

# **Euro-limpacs and reference conditions: learning from the past**

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## Outline

- Euro-limpacs: objectives and approaches
- Euro-limpacs: outputs
- Euro-limpacs: reference conditions



## ***Euro-limpacs***

# **Integrated Project to Evaluate the Impacts of Global Change on European Freshwater Ecosystems**

**<http://www.eurolimpacs.ucl.ac.uk>**

Co-ordinated by the  
Environmental Change Research Centre  
UCL

Euro-limpacs is funded by the European Union under Thematic Sub-Priority  
1.1.6.3 "Global Change and Ecosystems"

of the 6th Framework Programme

Co-ordinators: Environmental Change Research Centre, UCL

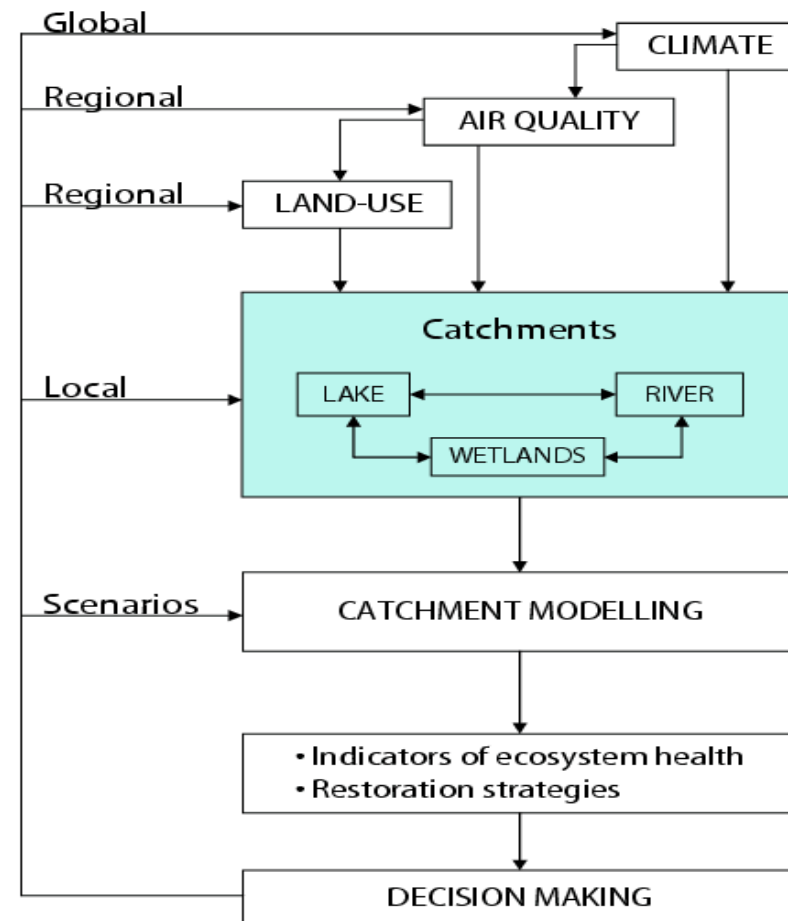


**Euro-limpacs**

## Euro-limpacs: aims and project structure

An **integrated** project to assess:

- how will (European) freshwater ecosystems respond to **future climate change** directly, through changes in temperature and precipitation, and indirectly, through interactions with hydromorphology, eutrophication, acidification and toxic substances?
- how can European freshwater systems thereby be better **managed**, e.g. with respect to the EU Water Framework Directive?



## 50 Key Questions (see website)

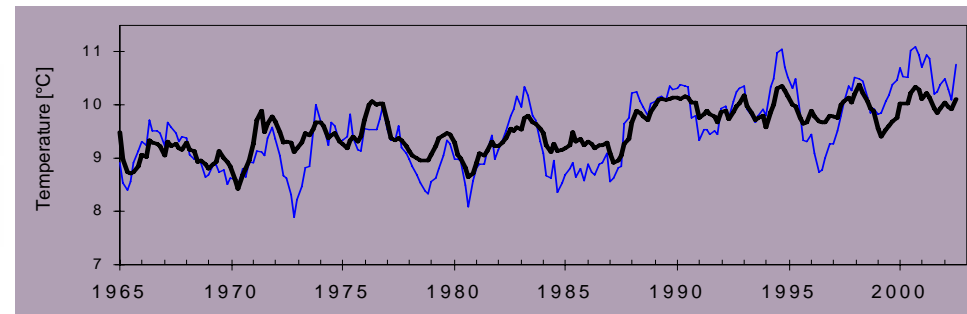
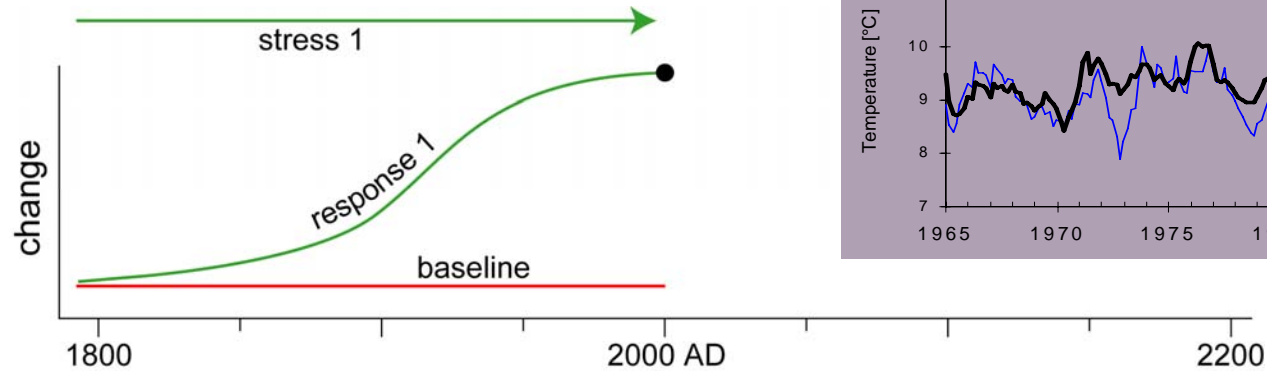
### Under the headings:

- Direct effects of climate change on freshwater ecosystems
- Climate change and hydromorphology
- Climate change and eutrophication
- Climate change and acidification
- Climate change and toxic substances
- Modelling the effects of climate change on surface waters
- Climate change indicators
- Climate change: reference conditions and restoration strategies
- Climate change: policy and management

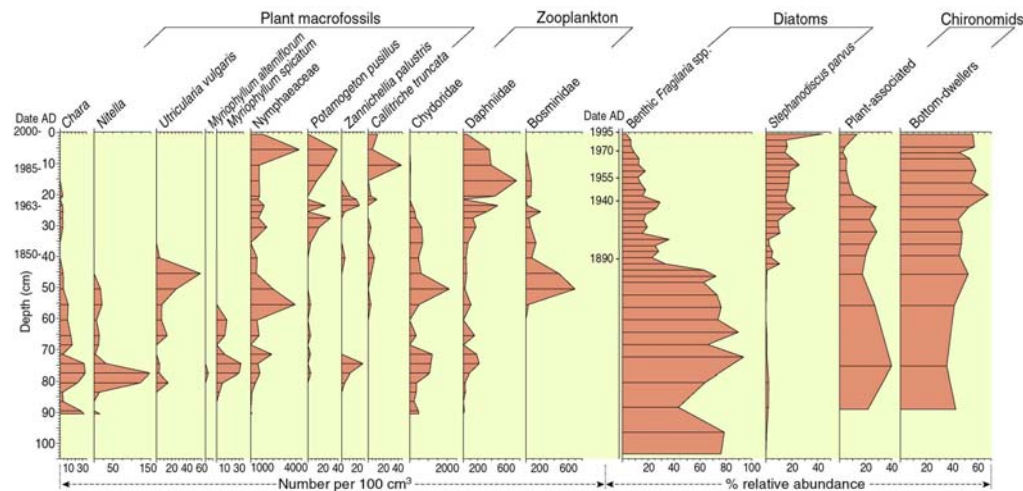


## Approaches in Euro-limpacs

### What is happening?



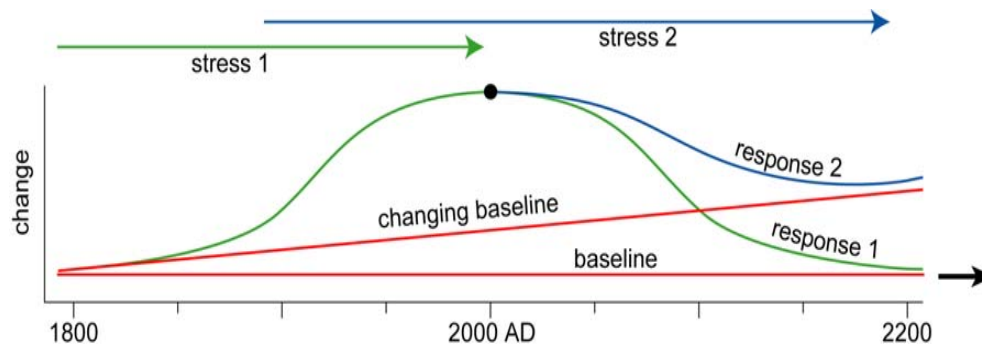
- high resolution palaeolimnological records
- long-term data-sets and time series



