

**Harry , Sally and the good and bad
guys**



Wat. Sci. Tech. Vol.17, Amsterdam, pp.757-768.
Printed in Great Britain.

0273-1223/85 \$0.00 + .50
Copyright © 1984 IAWPRC

RESTORATION OF LAKE VELUWE, THE NETHERLANDS, BY REDUCTION OF PHOSPHORUS LOADING AND FLUSHING

S. H. Hoser

Rijkswaterstaat — RIZA, P.O. Box 17, 8200 AA Lelystad, The Netherlands

Cats know it!!



after years with flushing of
lakes - HARRY met a GURU
(myyyyyy lake, myyyyyy students)
Long time ago when grand-
father was young

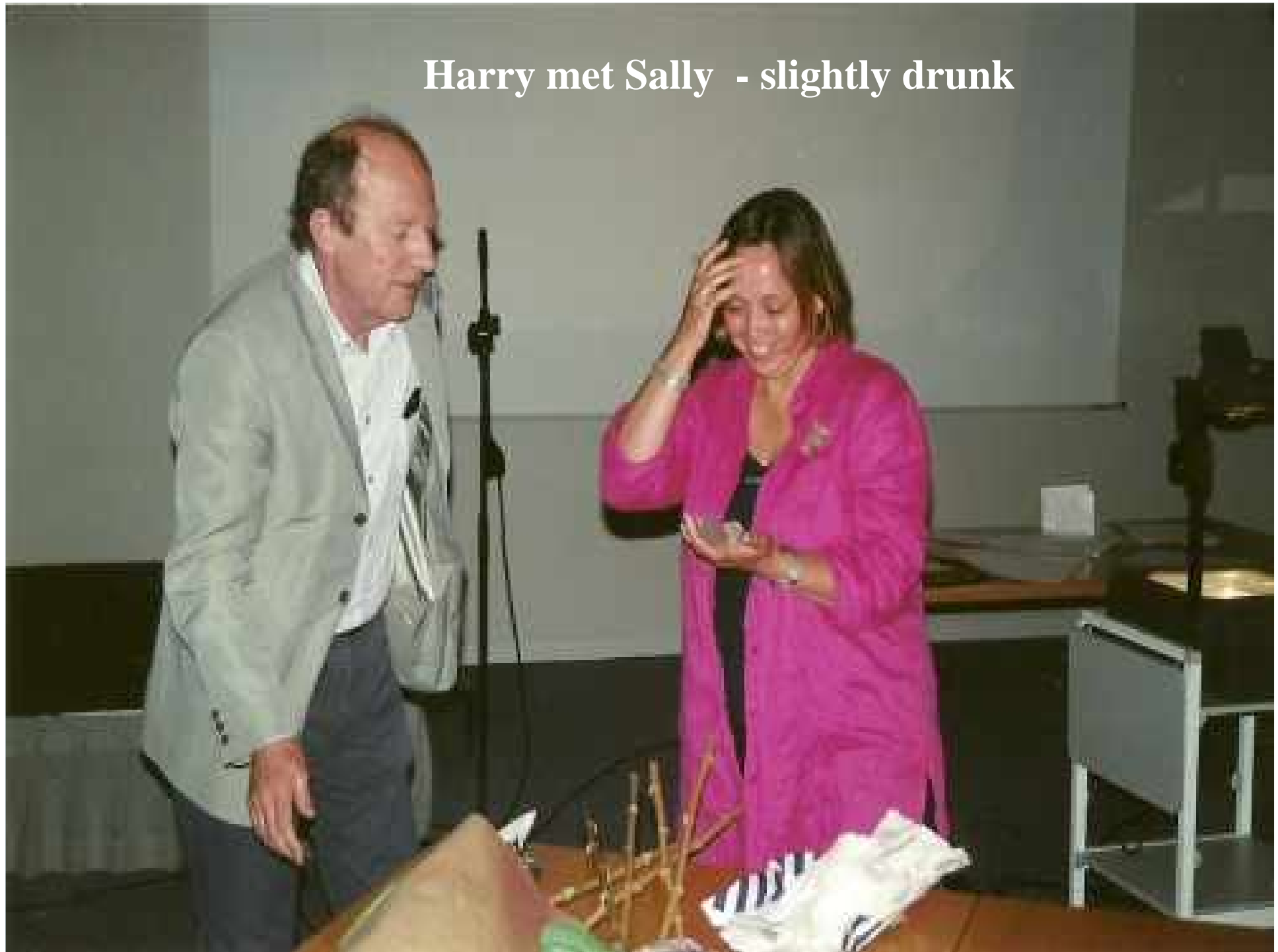
Harry

secretary

Guru



Harry met Sally - slightly drunk





shouldn't
we...

