decreasing acidification

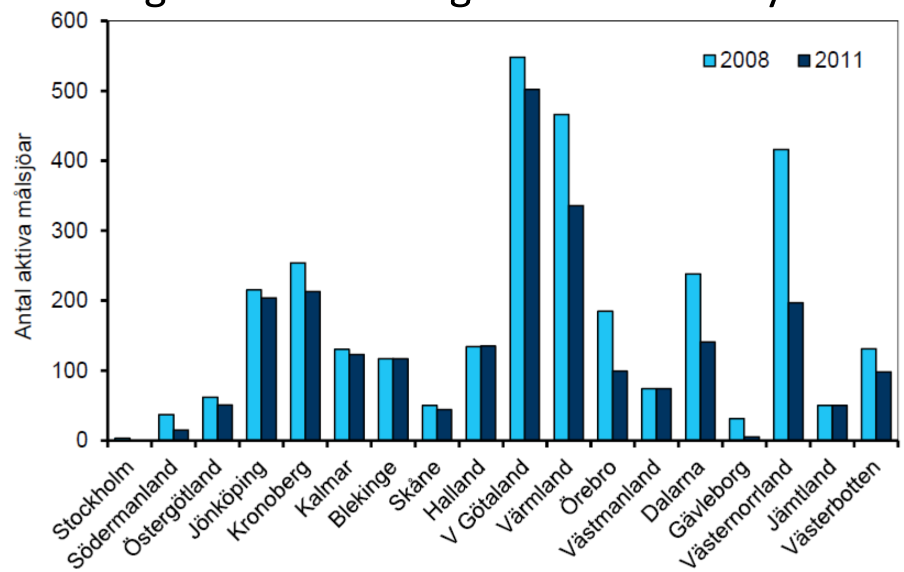
Våtmarker och många sjöar kalkas från helikopter med för ändamålet särskilt utformade spridningsbehållare. Foto: Kjell Hallin.

Swedish Agency for Marine and Water Management

Annual tons of spread limestone



Decreasing number of target lakes in many counties



Examples from: Abrahamsson et al. 2013

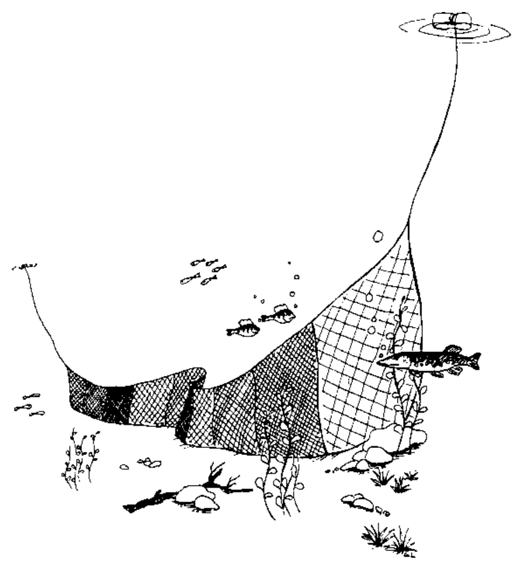
Expected recovery after liming

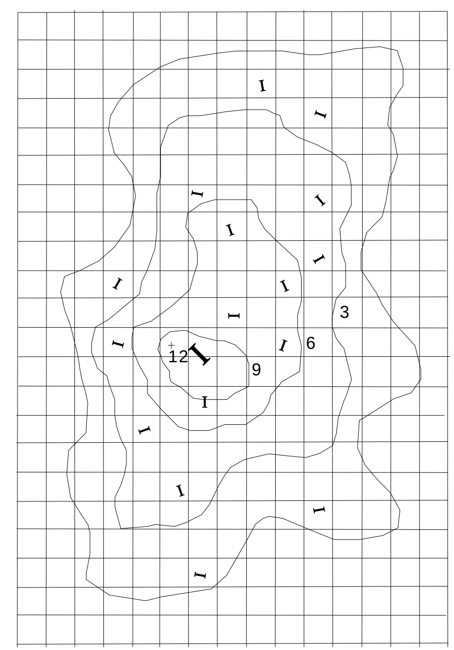
- Increasing occurrence of fish?
- Increasing fish species richness?
- More regular fish recruitment?
- Higher fish abundance?
- Improved ecological status?

We expected all changes to occur at the national scale, in spite of uncertain expectations at individual sites!

