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A statistical method for detecting artefacts in time series

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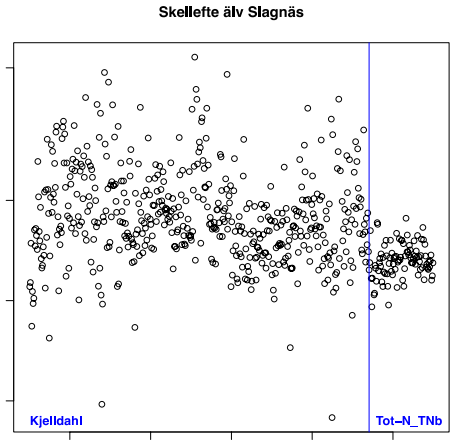
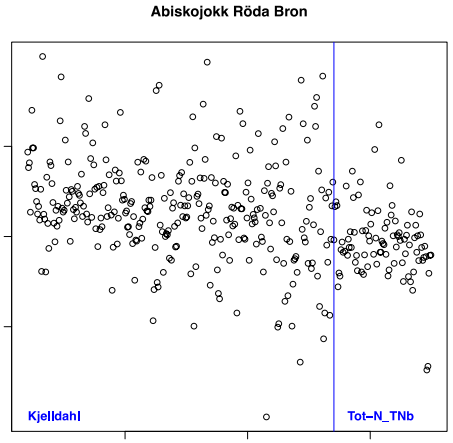
50 years of freshwater monitoring – How useful are the data for time series analysis?

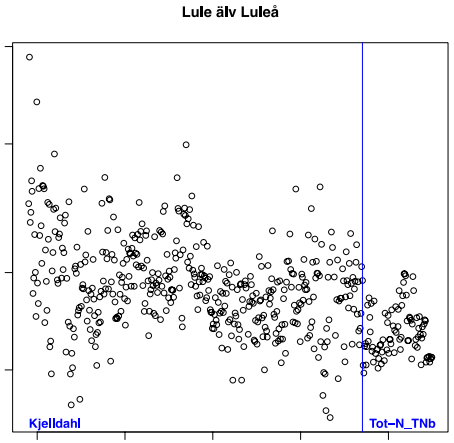
- **Changes in methods**
- **Changes between laboratories**
- **Laboratory errors**
- **Quality improvements**