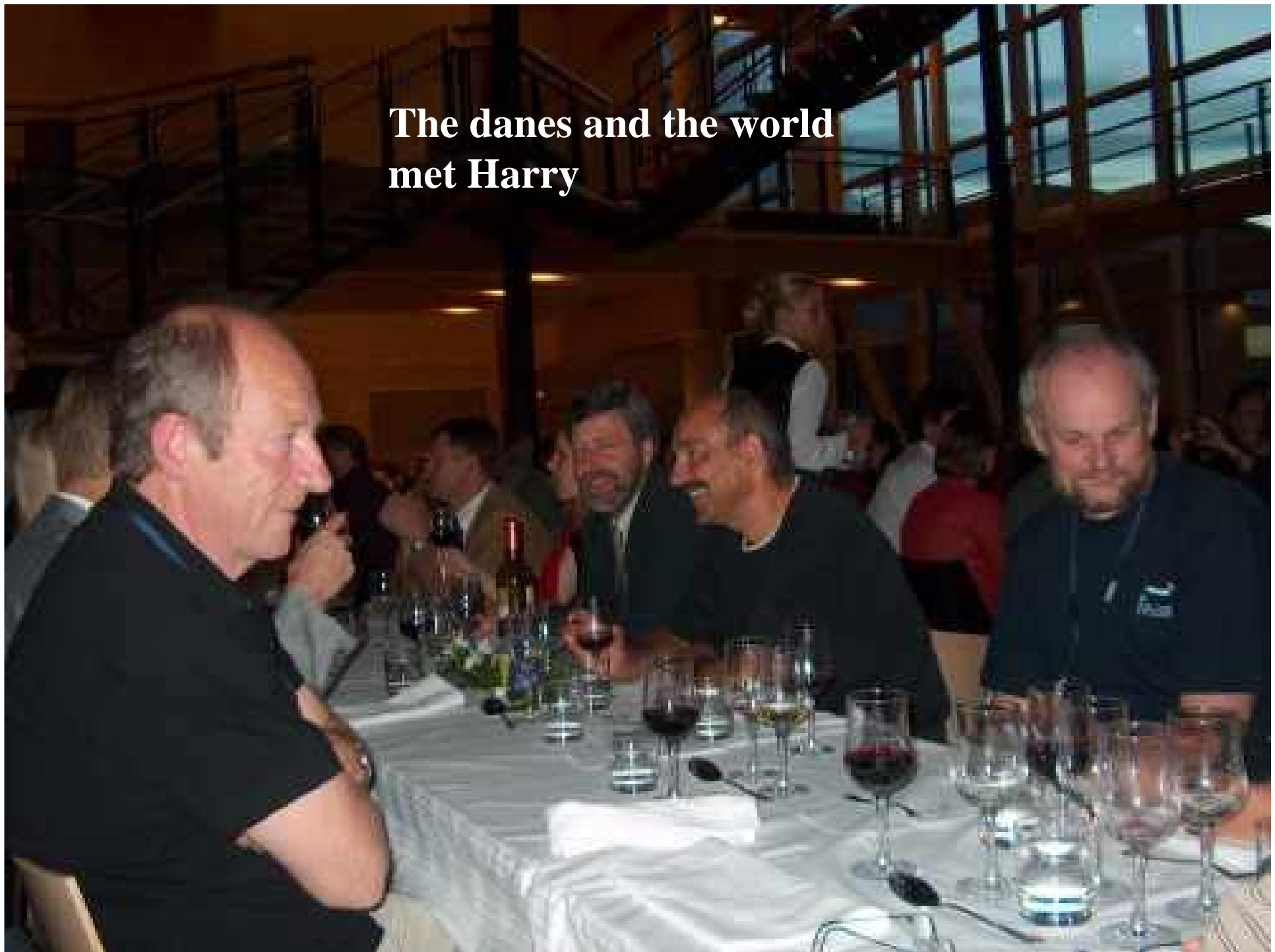
see mee
and my
glasses

see mee
and my
glasses

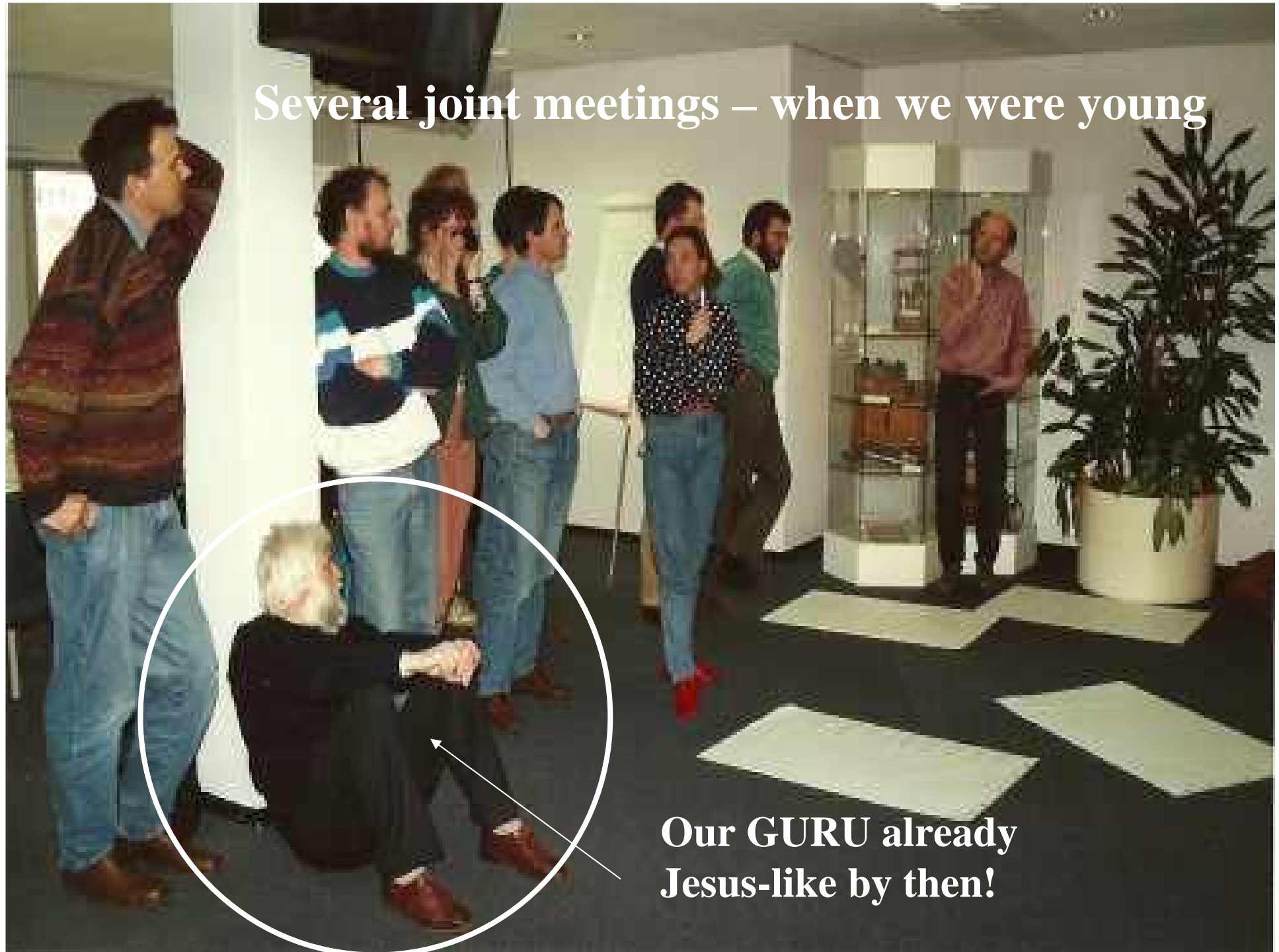


Harry met Marten
Egbert and Eddy

**The danes and the world
met Harry**



Several joint meetings – when we were young



Our GURU already
Jesus-like by then!

BIOMANIPULATION, NEW PERSPECTIVES FOR RESTORATION OF SHALLOW, EUTROPHIC LAKES IN THE NETHERLANDS

S.H. HOSPER

KEYWORDS: Biomanipulation; lake restoration; fish-stock management; eutrophication; algae.

Hydrobiologia 200/201: 523-534, 1990.

R. D. Gulati, E. H. R. R. Lammens, M.-L. Meijer & E. van Donk (eds), *Biomanipulation - Tool for Water Management*.

523

© 1990 Kluwer Academic Publishers. Printed in Belgium.

Biomanipulation additional to nutrient control for restoration of shallow lakes in The Netherlands

S. H. Hosper & E. Jagtman

Ministry of Transport and Public Works, Institute for Inland Water Management and Waste Water Treatment, P.O. Box 17, 8200 AA Lelystad, The Netherlands

LIVING WITH WATER: AT THE CROSS-ROADS OF CHANGE

Joost de Jong*, Peter T. J. C. van Rooy** and S. Harry Hosper***

* Institute for Inland Water Management and Waste Water Treatment, P.O. Box 17, 8200 AA Lelystad and Delft University of Technology, P.O. Box 5048, 2600 CA Delft, The Netherlands

** DHV Water BV, Postbus 484, 3800 AL Amersfoort, The Netherlands

*** Institute for Inland Water Management and Waste Water Treatment, P.O. Box 17, 8200 AA Lelystad, The Netherlands



Hydrobiologia 408/409: 13-30, 1999.

N. Walz & B. Nixdorf (eds), *Shallow Lakes '98: Trophic Interactions in Shallow Freshwater and Brackish Waterbodies*

© 1999 Kluwer Academic Publishers. Printed in the Netherlands.

13

Biomanipulation in shallow lakes in The Netherlands: an evaluation of 18 case studies

Marie-Louise Meijer¹, Ingeborg de Boois¹, Marten Scheffer², Rob Portielje¹ & Harry Hosper¹

¹Institute for Inland Water Management and Waste Water Treatment, P.O. Box 17, 8200 AA Lelystad, The Netherlands

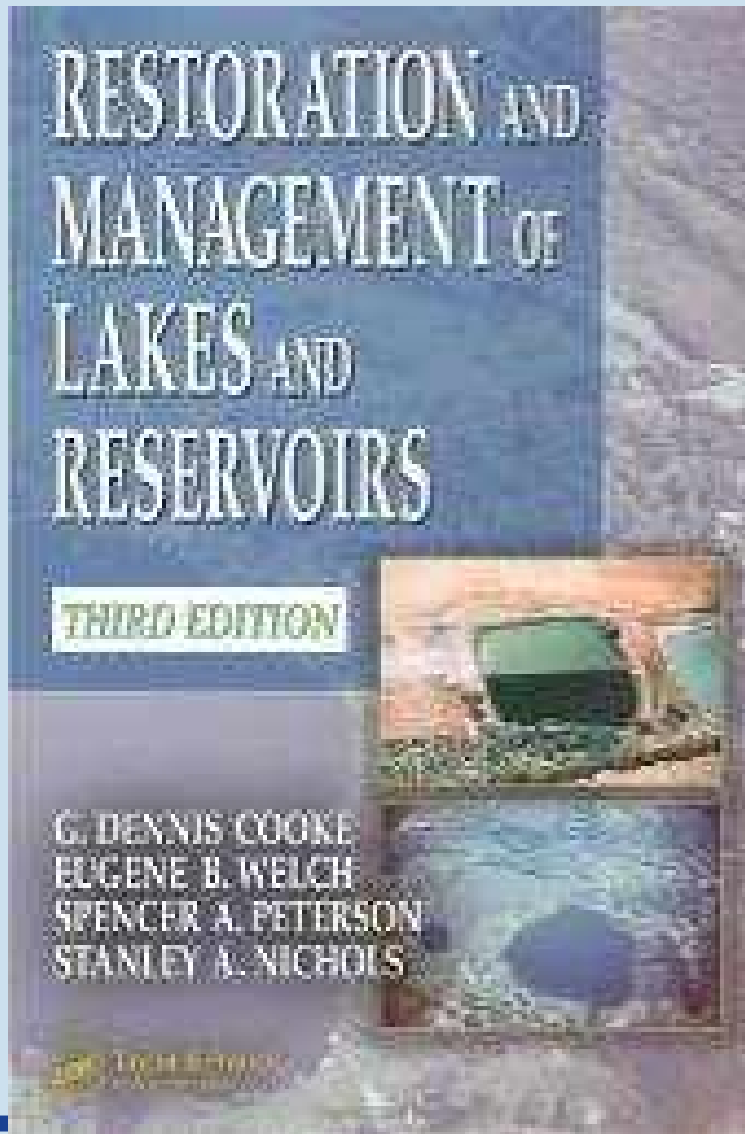
²Agricultural University, Department of Aquatic Ecology and Water Quality Management, P.O. Box 9101, 6700 HB Wageningen, The Netherlands

Book Chapters

- 1. Integrated water resources management : selected proceedings of "Living with Water"--the International Conference on Integrated Water Resources Management, held in Amsterdam, The Netherlands, 26-29 September 1994 1.329496891
English Publisher: Oxford ; New York : Pergamon, 1995.
by S H Hosper; et al BookLanguage: English
- Checking...
- Close2. Integrated water resources management : selected proceedings of "Living With Water", the International Conference on Integrated Water Resources Management, held in Amsterdam, The Netherlands, 26 - 29 September 1994 2.2316508452
H Hosper; Living With Water - the International Conference on Integrated Water Resources Management (1994, Amsterdam); Book : Conference publicationLanguage: English Publisher: Oxford [u.a.] Pergamon 1995
by S
- Checking...
- Close3. Integrated water resources management : Selected proceedings of "Living with water" - the International conference, Amsterdam 1994. 3.4733197533
by S H Hosper; International Association on Water Quality.;
Netherlands Association on Water Management.; IAWQ.; BookLanguage: English Publisher: Oxford : Pergamon Press, 1995.
- Checking...
- Close4. Handleiding actief biologisch beheer : beoordeling van de mogelijkheden van visstandbeheer bij het herstel van meren en plassen 4.658277814
by S H Hosper; M -L Meijer; M P Grimm; et al BookLanguage: Dutch Publisher: Lelystad :
Rijksinstituut voor Integraal Zoetwaterbeheer en Afvalwaterbehandeling (RIZA) ; Nieuwegein : Organisatie ter Verbetering van de Binnenvisserij (ÖVB), 1992.
- Checking...
- Close5. Natuur : zoete wateren 5.675056205
by S H Hosper; Werkgroep Natuur Zoete
Rijkswateren.; BookLanguage: Dutch Publisher: [S.I.] : Ministerie van Verkeer en Waterstaat [etc.], 1990.
- Checking...
- Close6. Combating algal blooms in the large and shallow IJsselmeer, the Netherlands: Perspectives for nutrient control and the reduction of commercial fishing intensity 6.944157556
by S H
HosperArticleLanguage: English Publication: Verhandlungen der Internationalen Vereinigung für Theoretische und Angewandte Limnologie. 27, no. 6, (2002): 3476Publisher: Stuttgart : E. Schweizerbart'sche Verlagsbuchhandlung, 1923-
Database: ArticleFirst
- Checking...
- Close7. Stable States, Buffers and Switches: An Ecosystem Approach to the Restoration and Management of Shallow Lakes in the Netherlands 7.1049152477
by S H HosperArticleLanguage: English Publication: Water science and
technology : a journal of the International Association on Water Pollution Research. 37, no. 3, (1998): 151Publisher: Oxford ;
New York : Pergamon Press, 1981-Database: ArticleFirst
- Checking...
- Close8. Integrated water resources management : selected proceedings of "Living with Water"--the International Conference on Integrated Water Resources Management, held in Amsterdam, The Netherlands, 26-29 September 1994 8.4904633668
by S
Harry Hosper; et al Book : Conference publicationLanguage: English Publication: Water science and technology, vol. 31, no. 8Publisher: Oxford ; New York : Pergamon, cop. 1995.
- Checking...
- Close9. Meerbegeleidende moerassen : voor waterzuivering en natuurontwikkeling 9.645630599
by J L Fiselier; H A Udo de Haes; S H Hosper Book : National
government publicationLanguage: Dutch Publisher: Leiden : Centrum voor Milieukunde, Rijksuniversiteit Leiden, 1987.
- Checking...
- Close10. Integrated water resources management : Proceedings of "Living with water" the International conference on integrated water resources management, held in Amsterdam, The Netherlands, 26-29 September 1994 10.30111455510
by S H Hosper;
International Association on Water Quality.; et al Book : Conference publicationLanguage: English Publication: Water science and technology. v.13- , 1981-Publisher: New York : Pergamon Press, 1995.
- Checking...
- Close