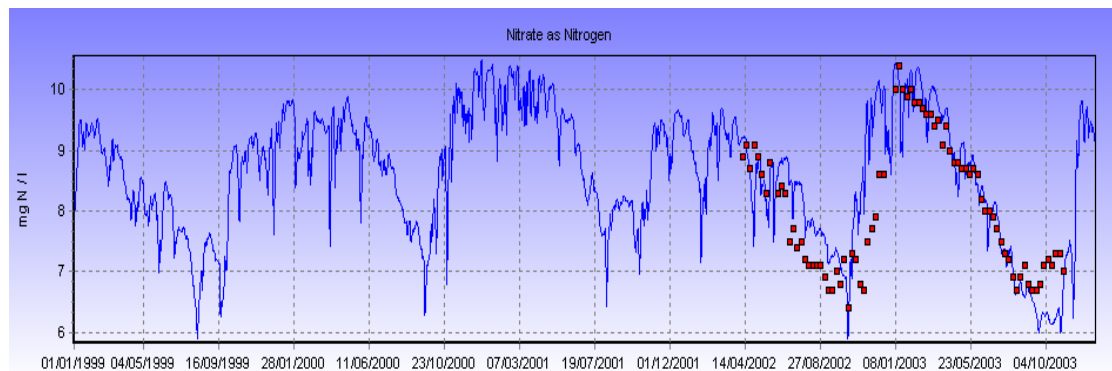
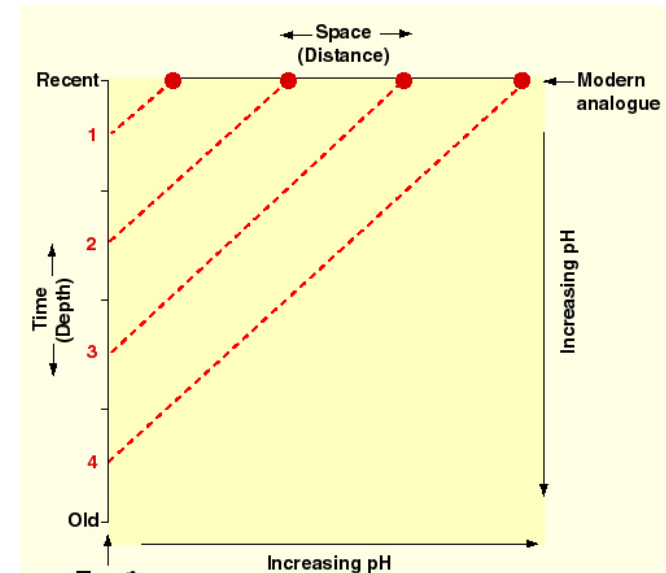
Euro-limpacs

## Approaches in Euro-limpacs

### What might happen?



- time-space substitution (climate gradients)
- experiments (field manipulations, mesocosms)
- modelling (statistical and process based)



## Outputs

- Over 300 **Papers** so far, several **special issues**
- Over 400 **Deliverables**
- **Website:** [www.eurolimpacs.ucl.ac.uk](http://www.eurolimpacs.ucl.ac.uk) (Public pages)
- **Book** details: '*Climate change impacts on freshwater ecosystems – direct effects and interactions with other stresses*' Kernan, Moss and Battarbee, Wiley-Blackwell (forthcoming, 2009)
- **Position paper:** "*Impact of climate change on European freshwater ecosystems: consequences, adaptation and policy*" Deliverable 301, Euro-limpacs website (2008)

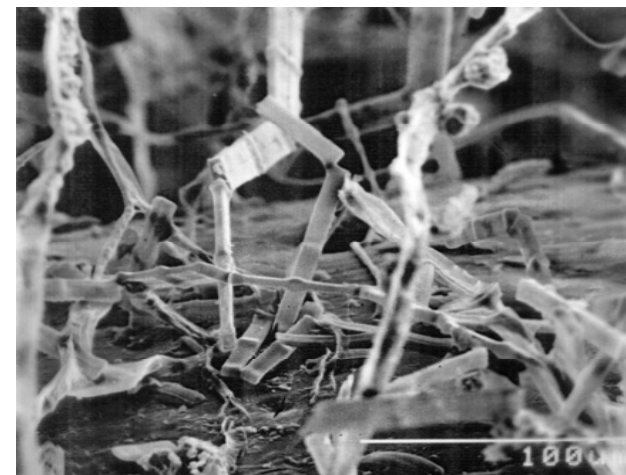
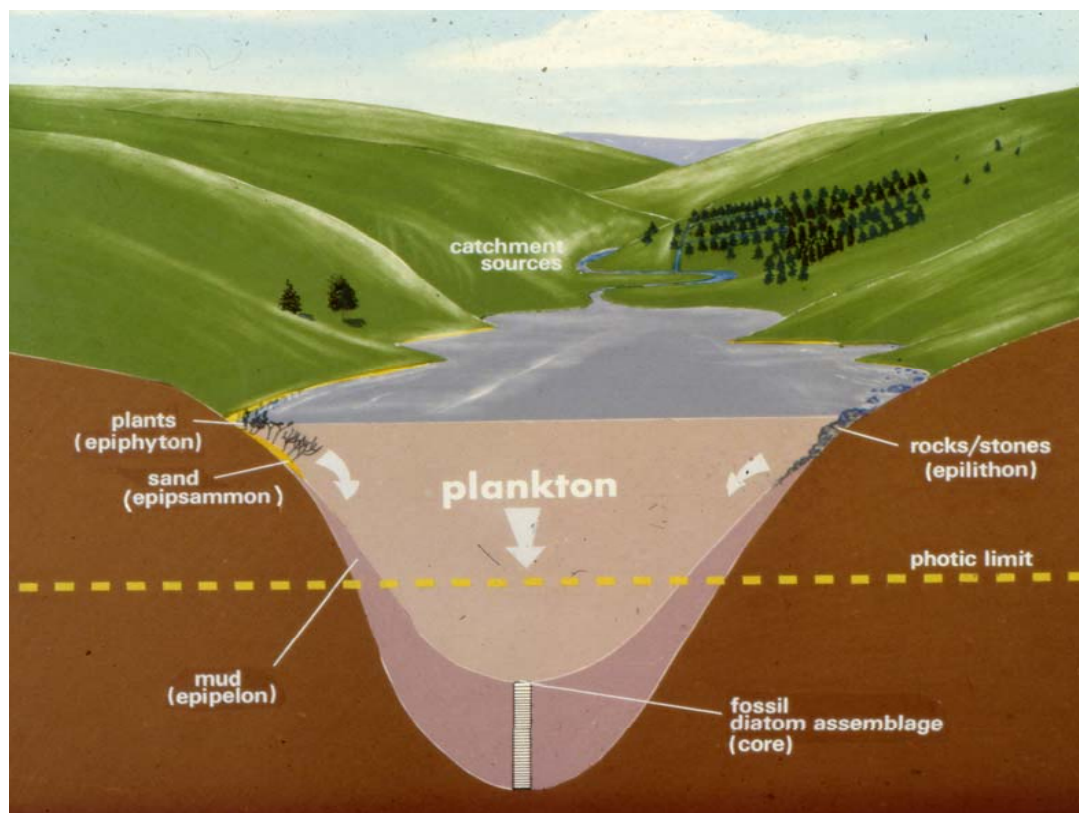