Change in method for Tot-N

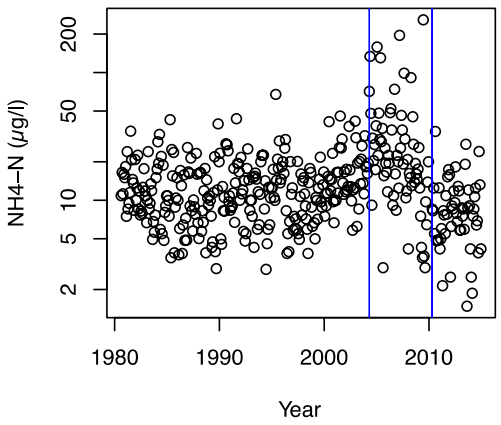
- Tot-N = Kj-N + NO_3
- Tot-N = TN_b

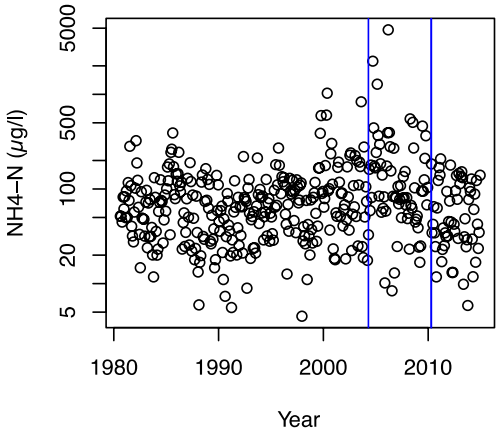


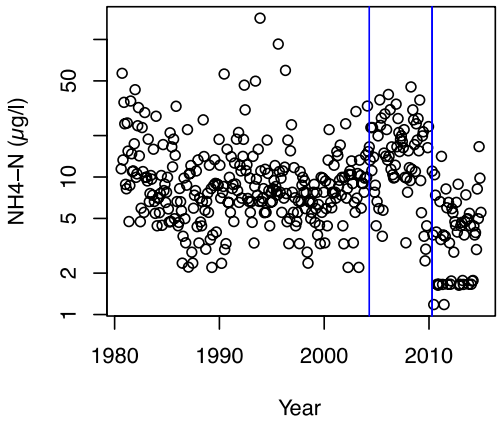


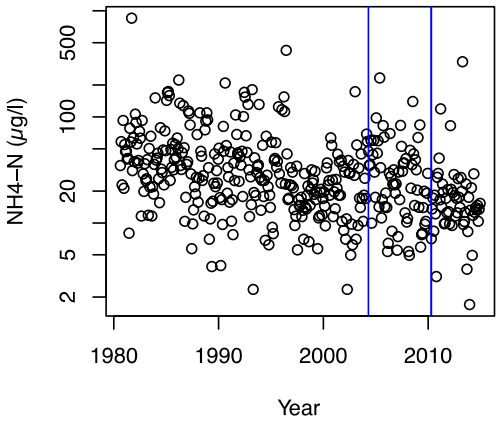


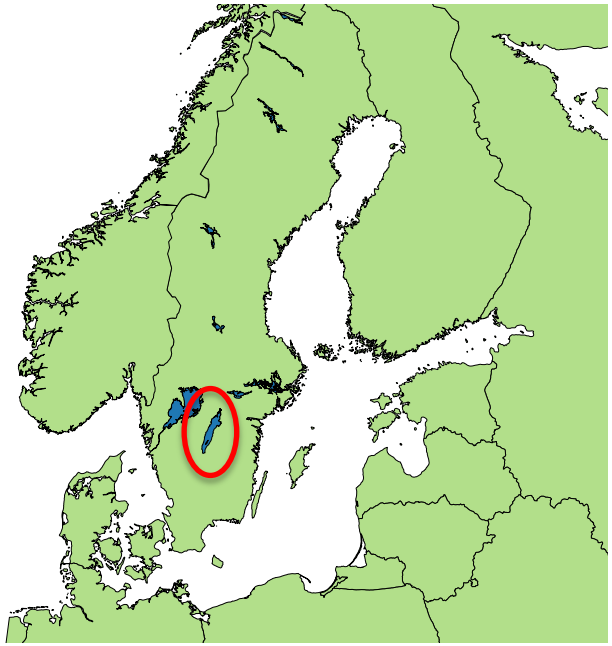
Change in laboratories in rivers discharging into lake Vättern