- **Clearing lakes**
***AN ECOSYSTEM APPROACH TO THE
RESTORATION AND MANAGEMENT OF
SHALLOW LAKES IN THE NETHERLANDS***
Harry Hosper.
- **Published 1997 Summary also in Dutch.**
Includes bibliographical references (p. 135-152).
**Thesis (doctoral)--Landbouwniversiteit
Wageningen, 1997.**

Lake restoration methods (to combat eutrophication)



Commonly used methods:

Hypolimnetic oxygenation

Sediment oxidation with nitrate (Riplox)

Addition iron

Addition calcium carbonate

Allumnium addition*

Phoslock addition*

Hypolimnetic withdrawal

Artificial circulation

Water level increase

Water level decrease

Sediment dredging

Sediment covering

Fish elimination (rotenon)

Fish removal (biomanipulation)*

Stocking of piscivores

Macrophyte introduction

Macrophyte protection

Macrophyte harvest

Stocking of fish herbivores

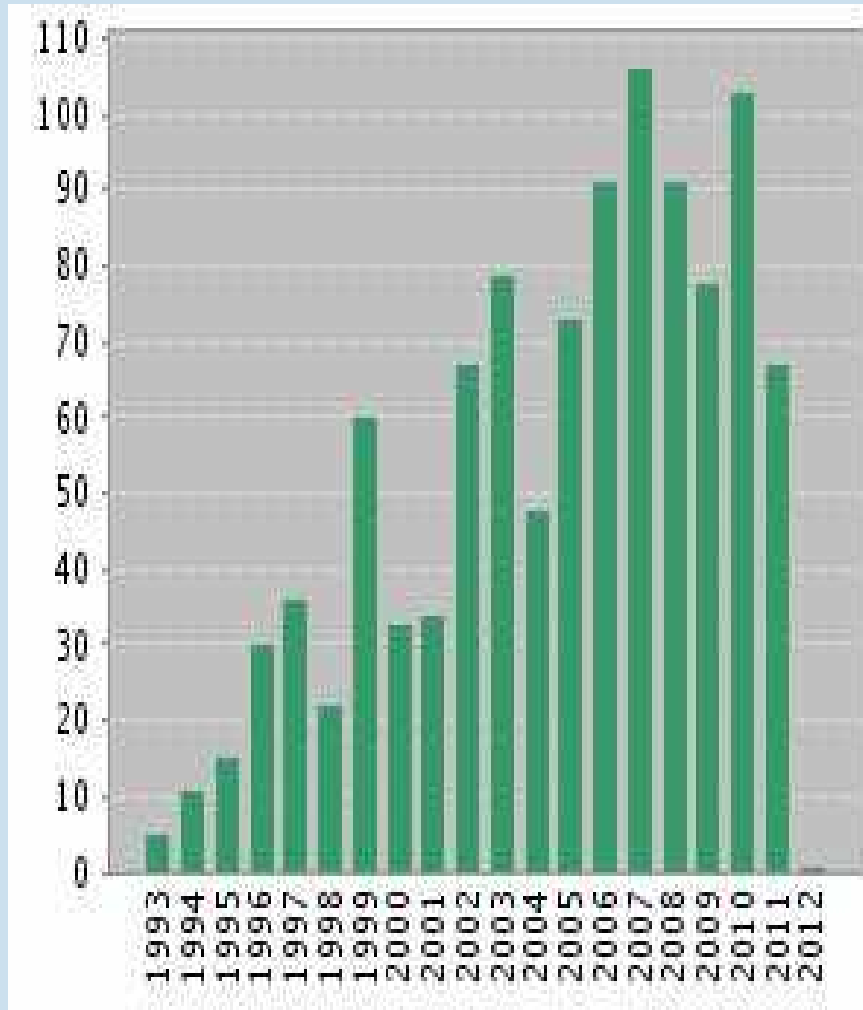
Introduction of zebra mussel

Barley straw addition

Bold: methods used in Denmark

*) Methods investigated in CLEAR

The man and his citations



Harry advices the world!!!







More clear
than Lake
Fogo

Pioner days....

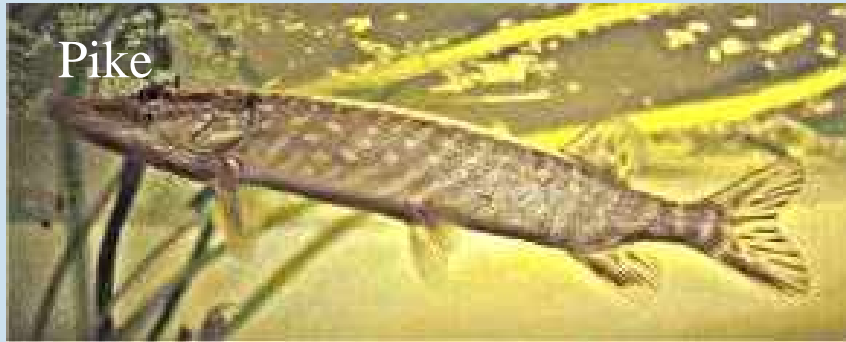
Biomanipulation roooooocks!!!!!!

Fish species in Denmark

48 species (10 introduced) in Denmark, but 4 species dominate:

Good guys

Pike



Perch (when big)



Bad guys

Roach



Bream



Carp are the worst!!!!



good guy

**really
bad guy!!**

Fish removal: methods



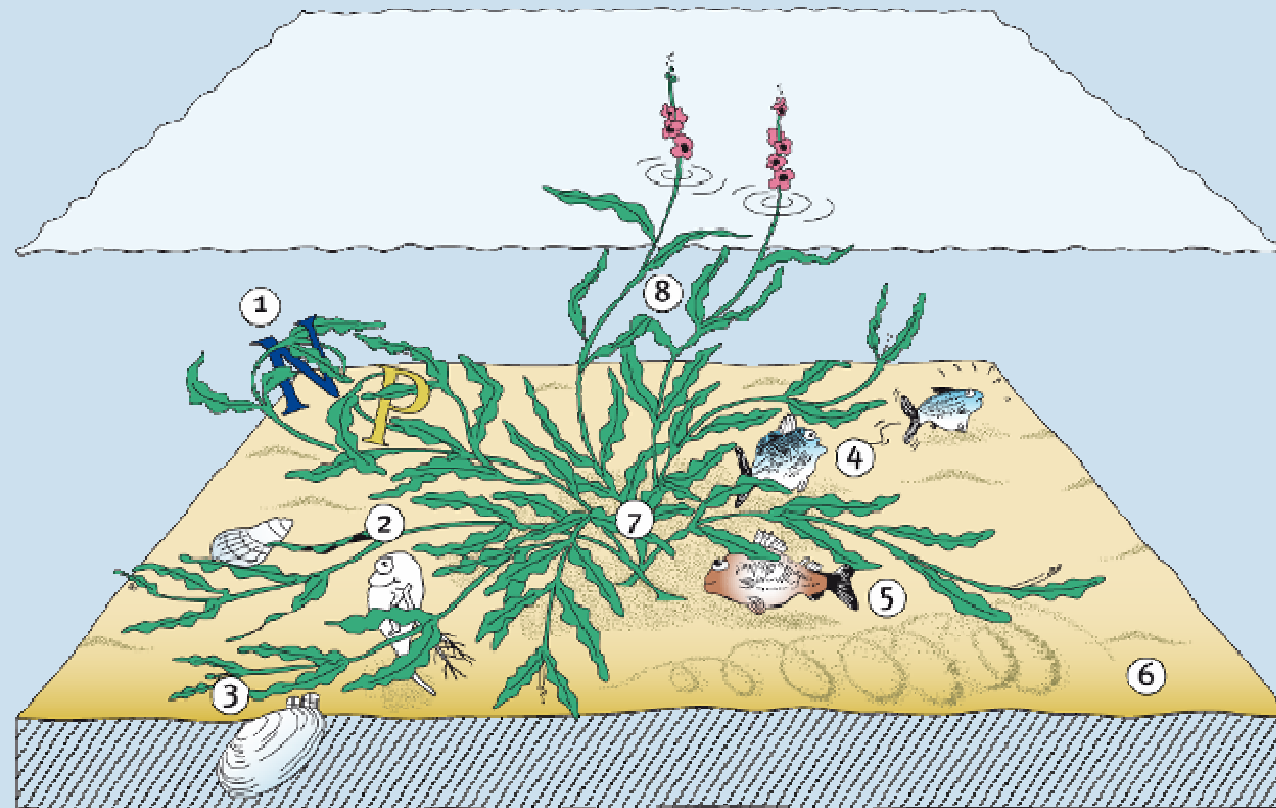
Lake restoration by removing fish



What has been achieved ?