European standard sampling

- CEN – electrofishing (EN 14011:2003)
- CEN – multi-mesh gillnets (EN 14757:2005, revised 2015)

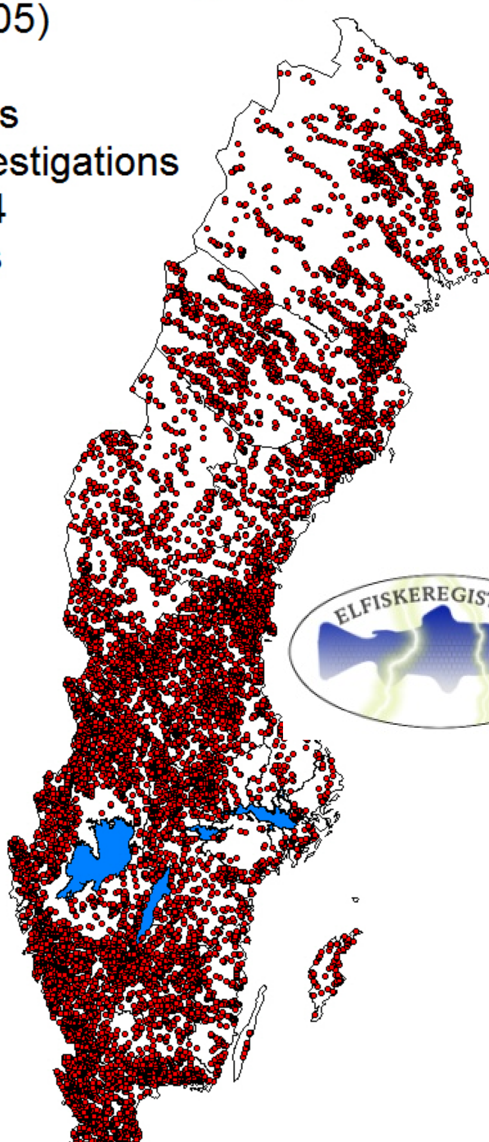




National data management of SERS and NORS

Swedish Electrofishing Registers - SERS
(2015-05-05)

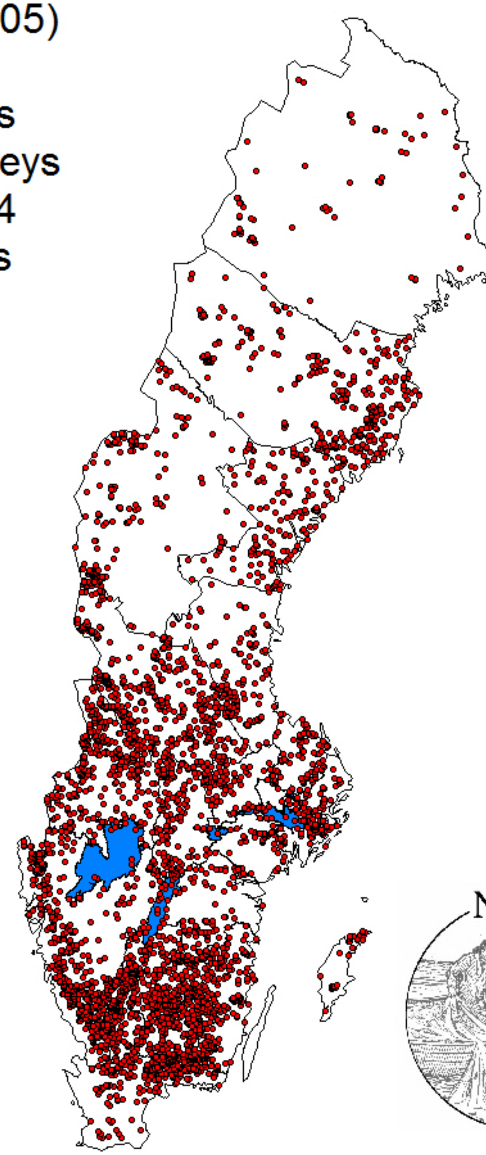
17785 sites
57956 investigations
1951-2014
48 species



ELFISKEREGISTRET

NatiOnal Register of Survey test-fishing - NORS
(2015-05-05)

3596 lakes
8197 surveys
1952-2014
47 species



NORS

Data used in this study:

Stream sites

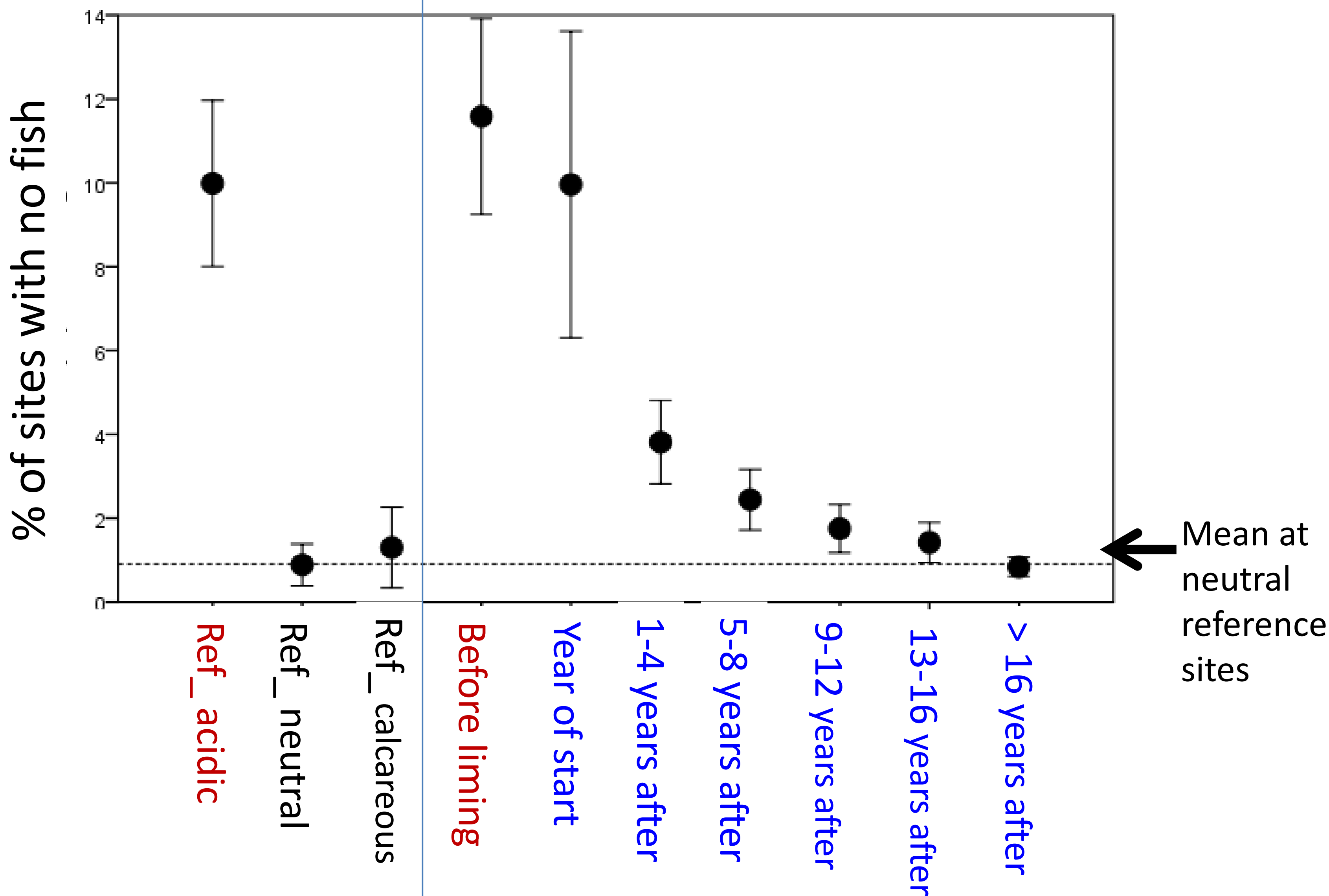
- $\geq$ 5 surveys/site, range $\geq$ 7 years, first year < 2000
- 1029 limed sites
- 195 non-limed sites (acid, low alk. or high alk.)

Lakes

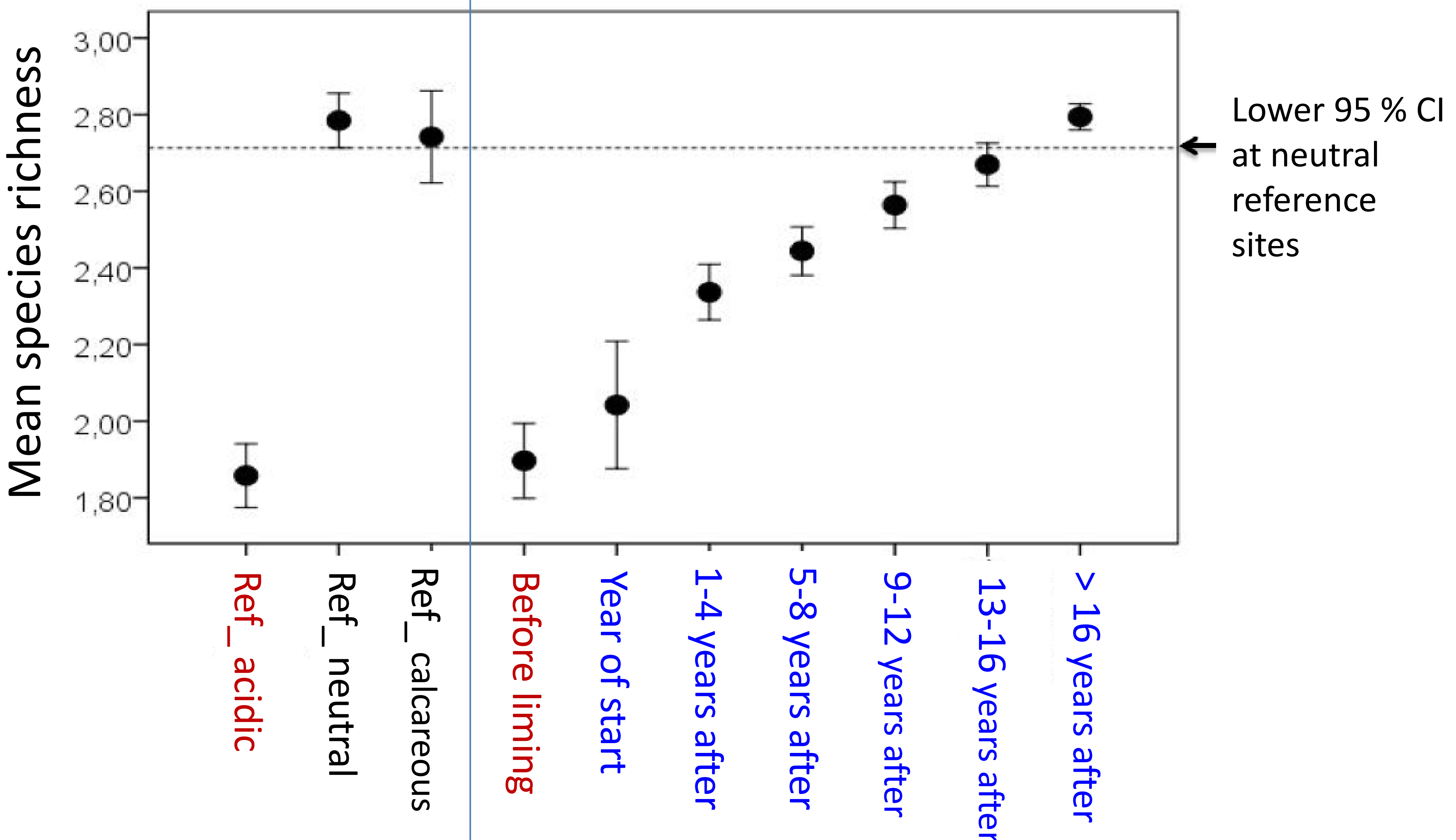
- $\geq$ 2 surveys/lake, range $\geq$ least 5 years, first year < 2000
- 754 limed lakes
- 237 non-limed lakes (acid, low alk. or high alk.)