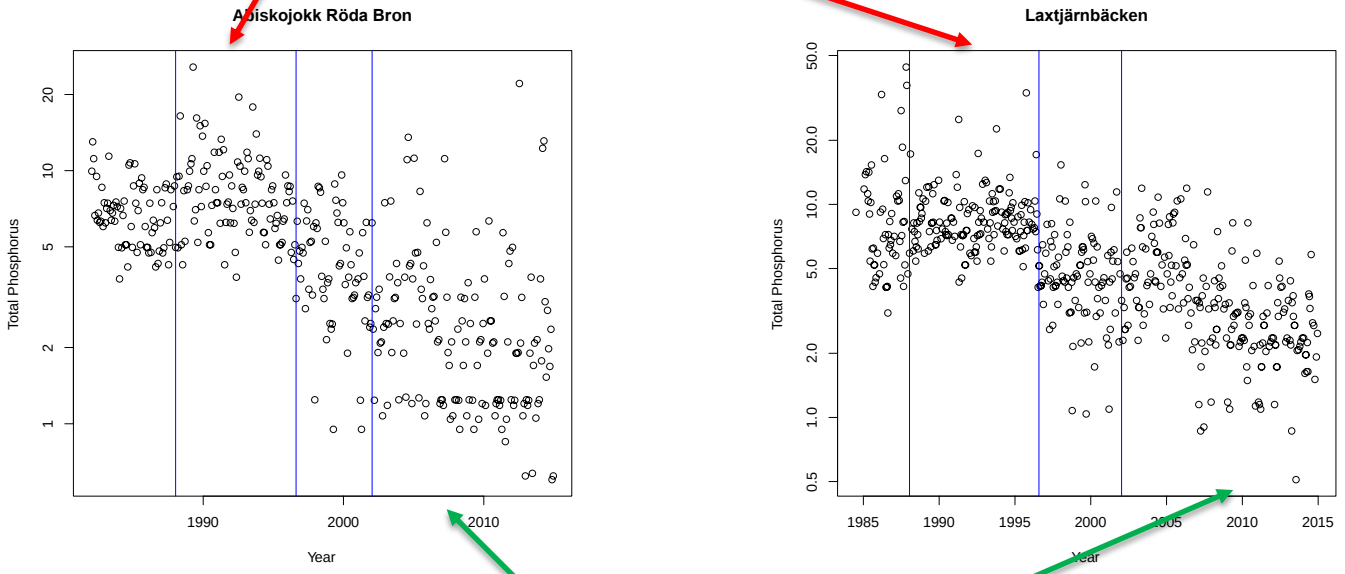






Malfunction and tool replacement of Tot-P analysis

Malfunction



New Autoanalyser

Can we test if there is a shift in a time serie?

- GAM-model (Generalized Additive Models)
  - Simultaeously identification of shifts, trends and seasonal variation.

Why use Generalized Additive Models (GAMs)

- Smooth funcitons can be used such as local linear regression (loess) or splines.
    - We do not need to determine the functional form of the relationship in beforehand (e.g. linear or exponential)
- We have most of the possibilities we have with GLMs, GLiMs, and GLMM, e.g. we can
    - include categorical predictors and interactions and
    - use other distributions than normal for the response
    - use mixed approaches to include autocorrelation estimates or hierarchical sampling structures

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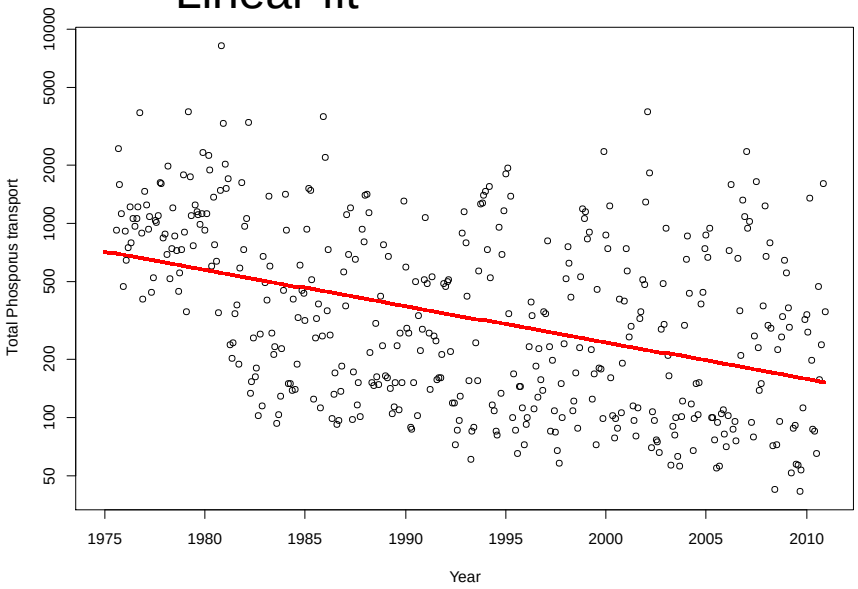
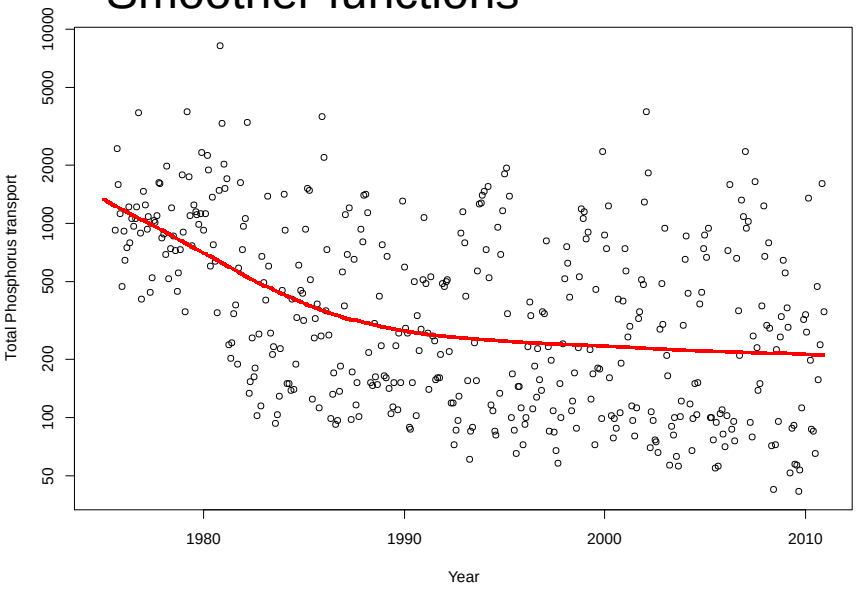
Smoother functions