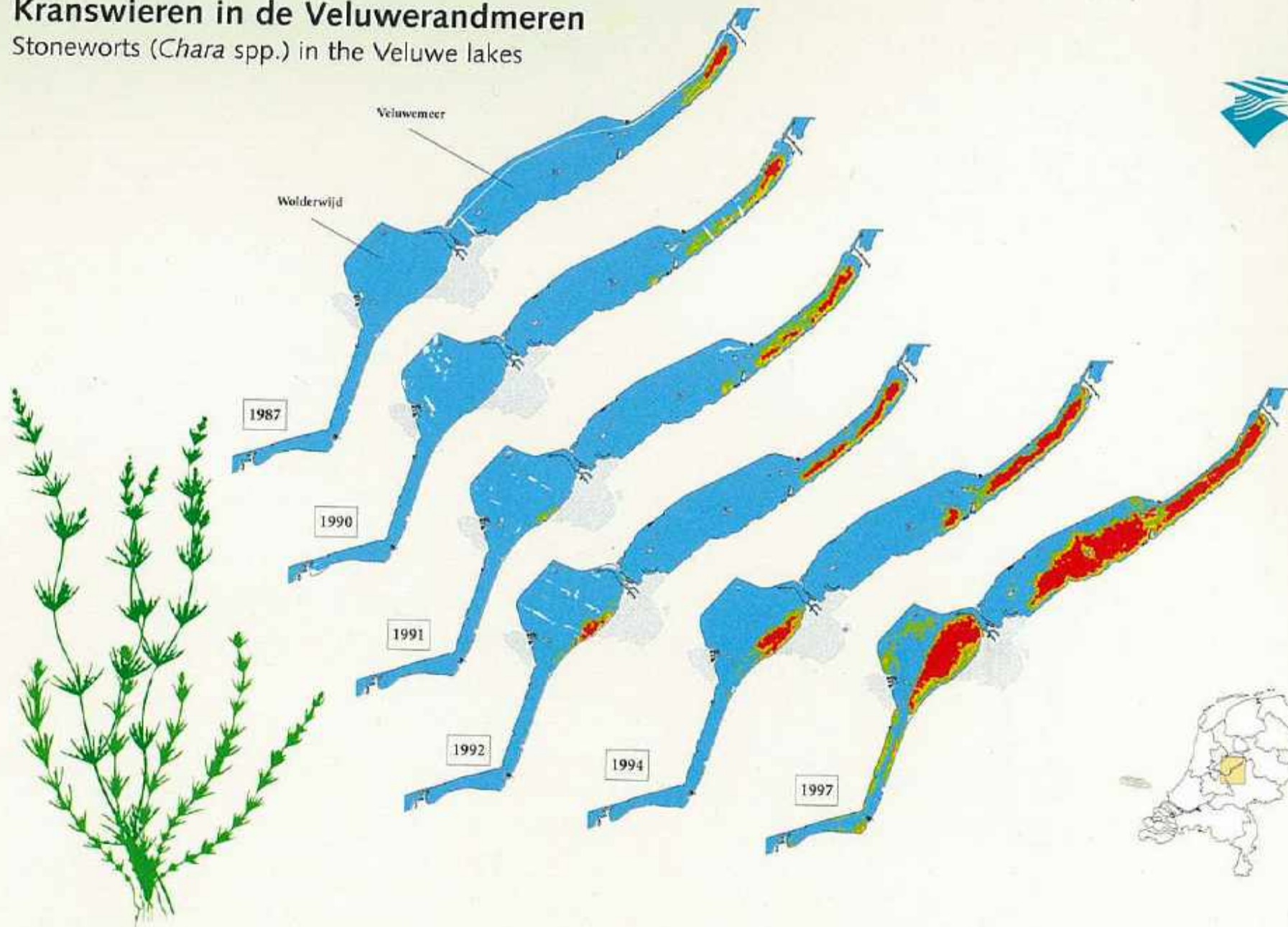
Submerged macrophytes and lake ecosystems



- | | |
|---|---|
| ① Remove nutrients for growth | ⑤ Refuges for small perch and small pikes |
| ② Refuges for zooplankton | ⑥ Stabilize sediment, reduce resuspension |
| ③ Improve conditions for macro filtrators | ⑦ Enhance denitrification |
| ④ Favourize small perch over small roach | ⑧ May have allelopathic effects |

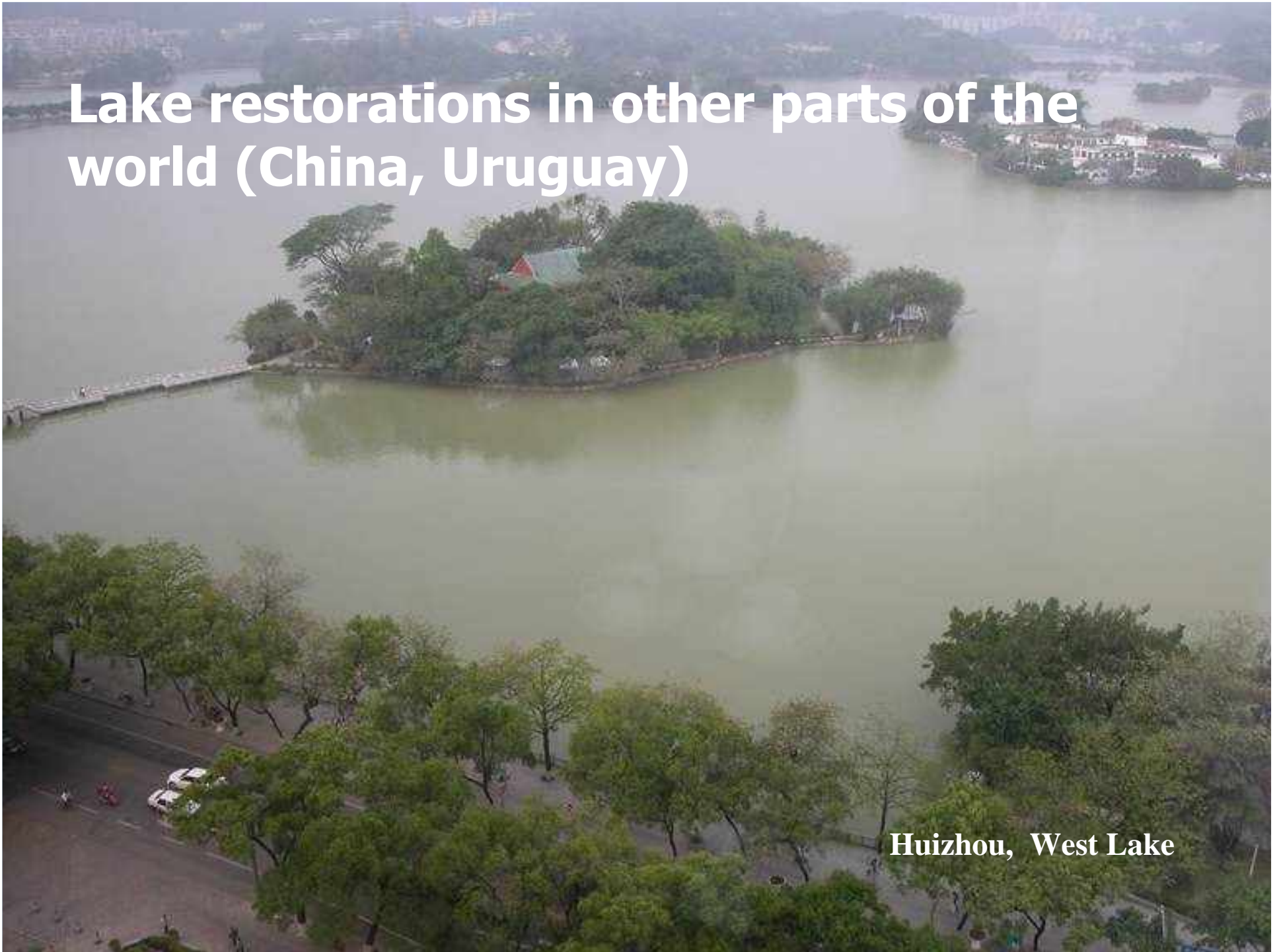
Kranswieren in de Veluwerandmeren

Stoneworts (*Chara* spp.) in the Veluwe lakes



Lake restorations in other parts of the world (China, Uruguay)