Reference conditions: learning from the past



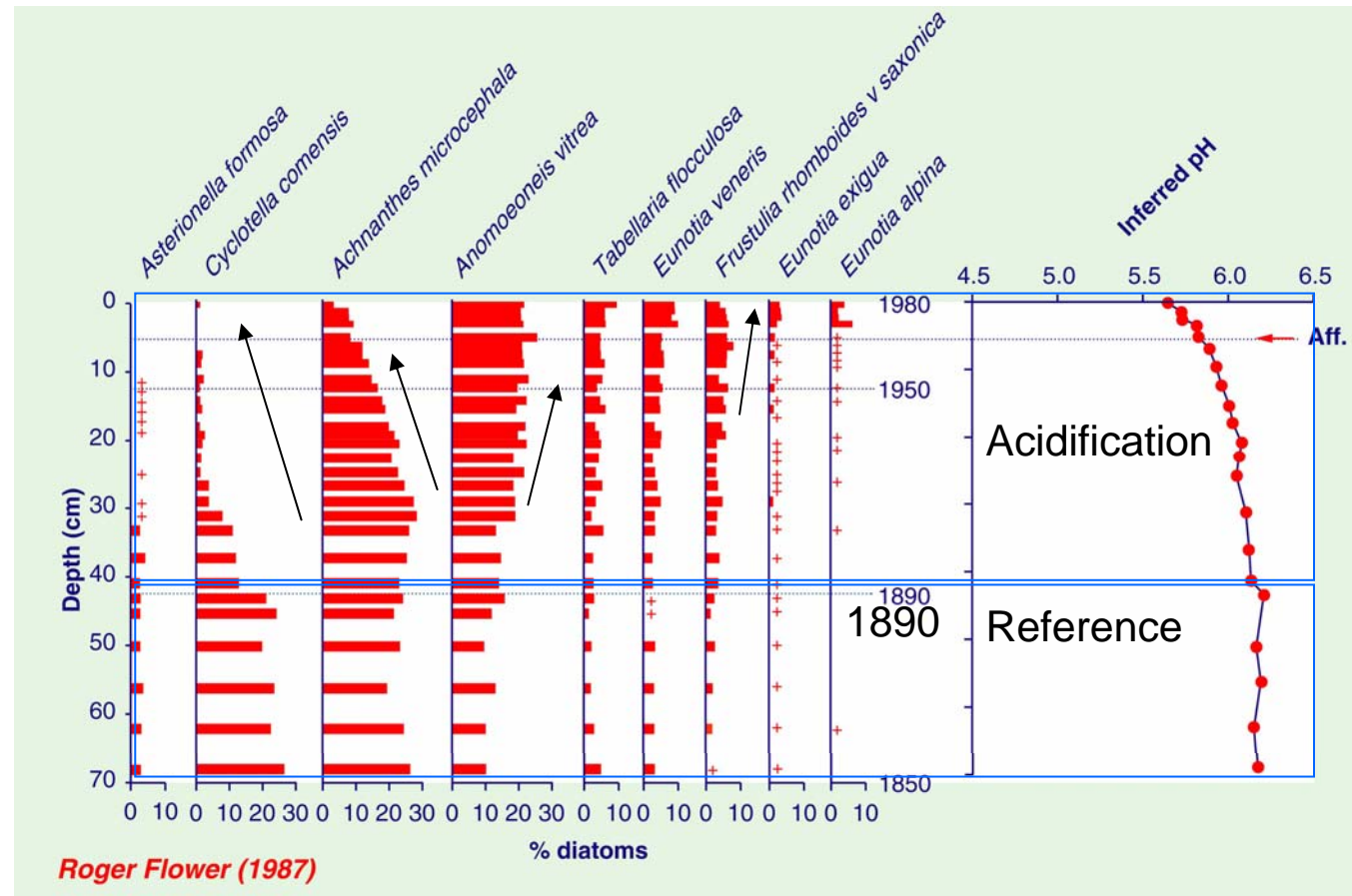
## Diatom analysis



## Reference conditions using palaeoecology - principles



**Reference diatom community:** *C. comensis*, *Ach. microc*  
**Reference pH:** 6.1 **Reference date:** before 1890



## Macrofossil analysis



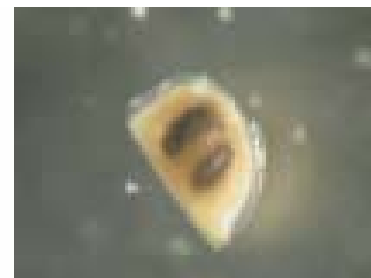
Waterlily seed



Horned pondweed



Valve snail



Daphnia resting egg



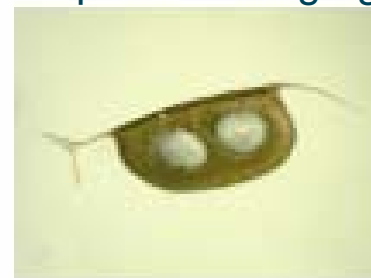
Chara oospore



Lily leaf cell



Perch scale



Daphnia resting egg



Pondweed leaf tip



Starwort seed



Pike scale

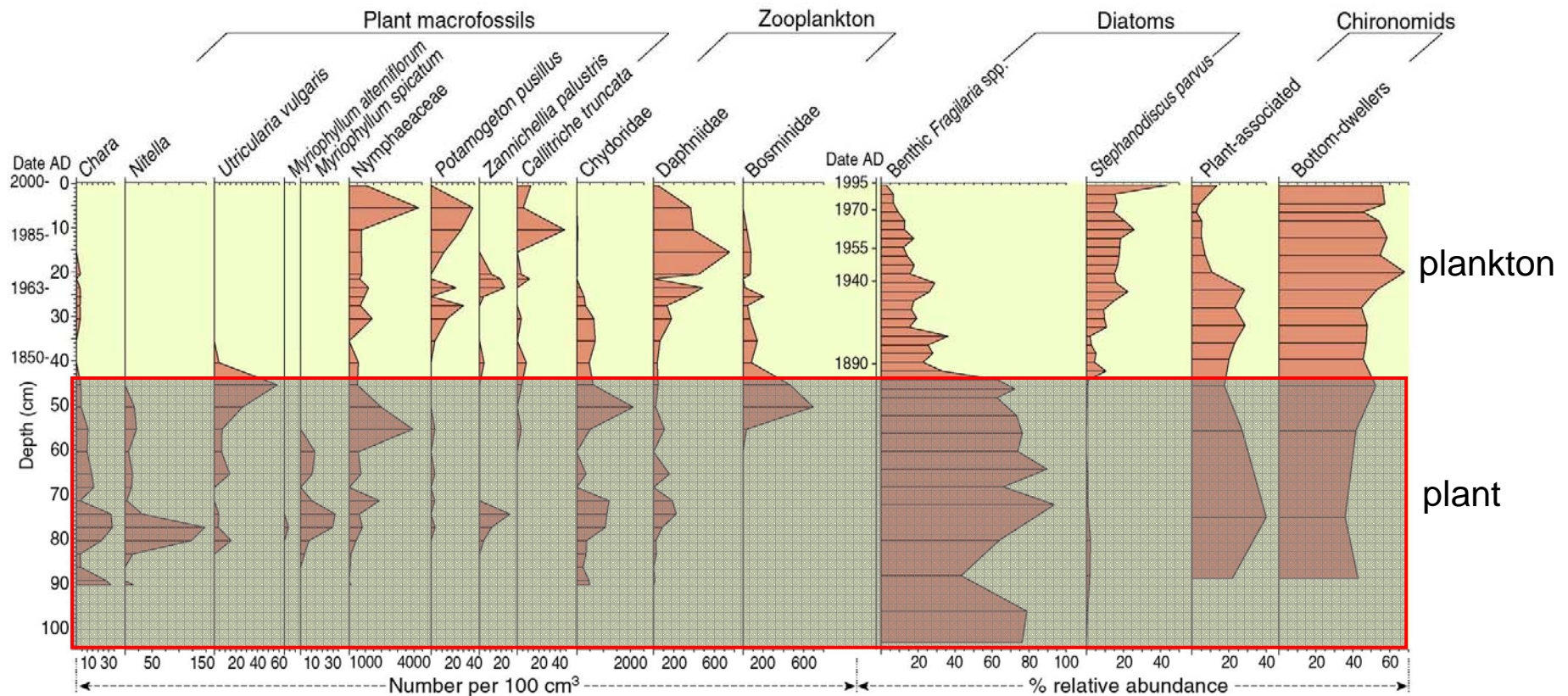


Daphnia resting egg

[Slide courtesy of Dan Hoare, ECRC, UCL]