Acid if mean pH < 6 or min. pH < 5.4, alk. limit 0.5 meq/L

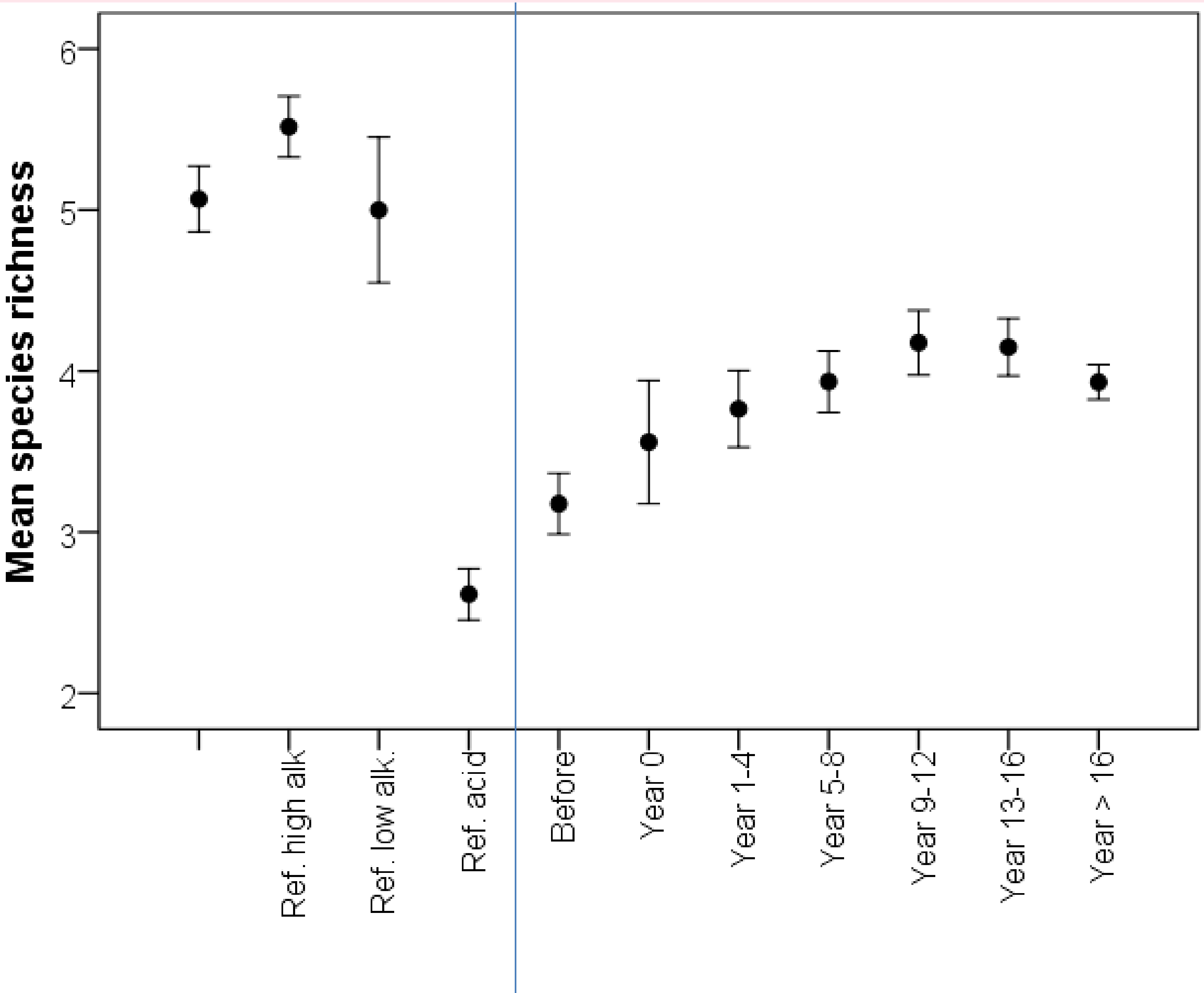
% of stream sites with no fish catch



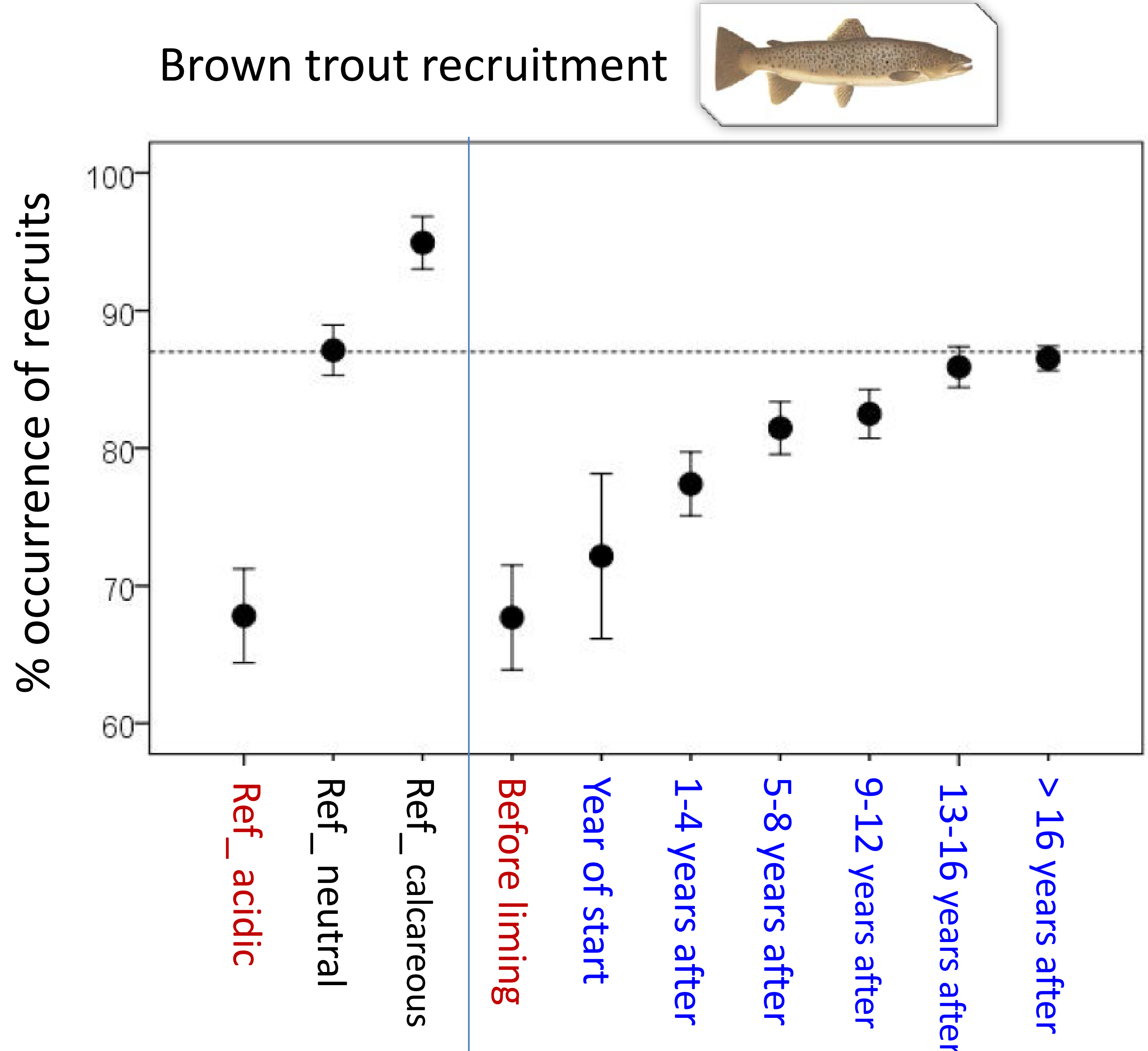
Fish species richness at stream sites



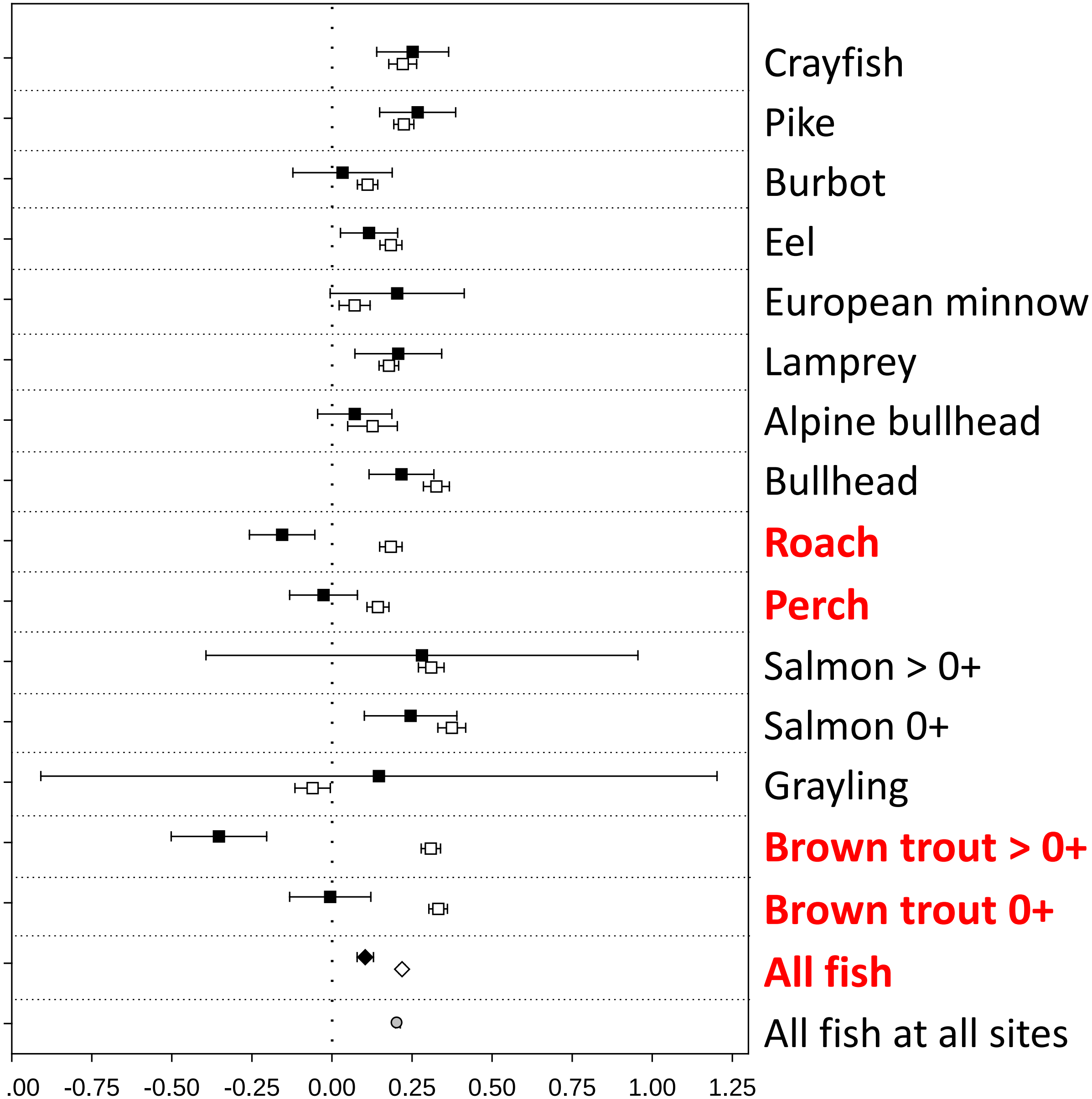
Fish species richness in lakes



Brown trout recruitment