Huizhou, West Lake







**No fish
removal**

Fish removal

**Fish removal in Huizhou
West Lake.**

Long term problems

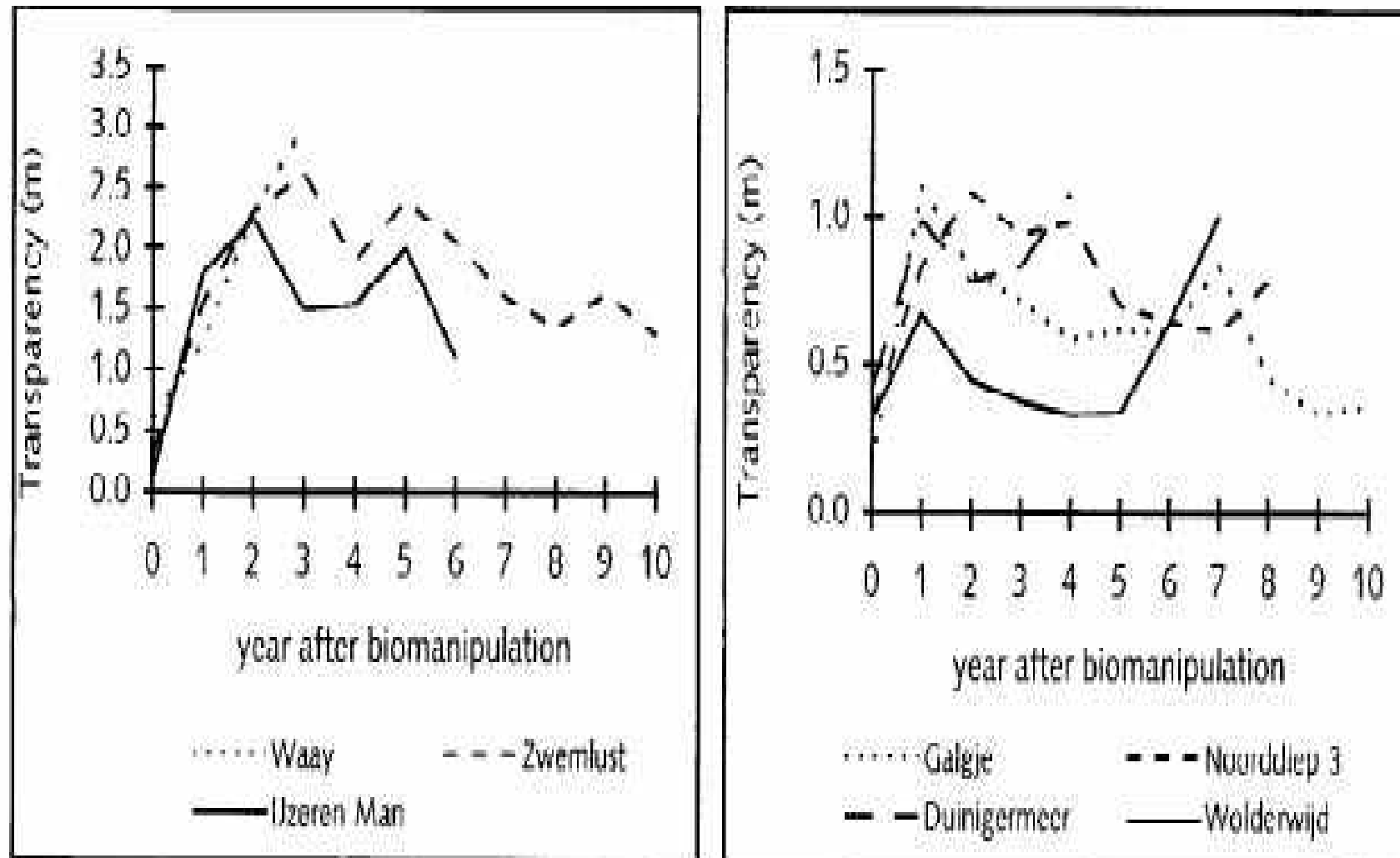
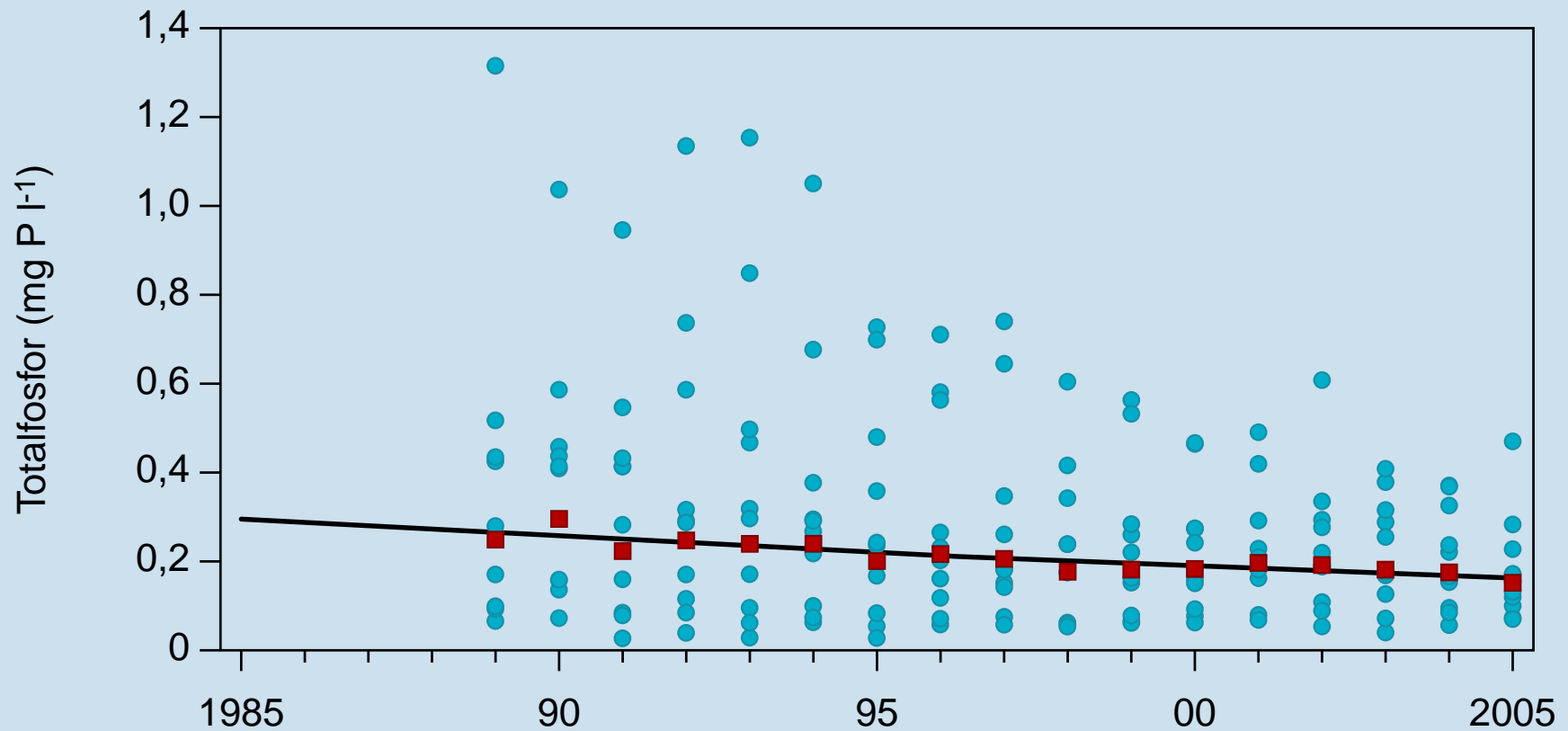


Figure 2. Summer mean Secchi depth in seven successfully biomanipulated lakes.

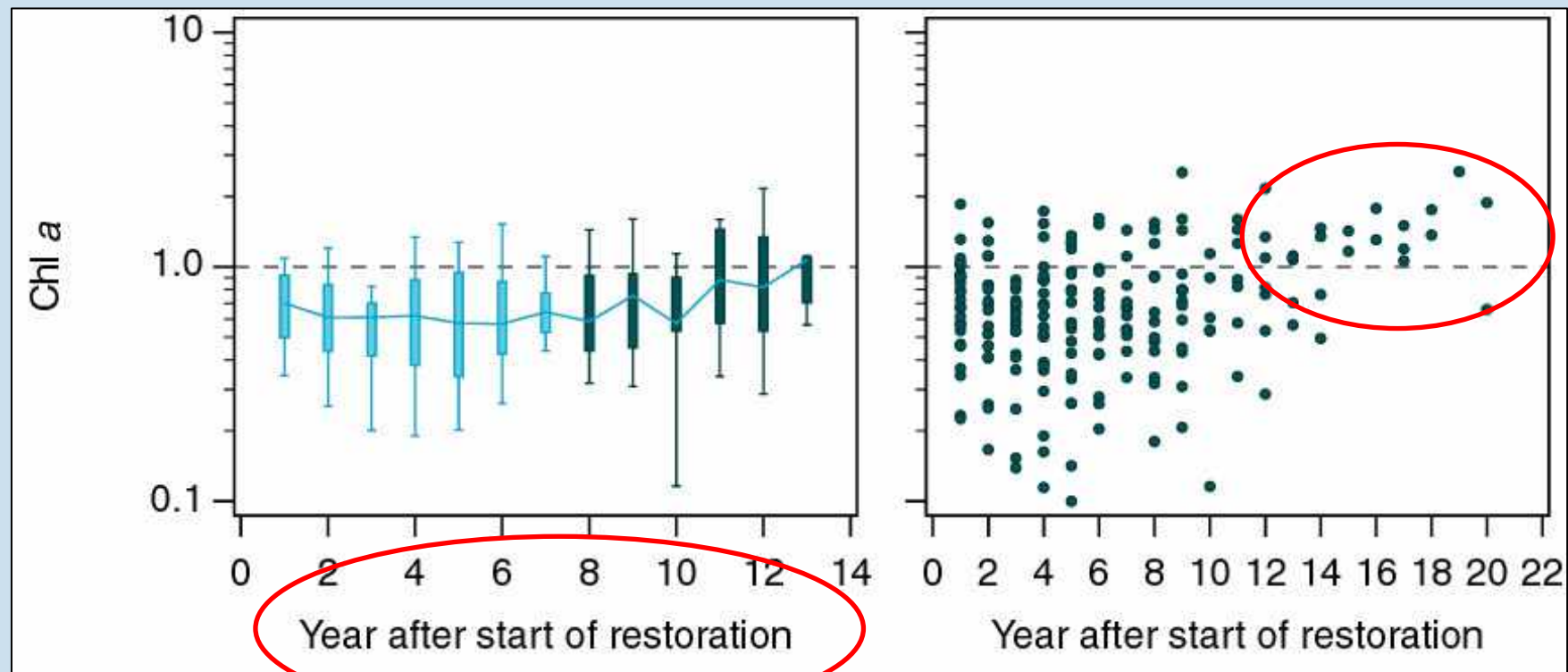
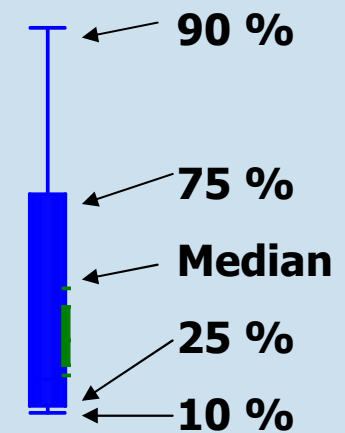
Reduced loading and concentration of TP in Danish lakes



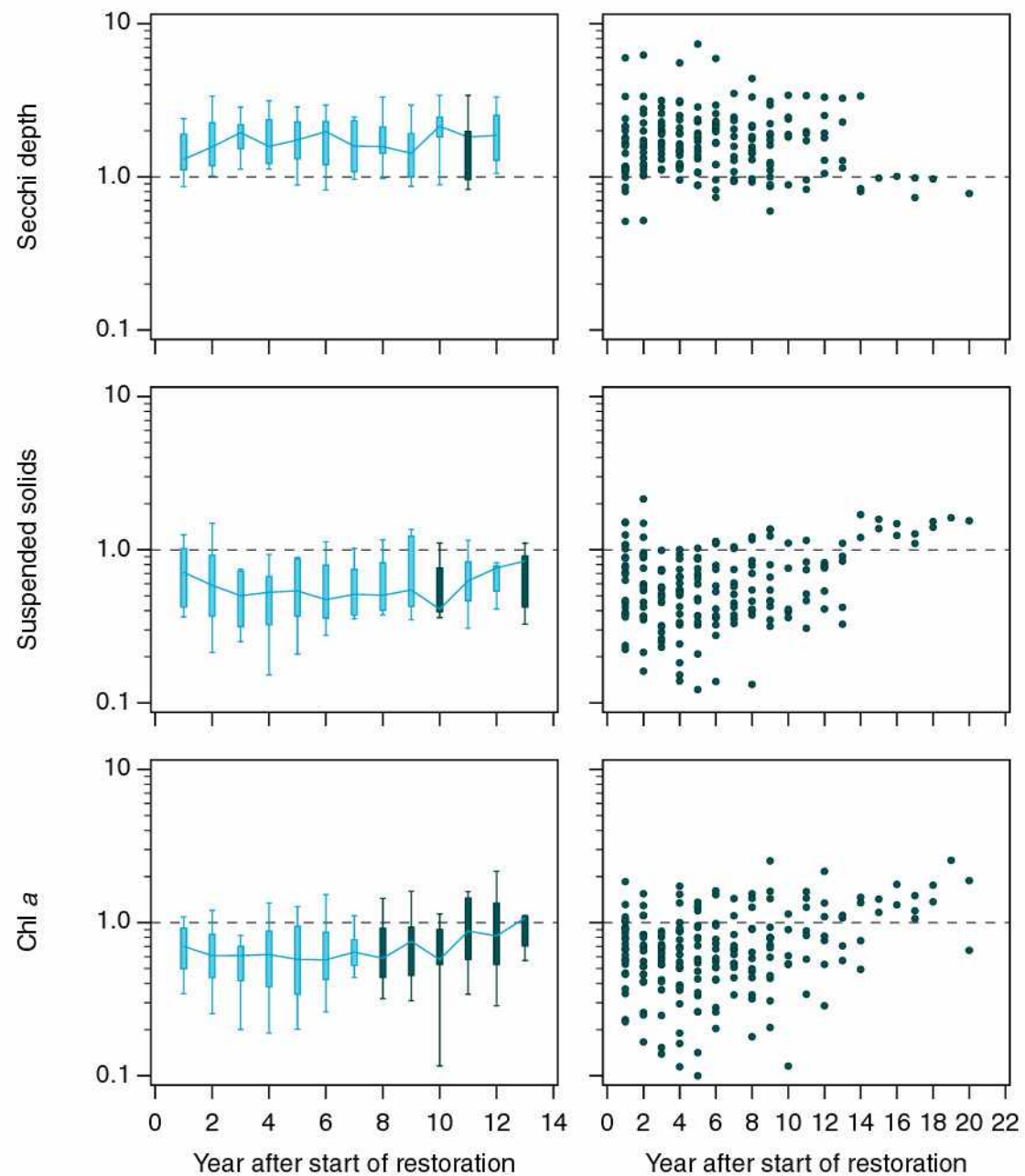
**Makes it more complicated to extract the effects of fish removal
contra the effect of reduced loading and internal P loading**