## Hydrobiological reference conditions using a multi-indicator approach

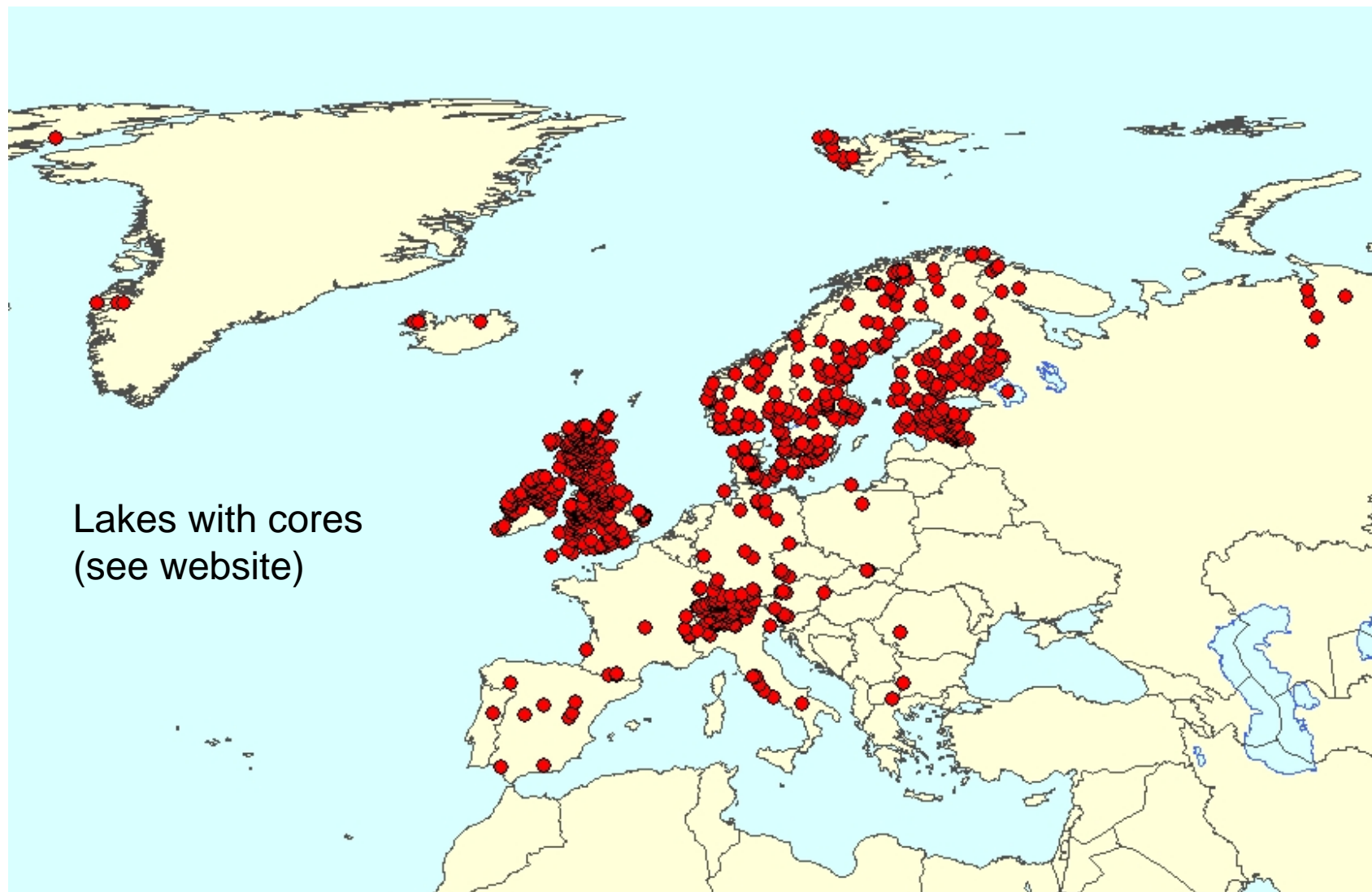


Groby Pool

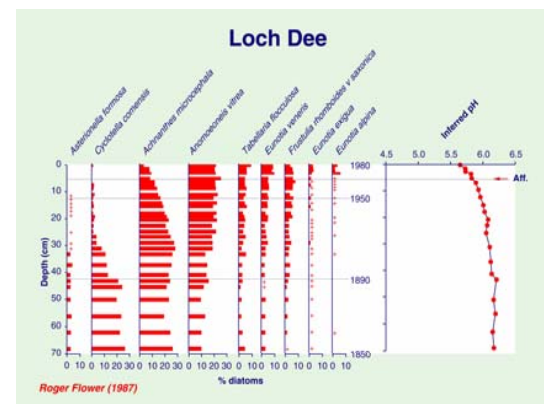
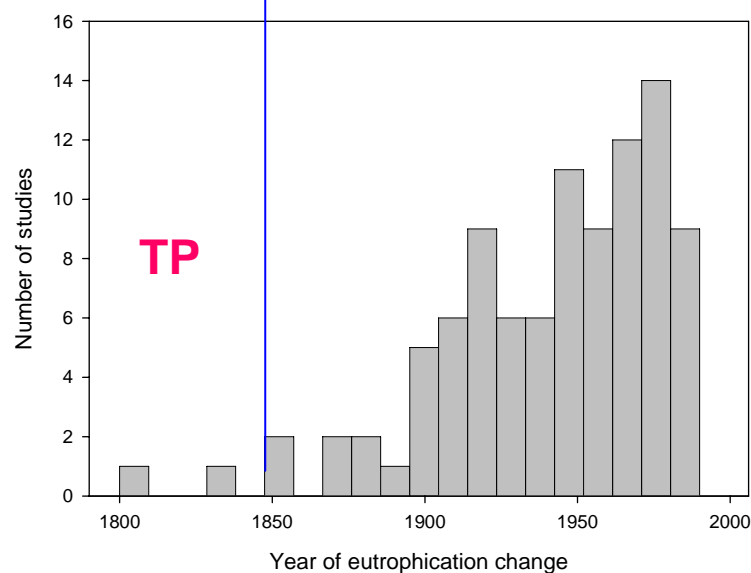
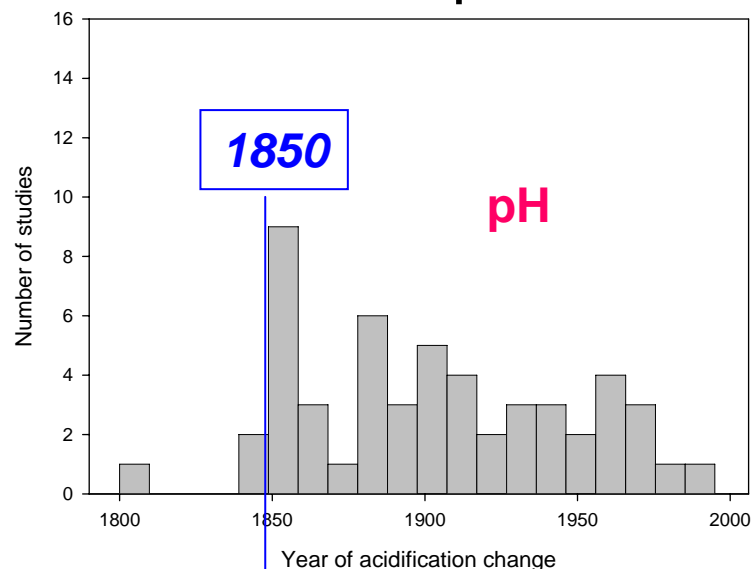
(Davidson et al. 2005)



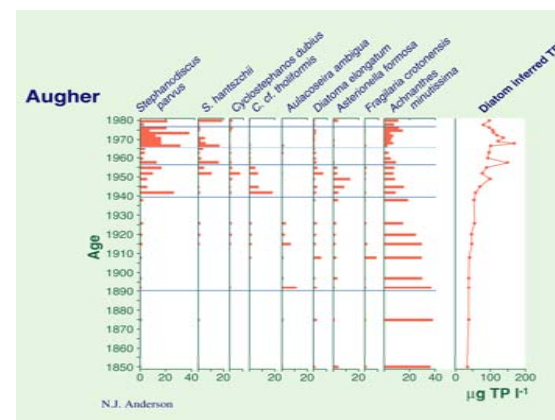
## Euro-limpacs palaeo-meta-database



# First evidence of pH and TP change by decade (reference date)



Point of acidification change



Point of eutrophication change

(from Battarbee et al. 2007)