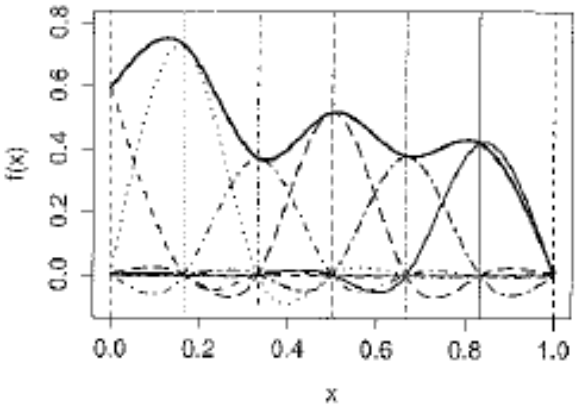
Linear fit



Smoother functions



Smooth function:
A combination of many curve functions



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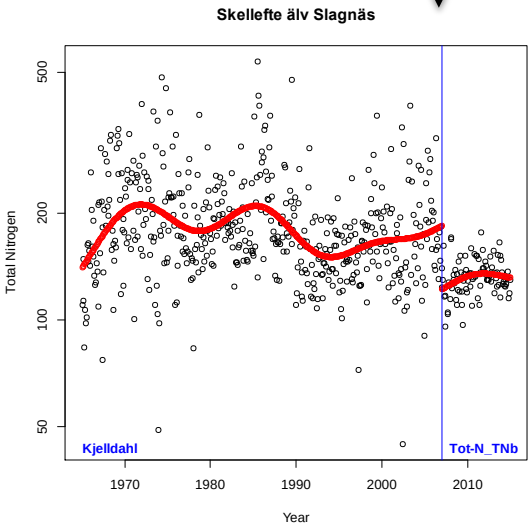
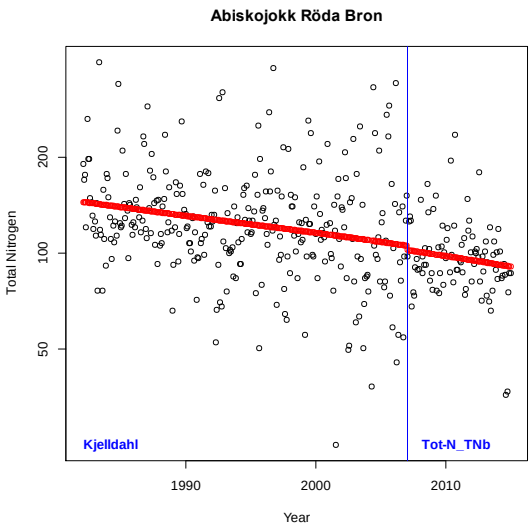
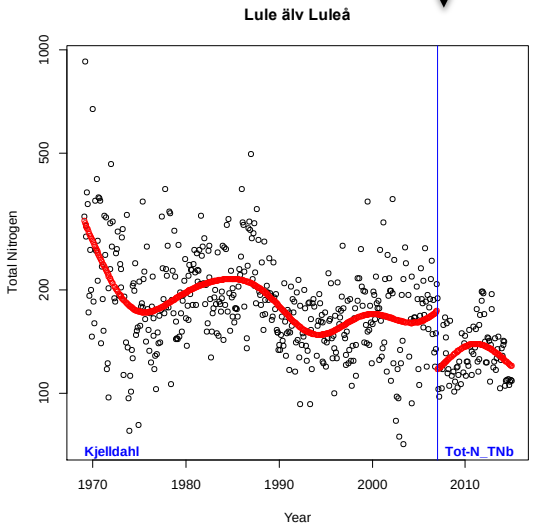
Change in method for Tot-N