Presentation of data

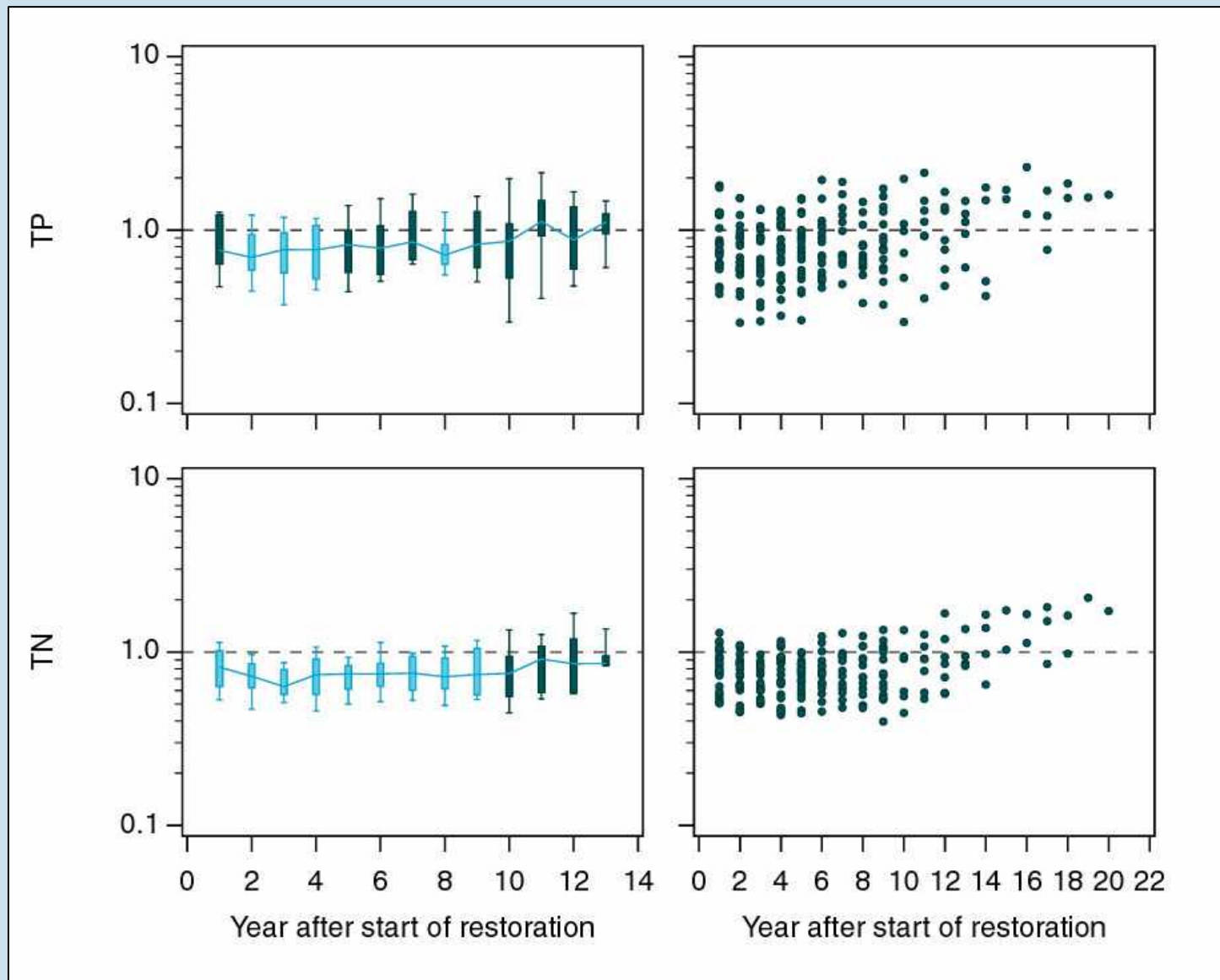
- Relative units (relative to before restoration)
- Significant difference marked with blue color
- log scale



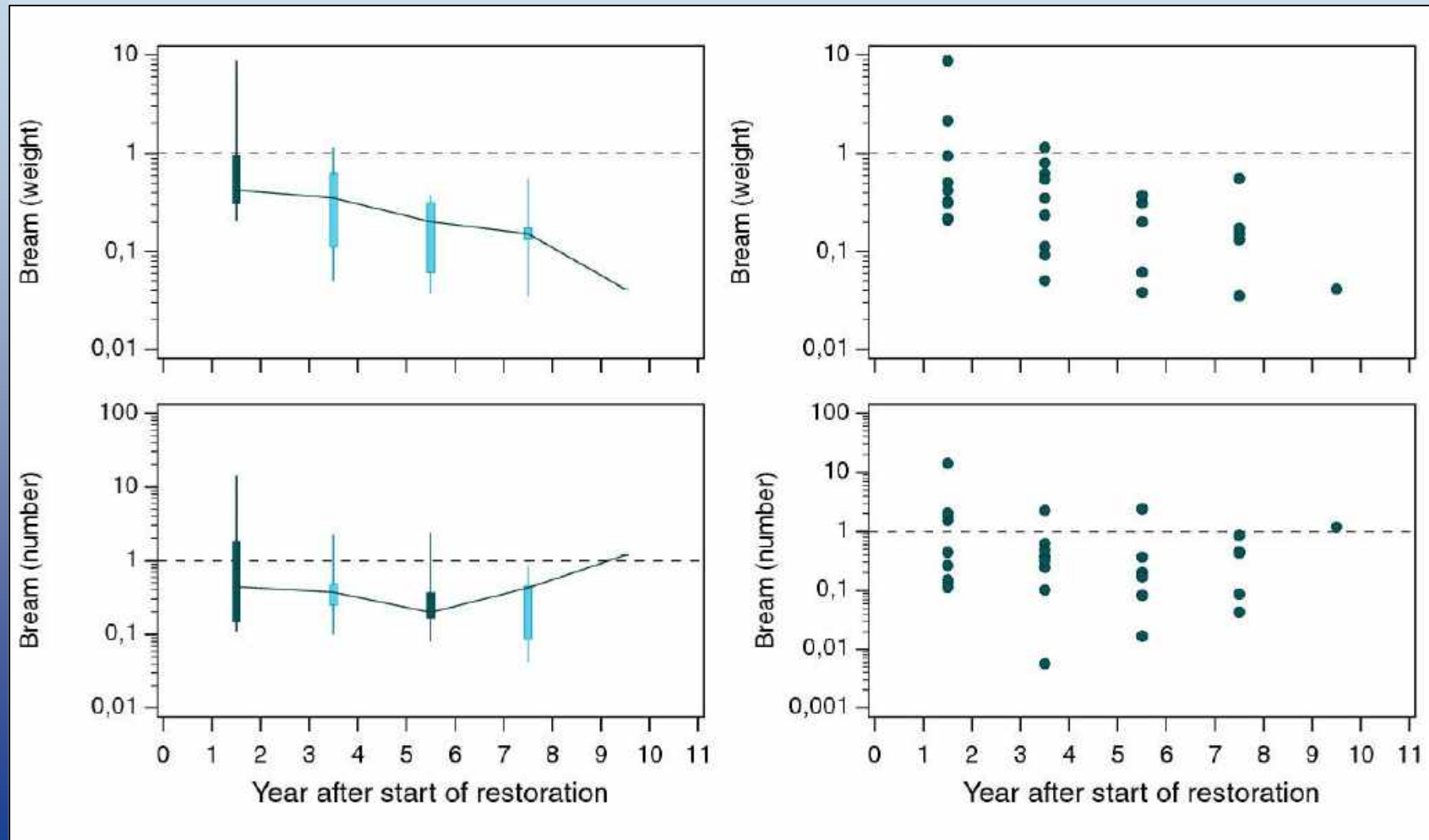
Secchi depth, suspended solids and chlorophyll a