## The role of climate?

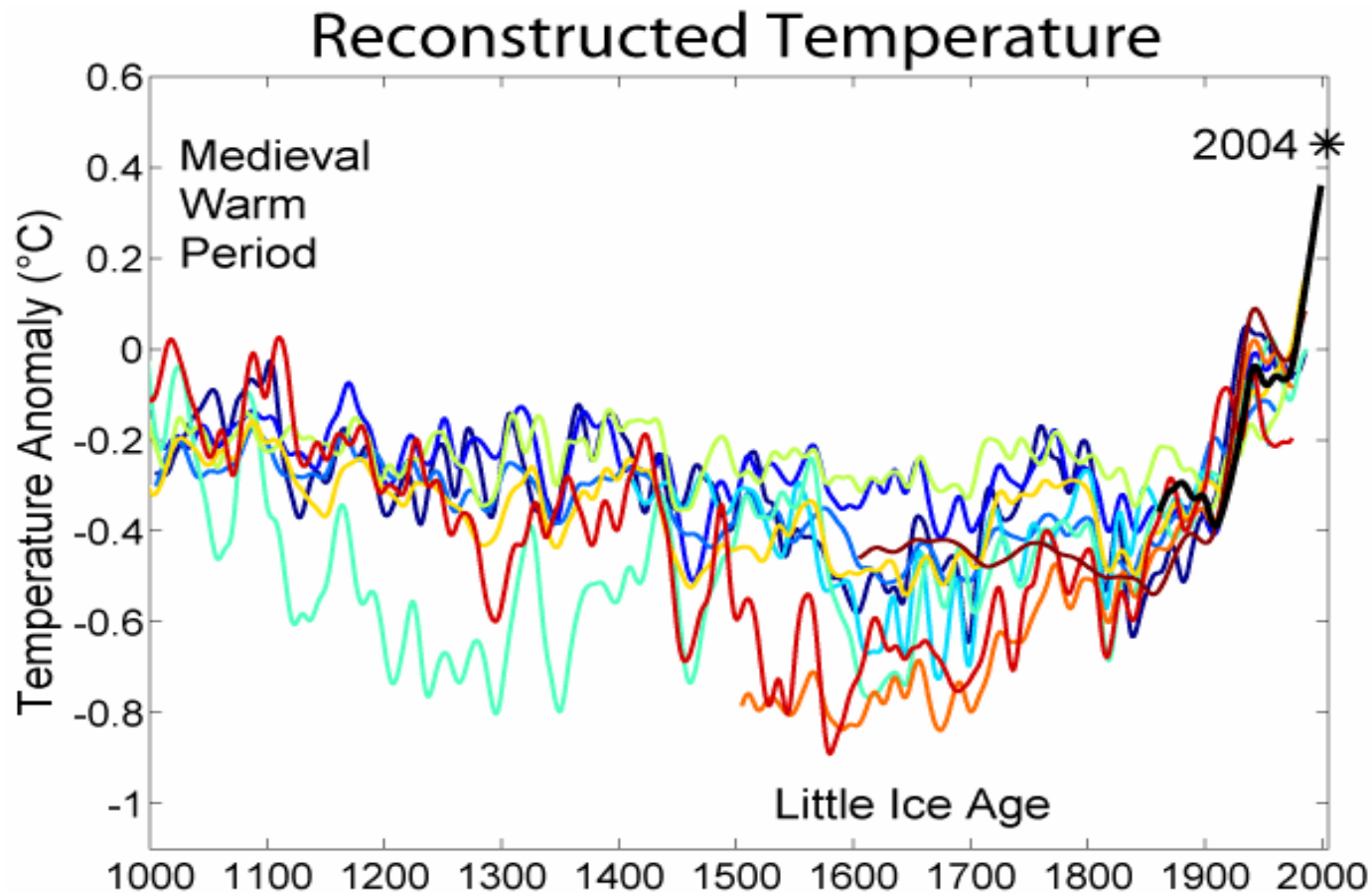
- natural variability
- anthropogenic forcing – remote lakes
- anthropogenic forcing – interactions with pollutants





## Past climate variability – last 1000 years (NH)

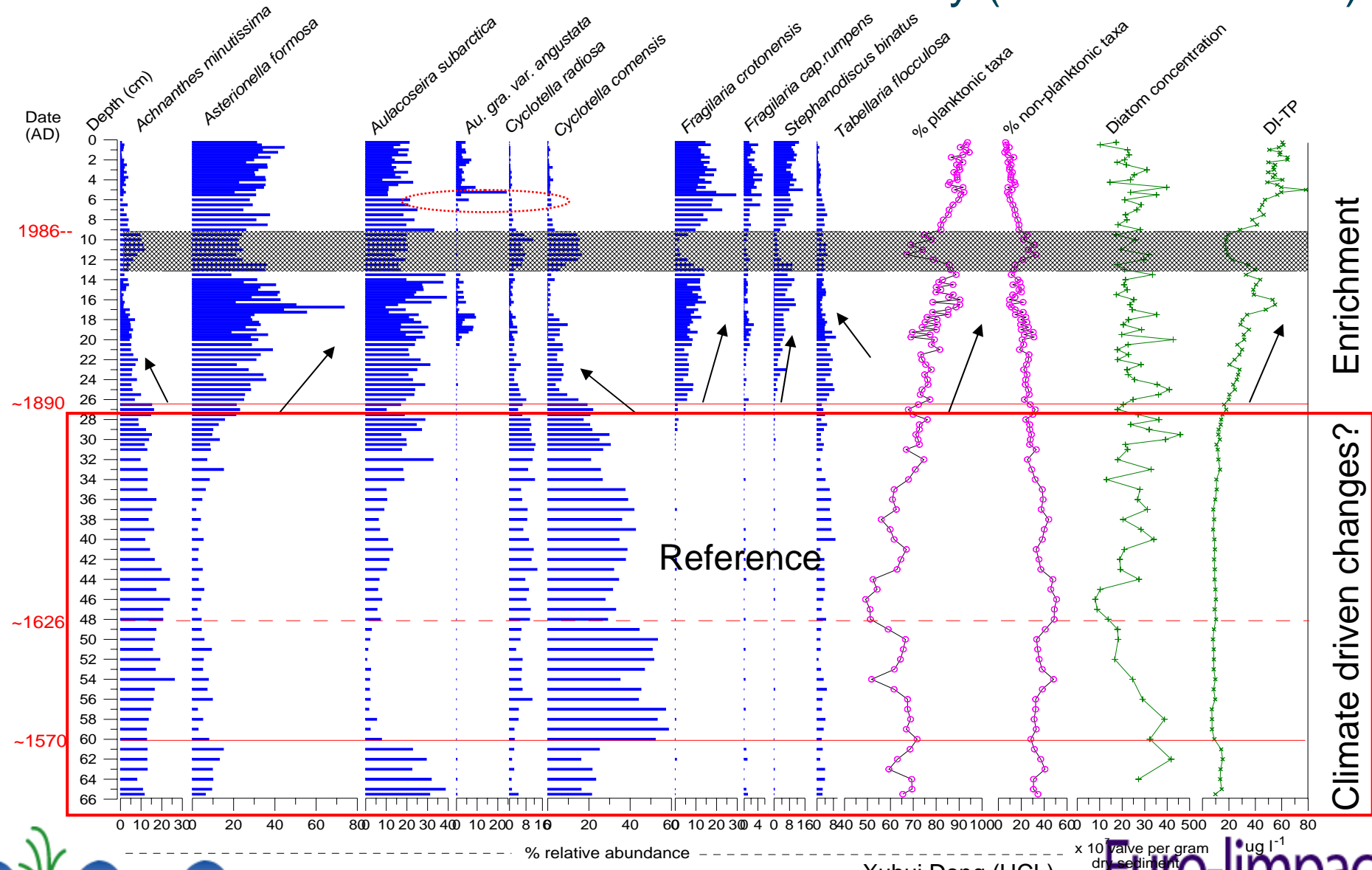
Solar variability, volcanic dust, NAO, greenhouse gases