Sign. shift



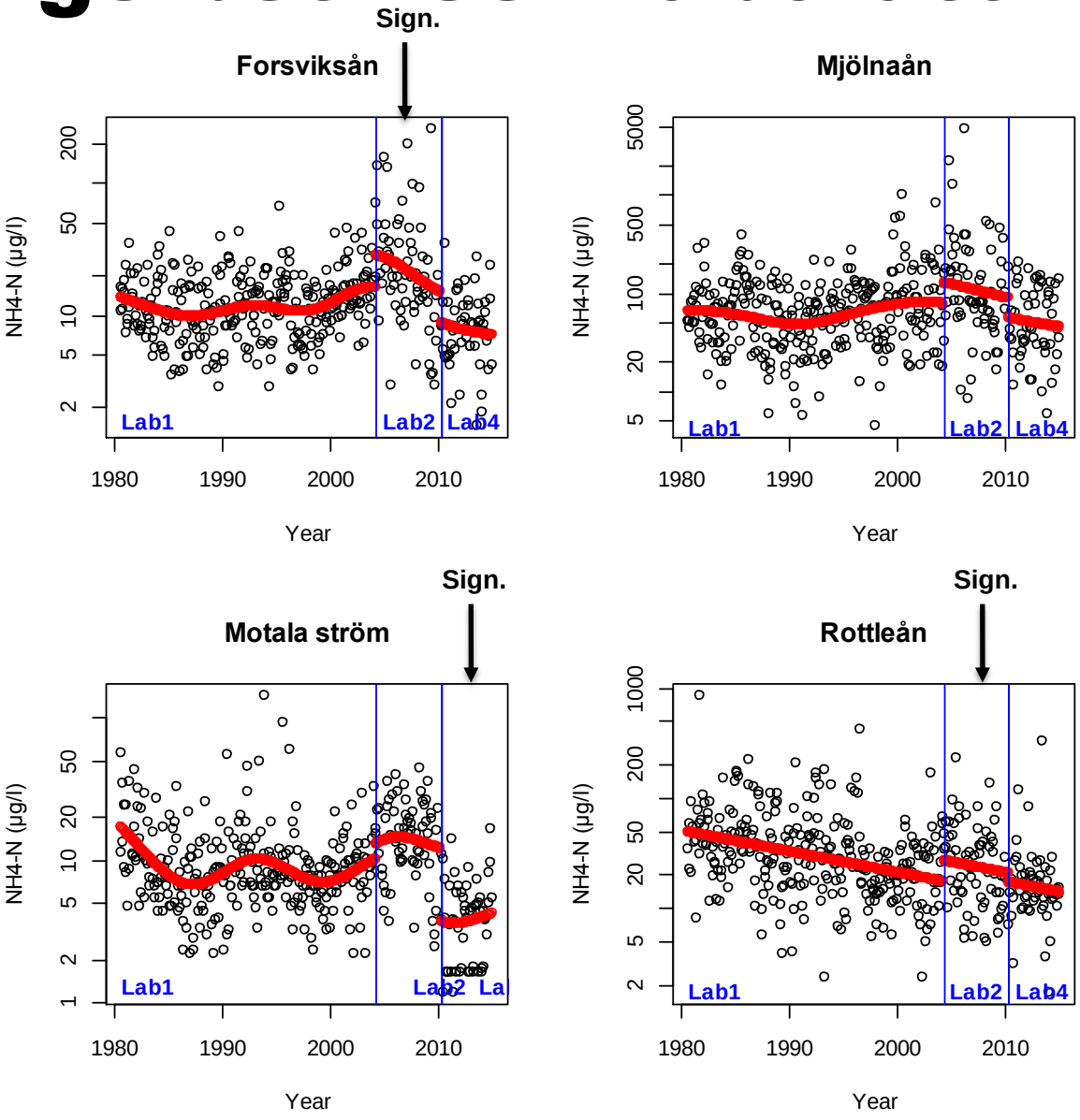


Sign. shift

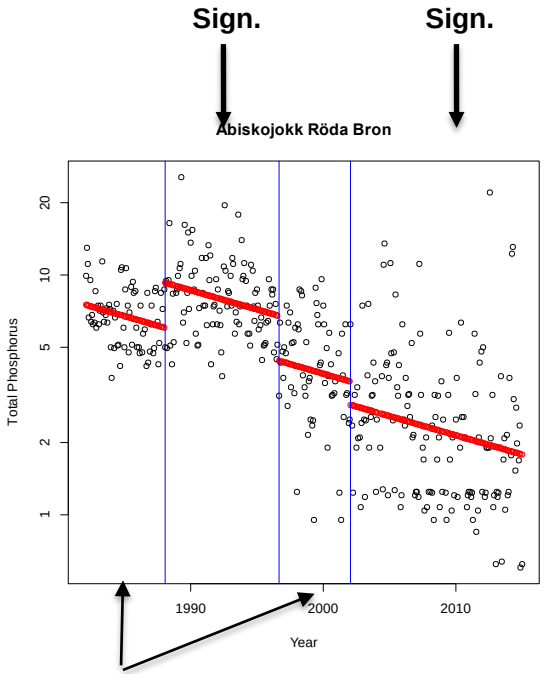


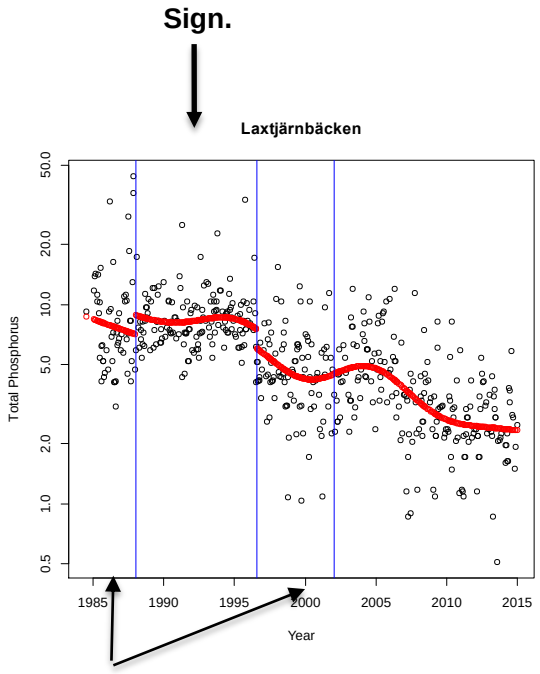
Variance:	0,094	0,036	0,398	0,276	0,086	0,050

Change between laboratories



Malfunction and equipment replacement of Tot-P analysis





Variance: 0,163 0,149 0,269

0,280 0,165 0,25

Conclusions

- GAM can be used to exclude suspected shifts
- Interactions between several shifts and trends can give ambigous results
- The magnitude of a shift is difficult to estimate when there is a trend

How to deal with signifacant shifts

- Estimate the shift from a large number of time series facing the same shift
- Estimate shift by comparing time series from the same site (or close sites) from different labs.
- Estimate shift from overlapping time series
- Test for stability of the trend by simulations