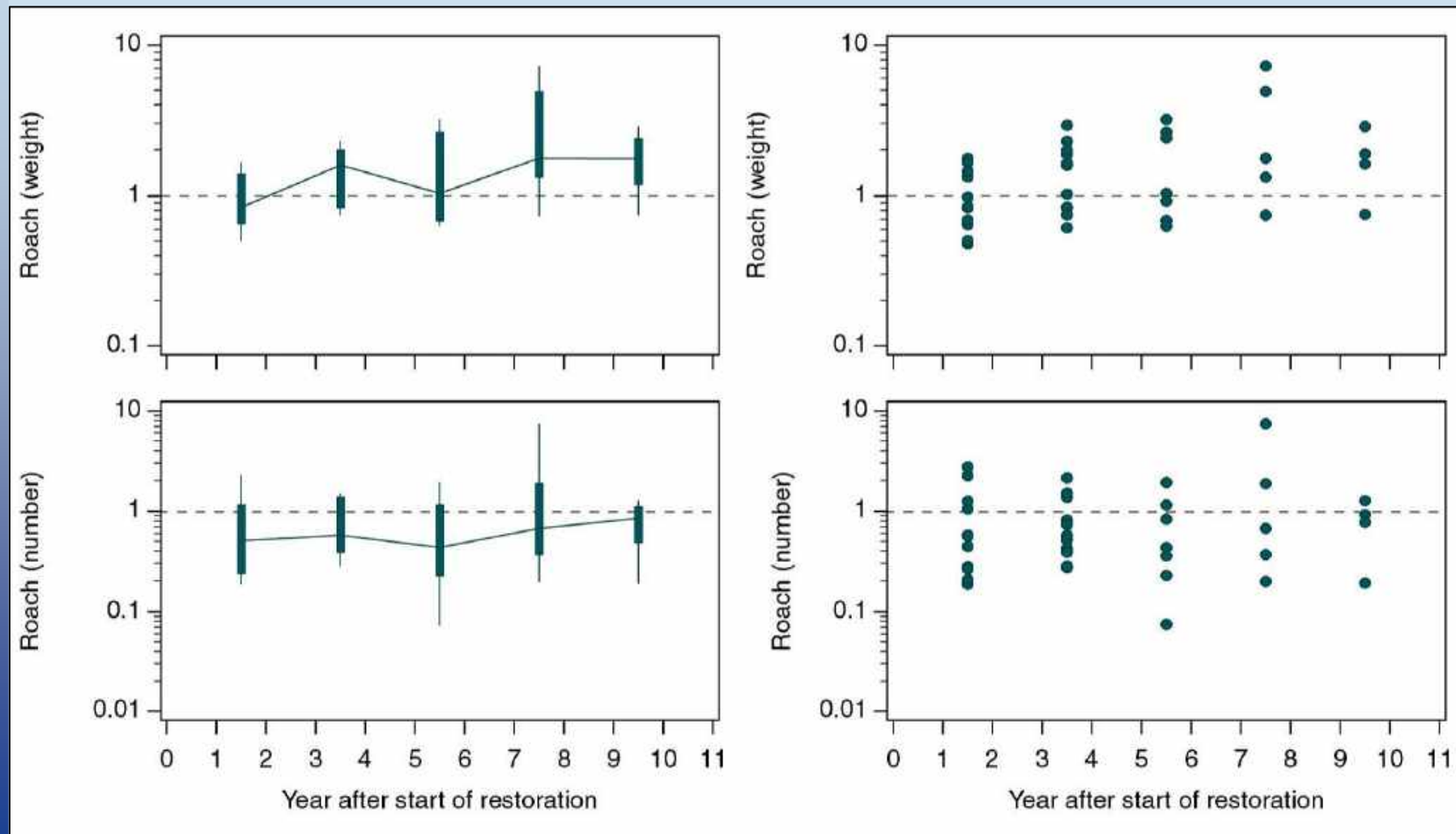
TP and TN



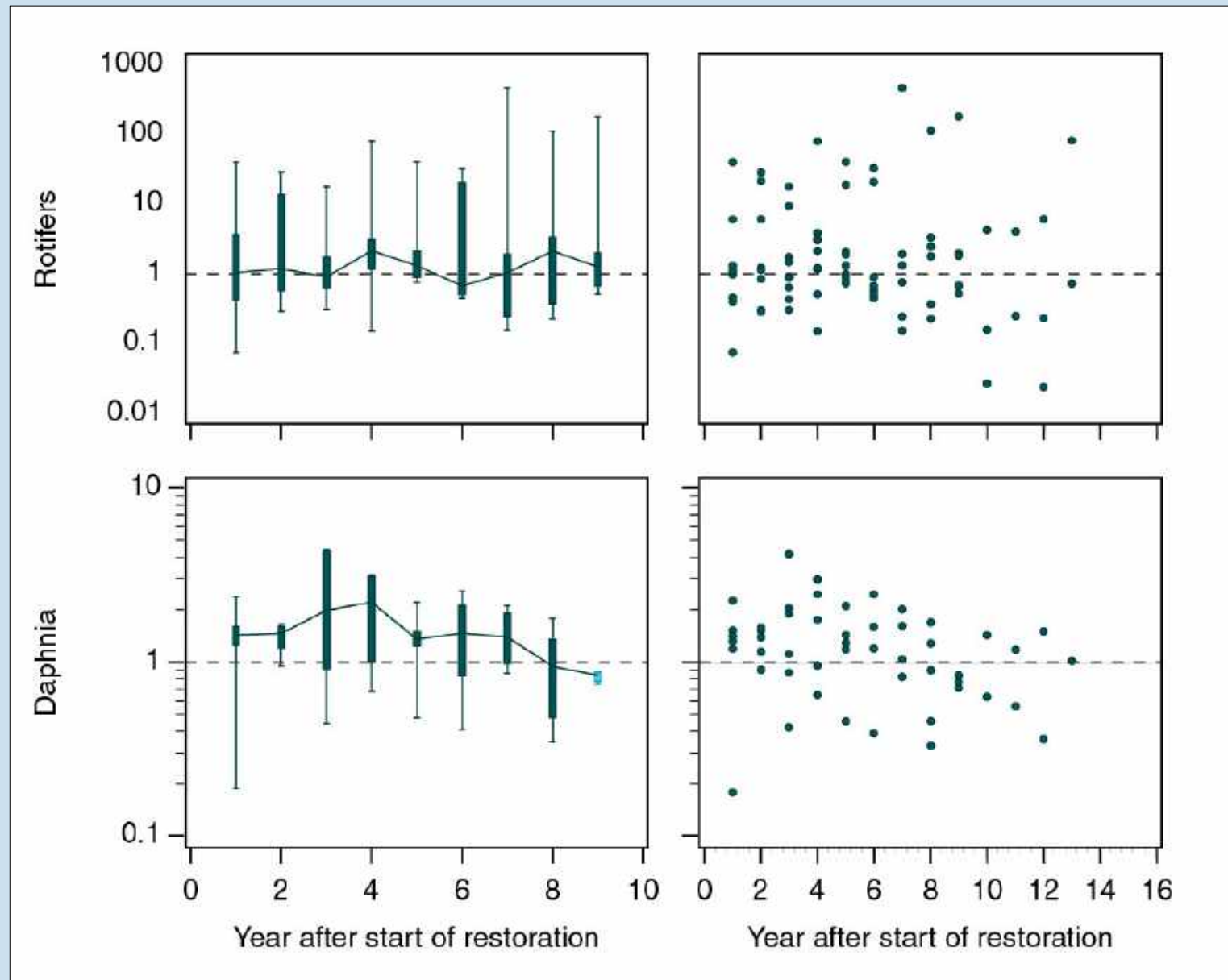
Fish (**bream** CPUE; weight and number)



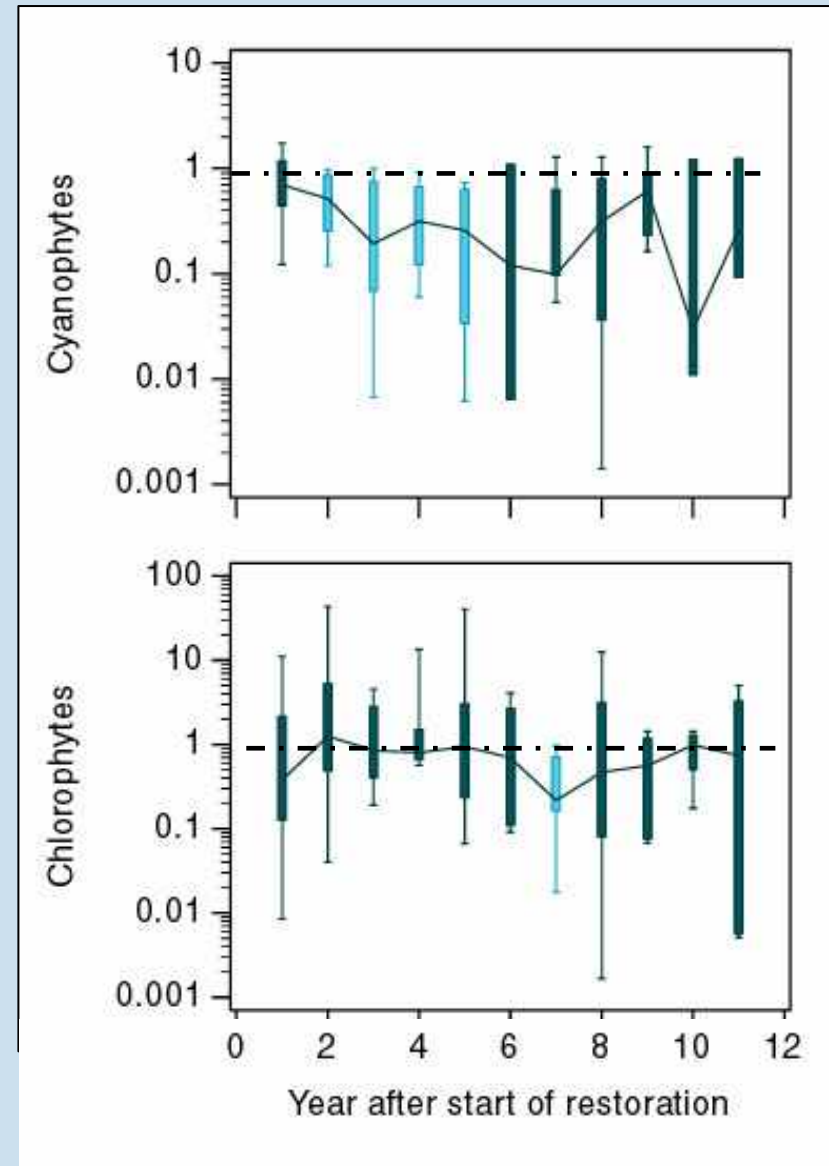
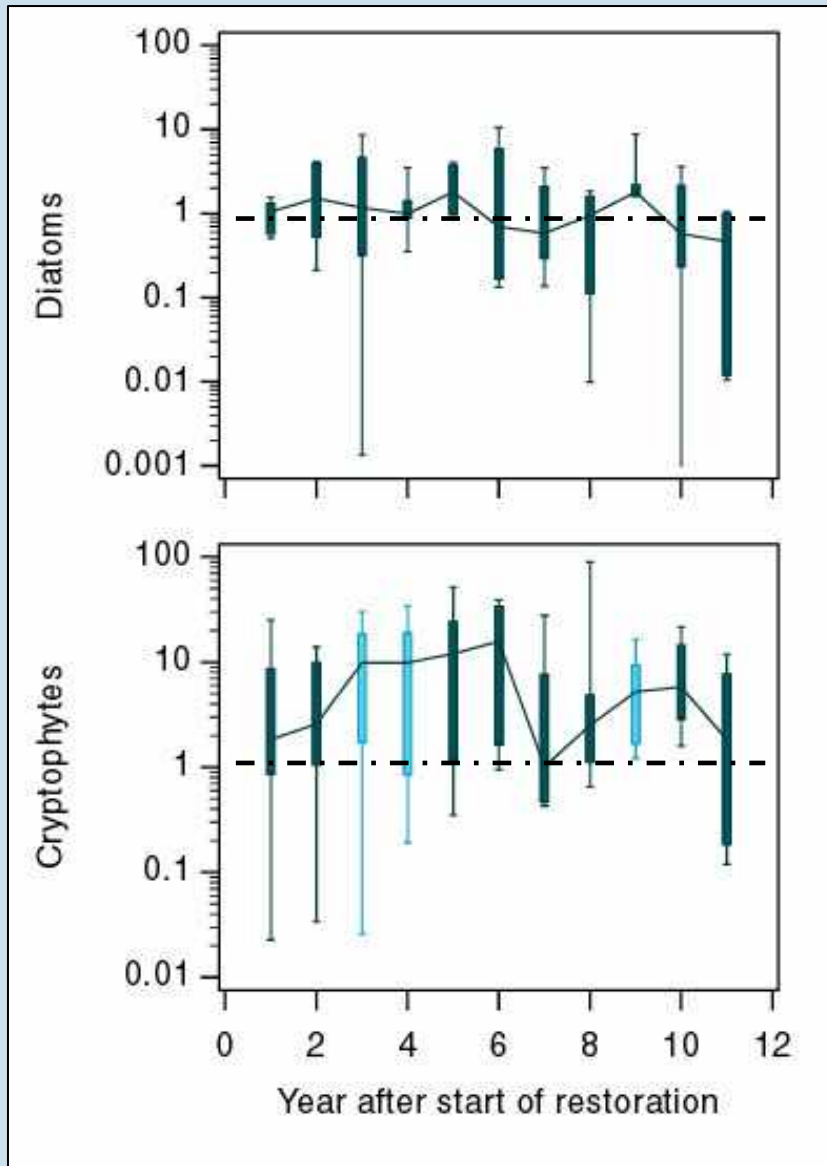
Fish (**roach** CPUE; weight and number)