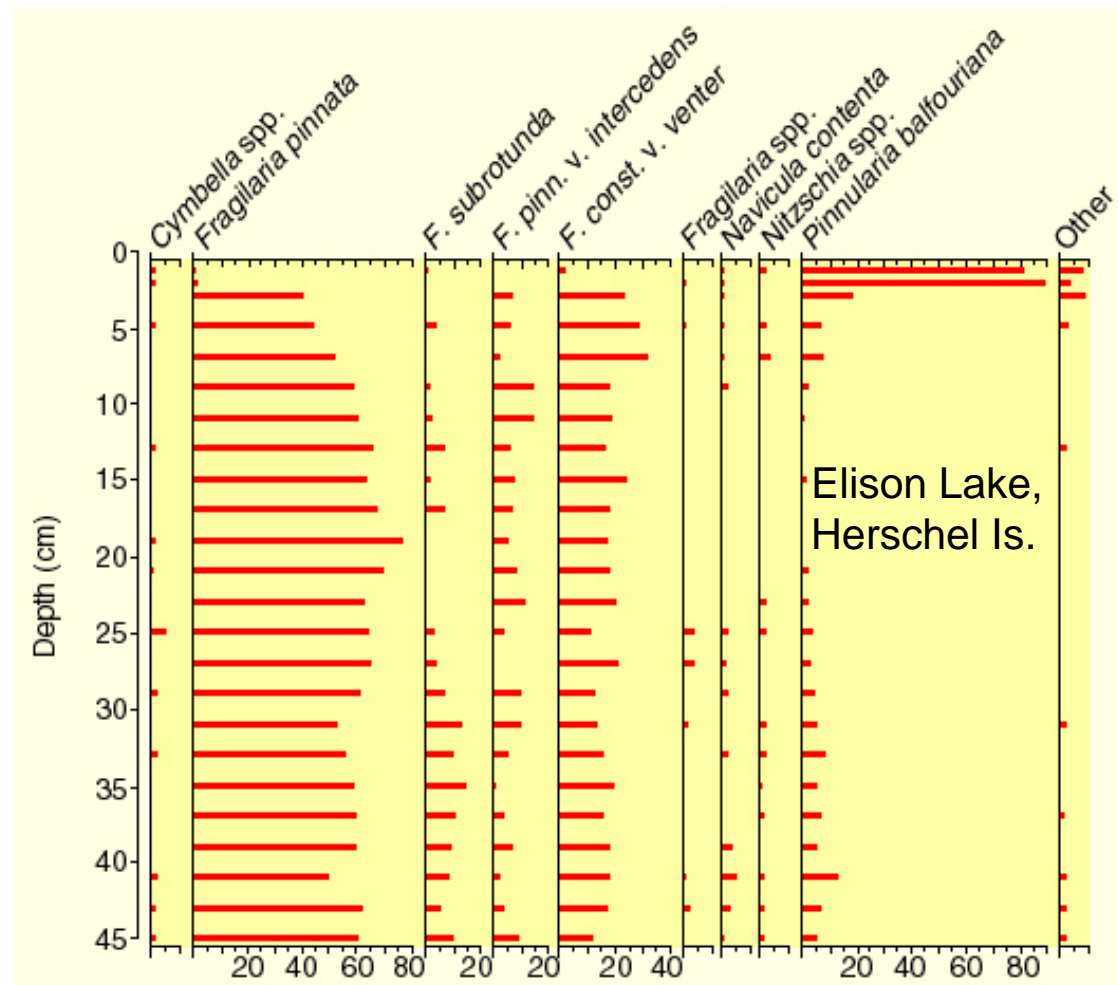
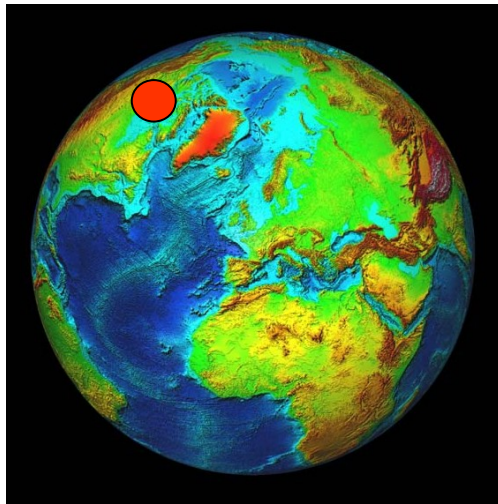
From Wikipedia

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# Reference state – natural climate variability (Esthwaite Water)



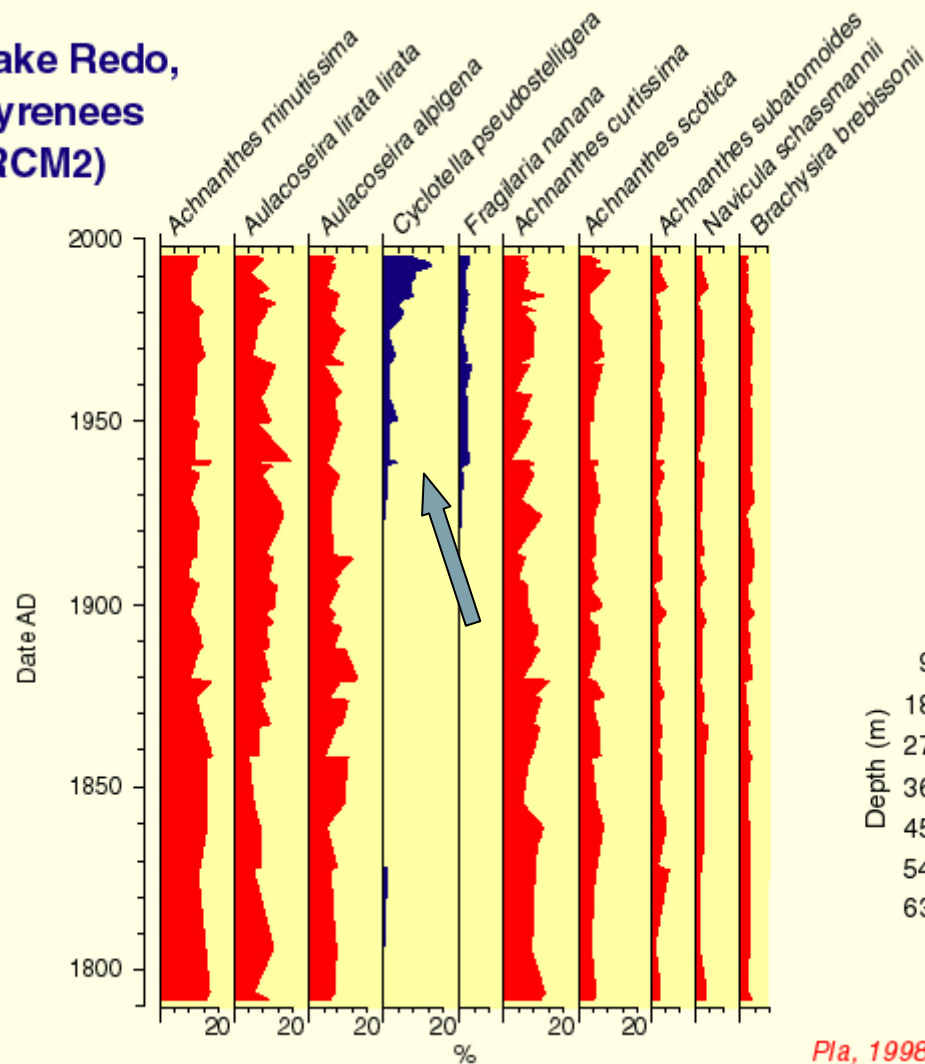
## Evidence for anthropogenic forcing – **habitat change** in the arctic



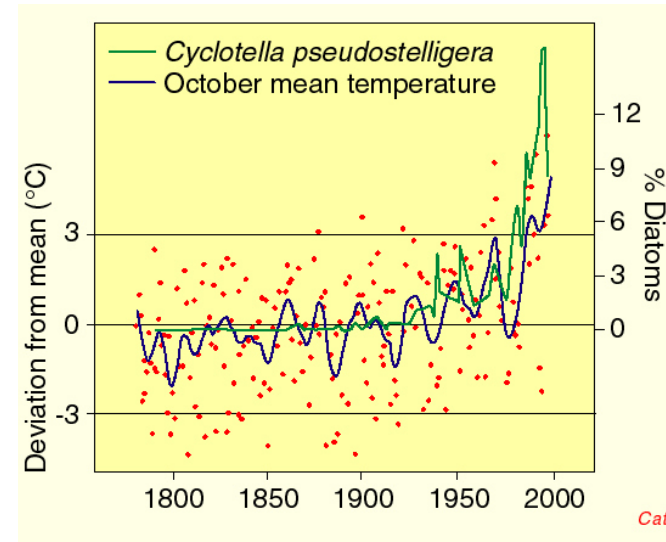
(Douglas et al. *Science*, 1994,  
and Smol et al. *PNAS*, 2005)