Site-specific changes in abundance after liming

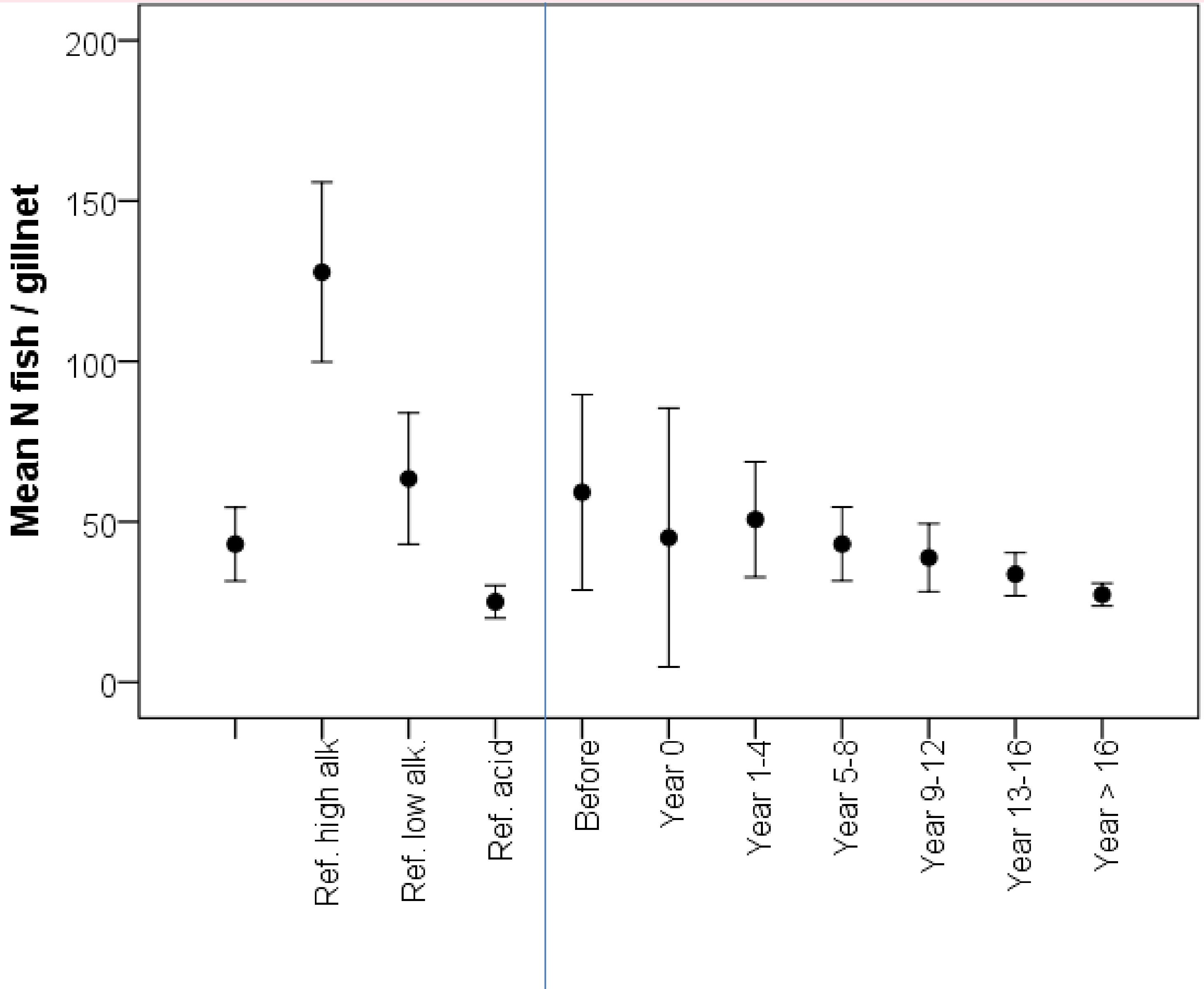


White boxes = Limed sites

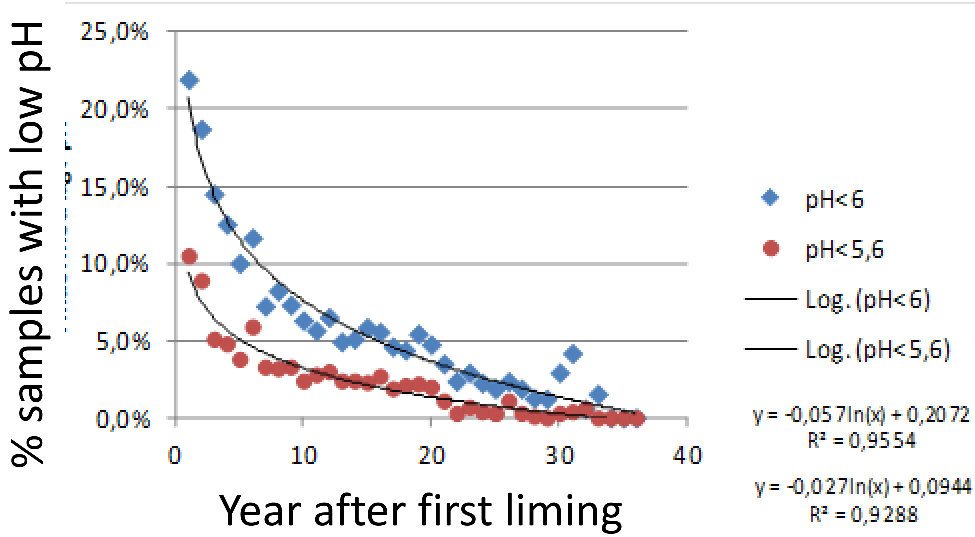
Black boxes = Non-limed sites

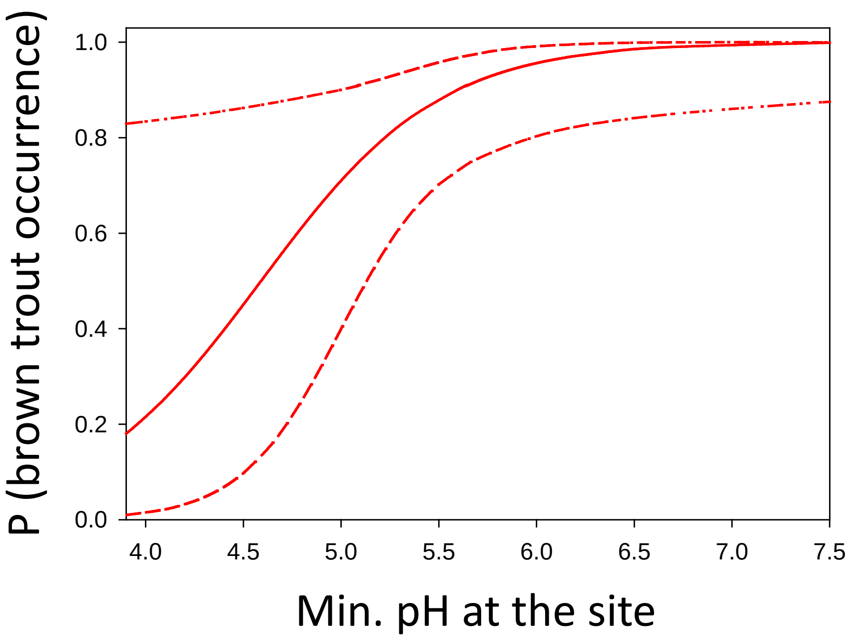
Non-limed sites were compared before and after 1986, which was the median year of first liming.