# Anthropogenic forcing – plankton increase in mountain lakes

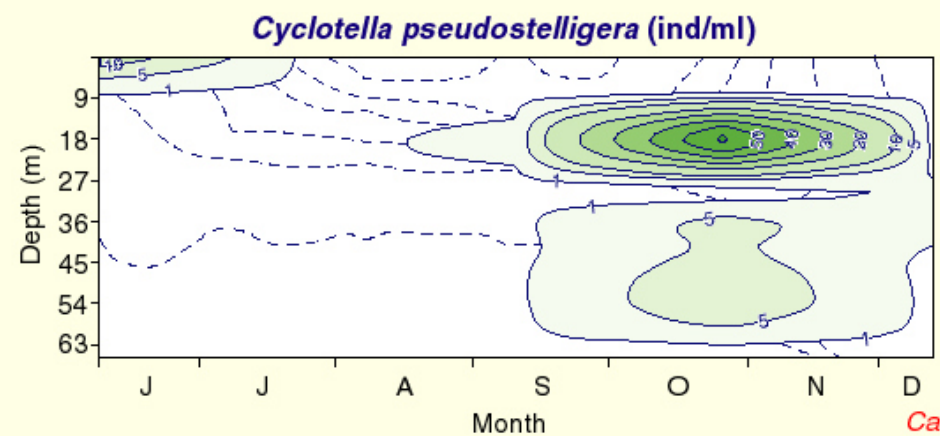
## Lake Redo, Pyrenees (RCM2)



Pla, 1998



Cal



Ca

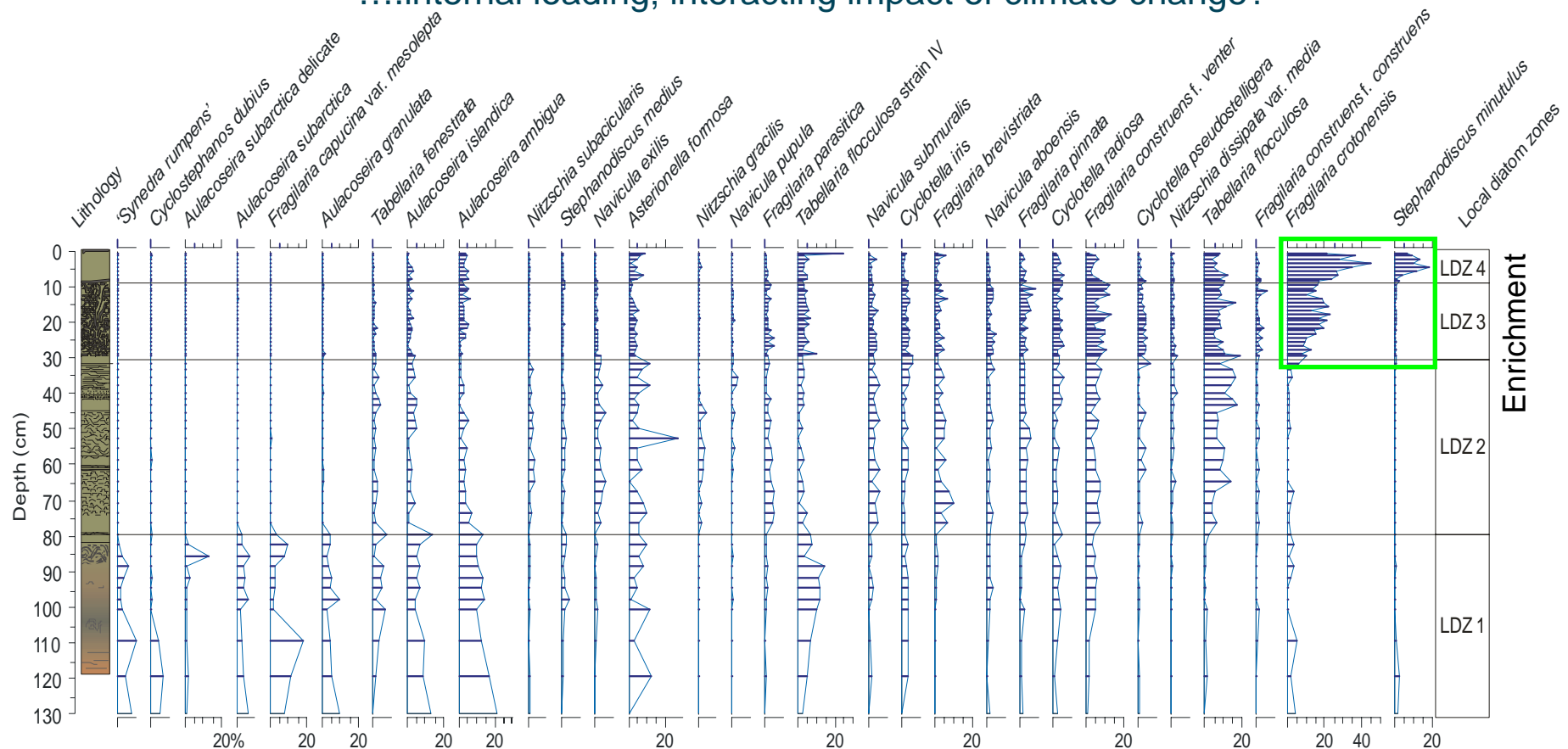
Catalan et al. 2002

The impact of climate change in polluted lakes is still difficult to detect because of the masking effect of the pollutants



# Lake Pyhäjärvi, Finland: diatom changes in the sediment record

Lack of recovery despite reductions in nutrient concentrations since ~1980...  
 ....internal loading; interacting impact of climate change?



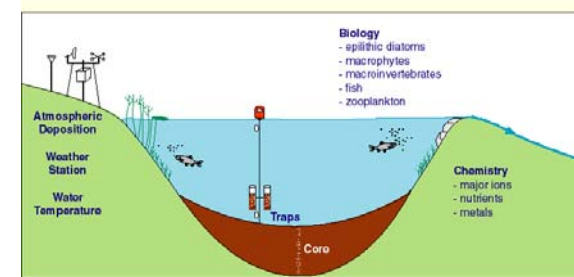
Analyst: Tommi Kauppi

(Amsinck et al. unpublished)

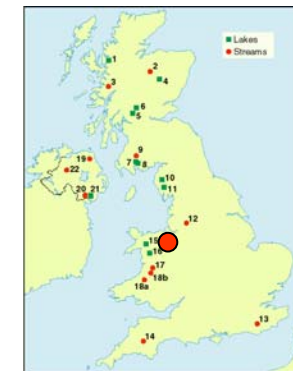
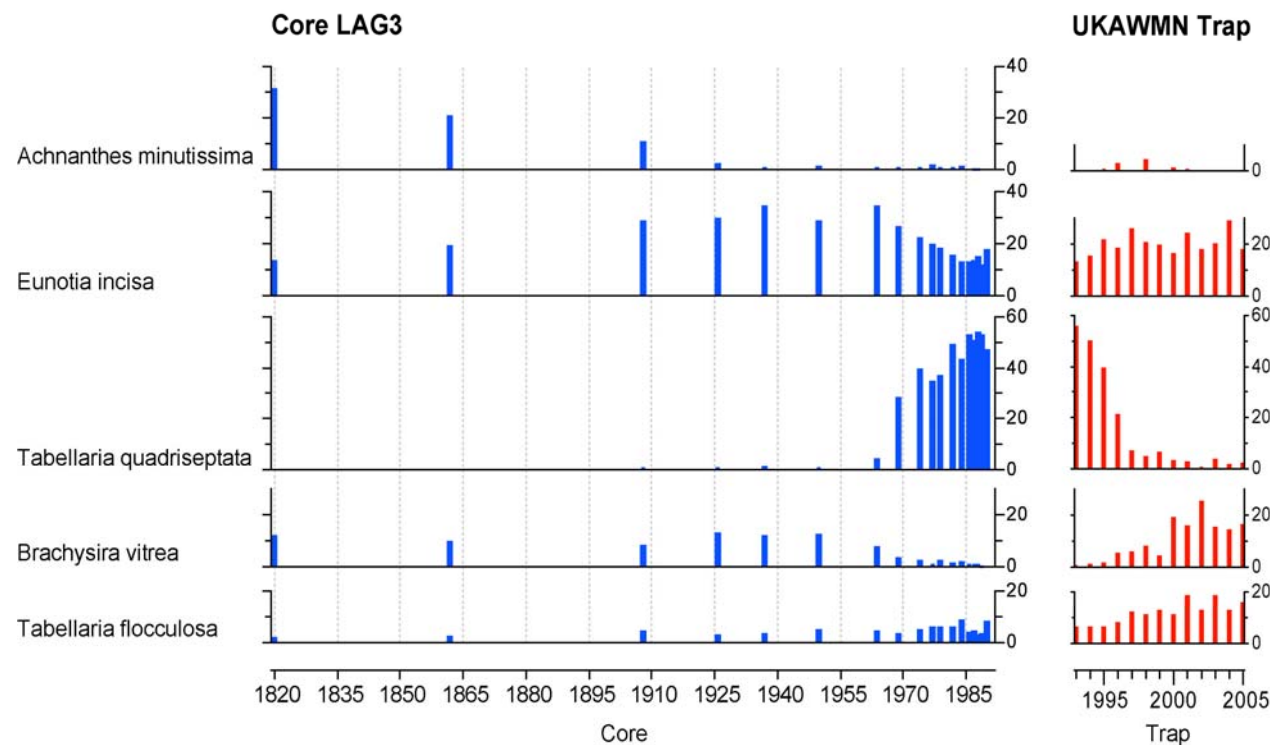
Euro-limpacs