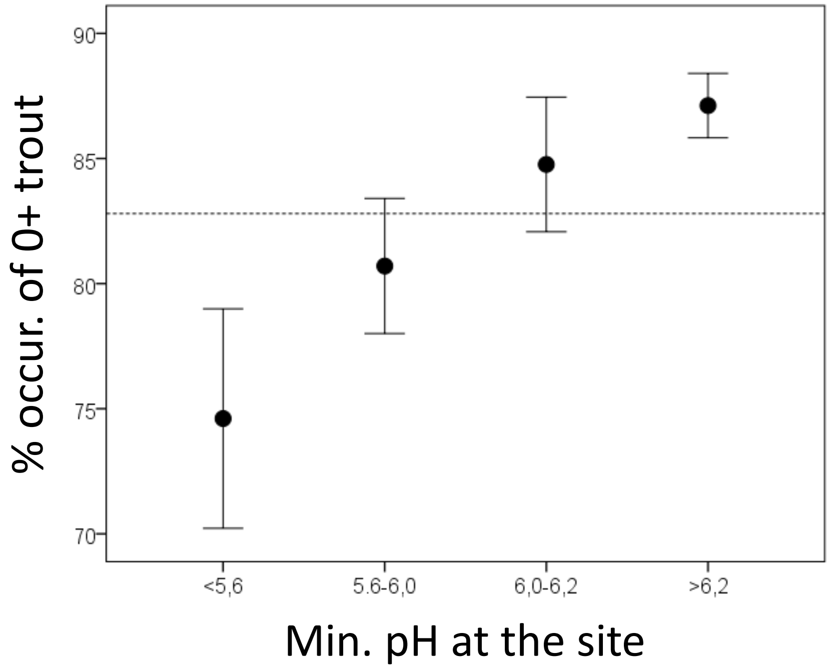
Relative fish abundance (NPUE) in lakes



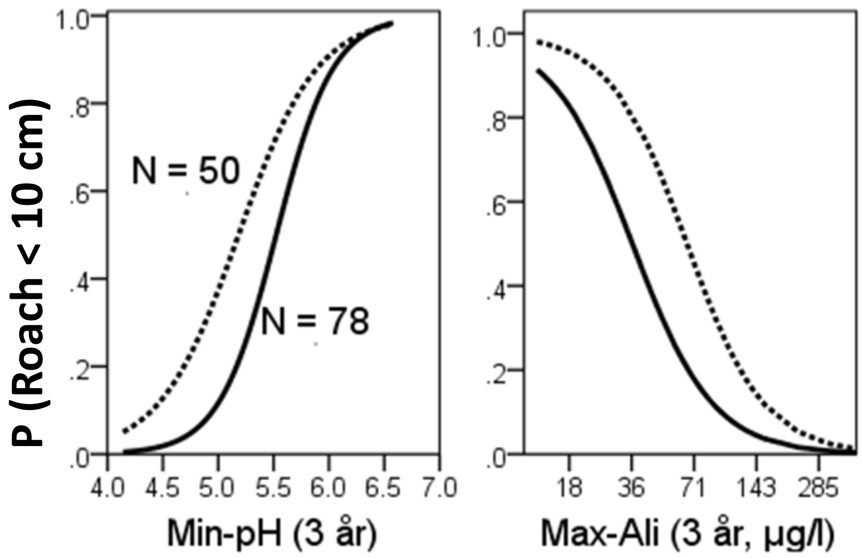
Importance of minimum pH for fish in streams







pH or inorganic aluminium (Al_i) predicts occurrence of small roach in Swedish lakes



Solid lines:
N = 78 non-limed lakes,
Best predictor: Min-pH
Dotted lines:
N = 50 non-limed lakes with roach occurrence
Best predictor: Max-Ali

From: Holmgren 2011

Take home messages:

- Slow fish recovery, but generally expected development in limed streams
- Less general and predictable development of fish in limed lakes than in streams
- Fish recruitment responds to decreasing frequency of low pH in limed streams
- Ageing is needed to evaluate recruitment success in lakes sampled by gillnets

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Thank you!

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Long term national program