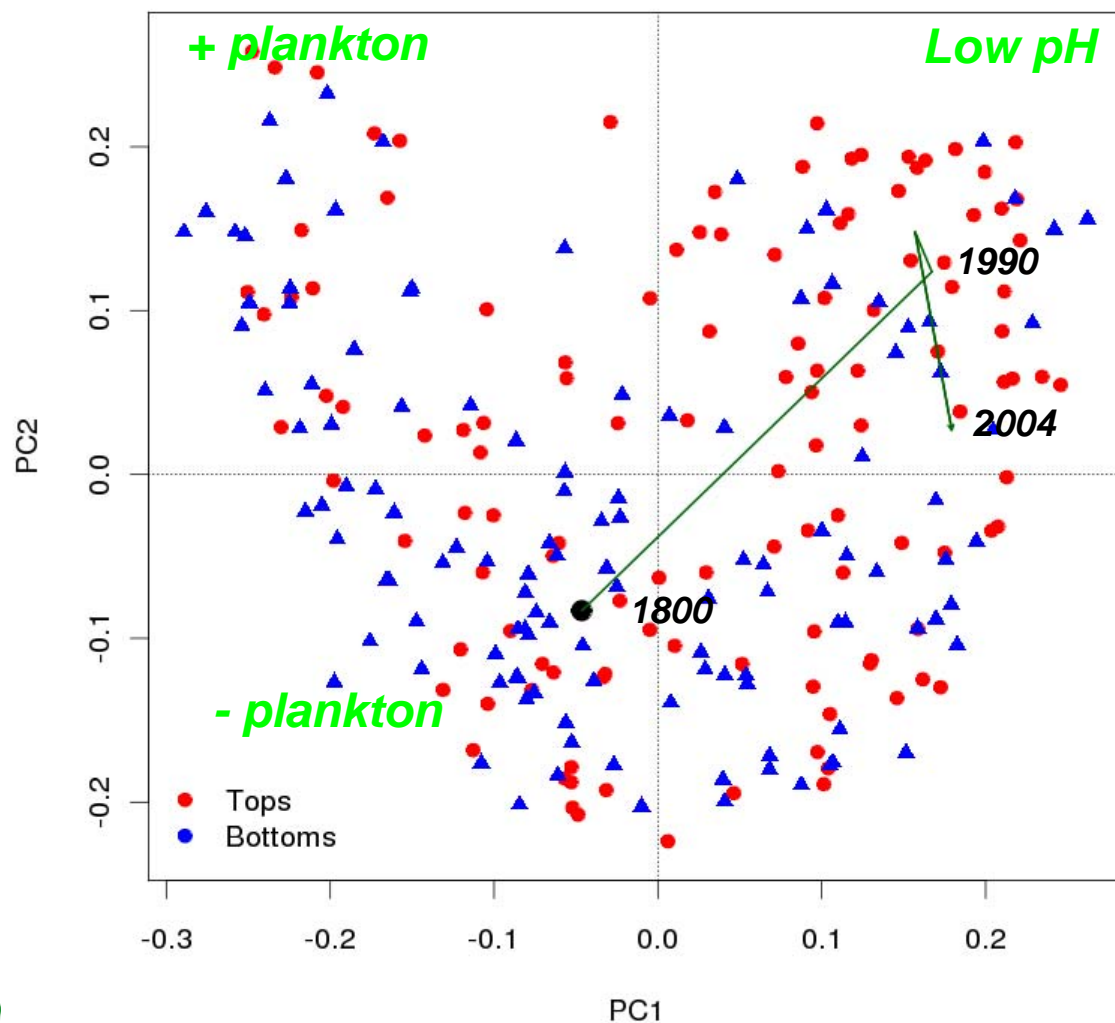
# Response of lakes in the UK to a reduction in acid emissions



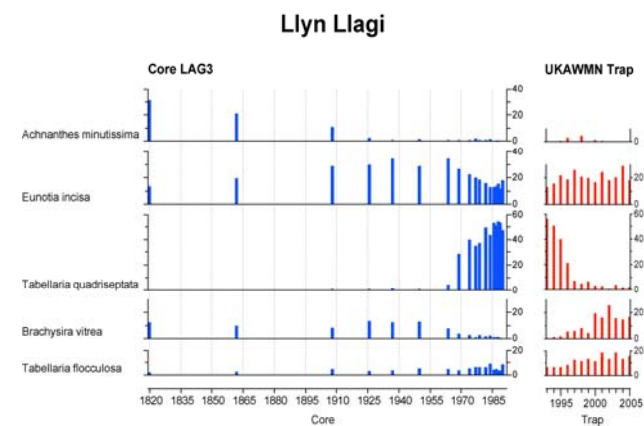
## Llyn Llgi



## UK Cores: Llagi Core and Traps

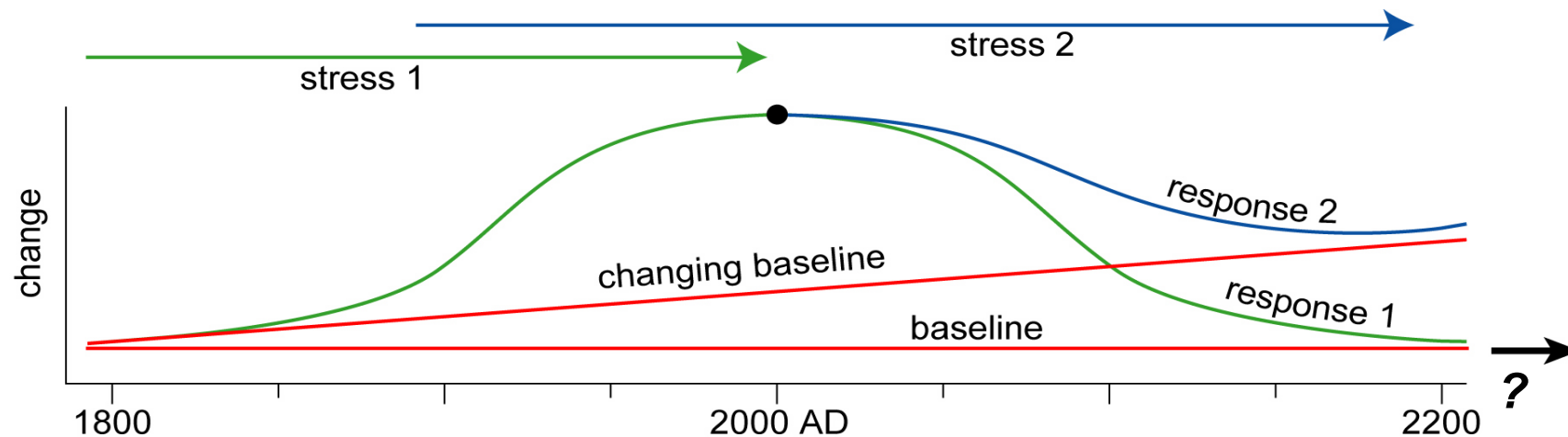


Hysteresis?  
N deposition?  
Climate change?





## What are the implications of future climate change for aquatic ecosystem restoration policies?



- The climate system is dynamic, so the reference state is dynamic,
- Boundary conditions will change through time
- Climate change will become the dominant driver as pollutant loading is controlled
- Restoration to “good ecological status” will depend on complex interactions between continuing stresses, recovery processes and climate change