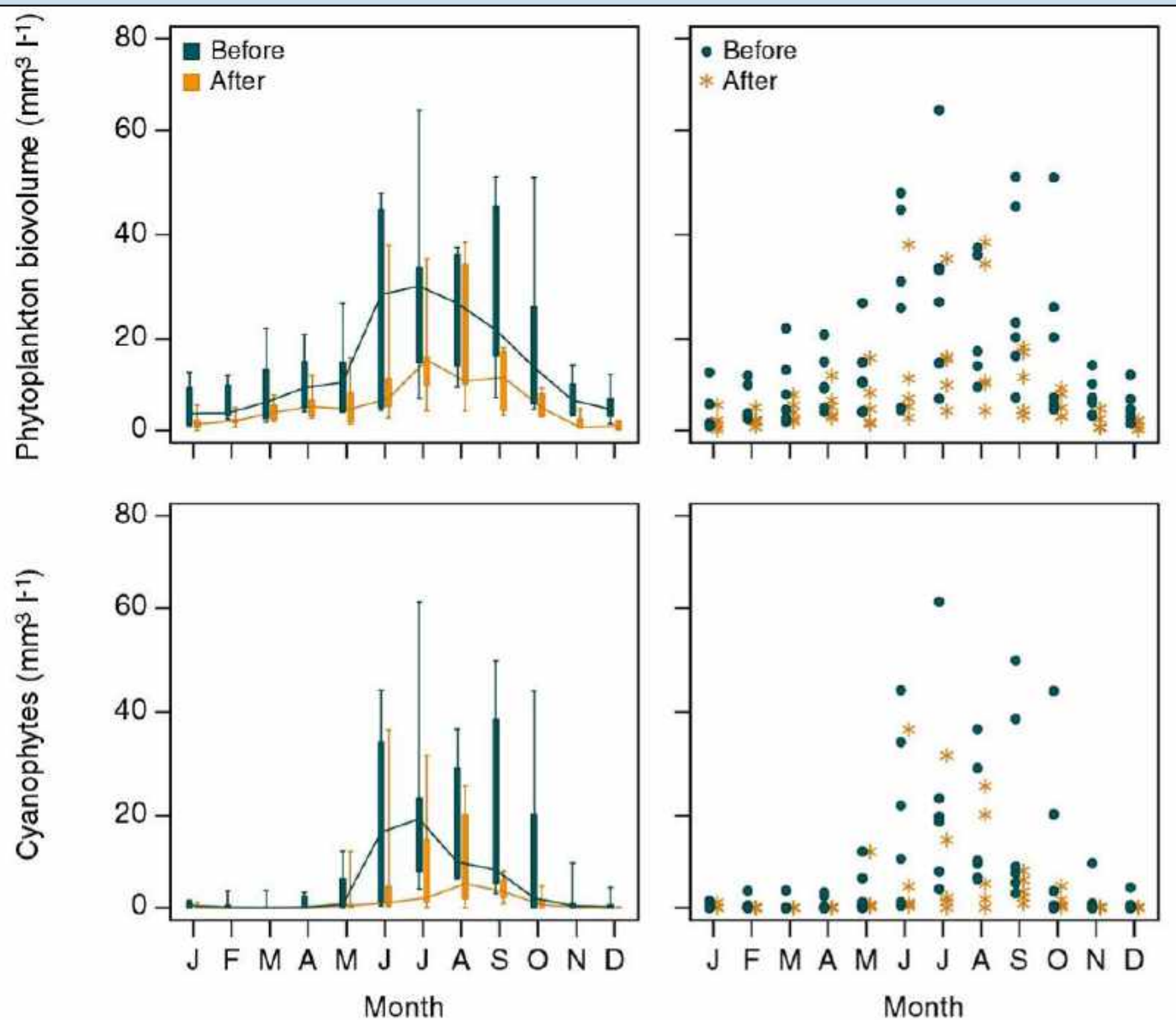
Zooplankton biomass



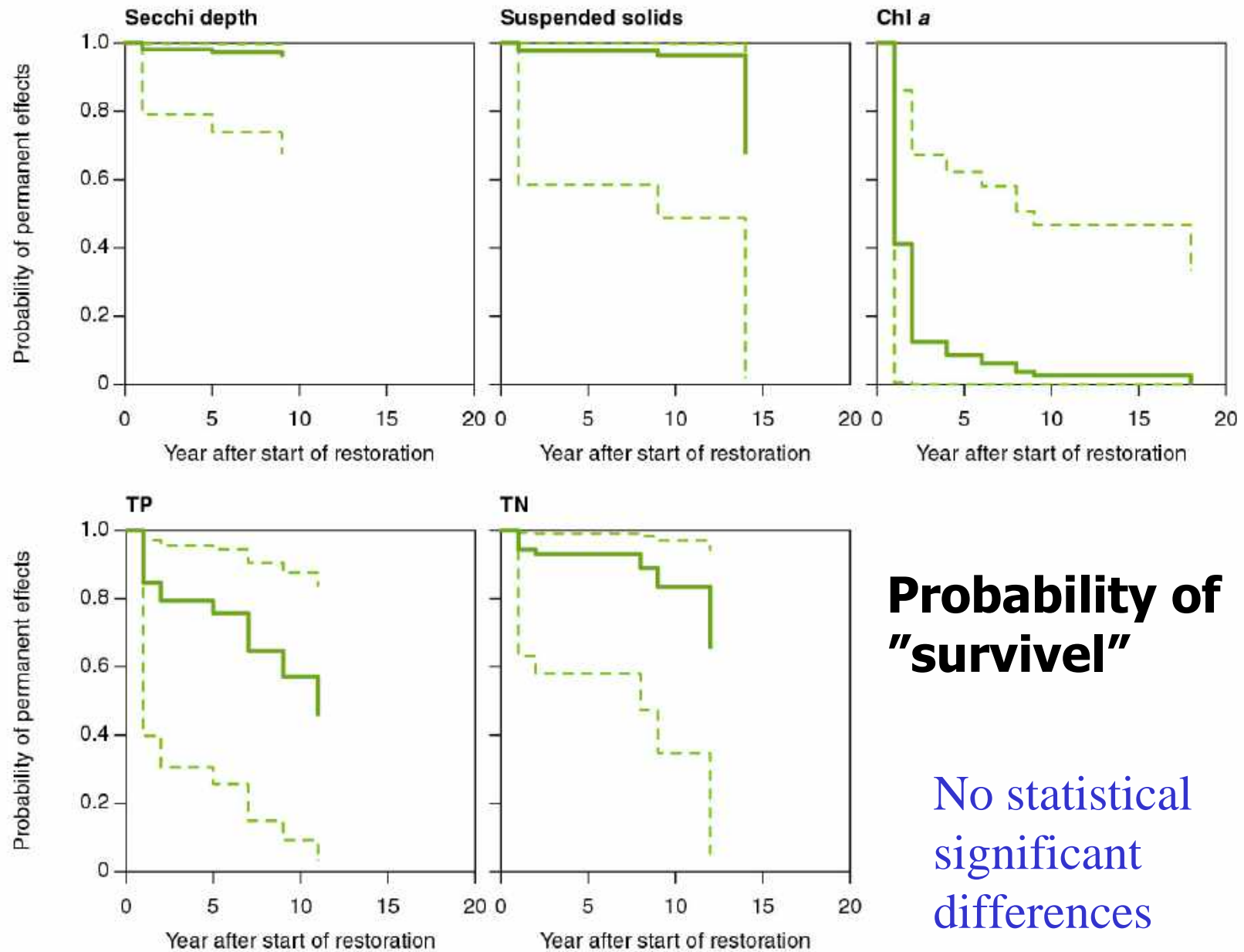
Biovolume of main phytoplankton classes



Seasonality of phytoplankton biovolume



**Absolute
units**



**Probability of
"survival"**

No statistical
significant
differences

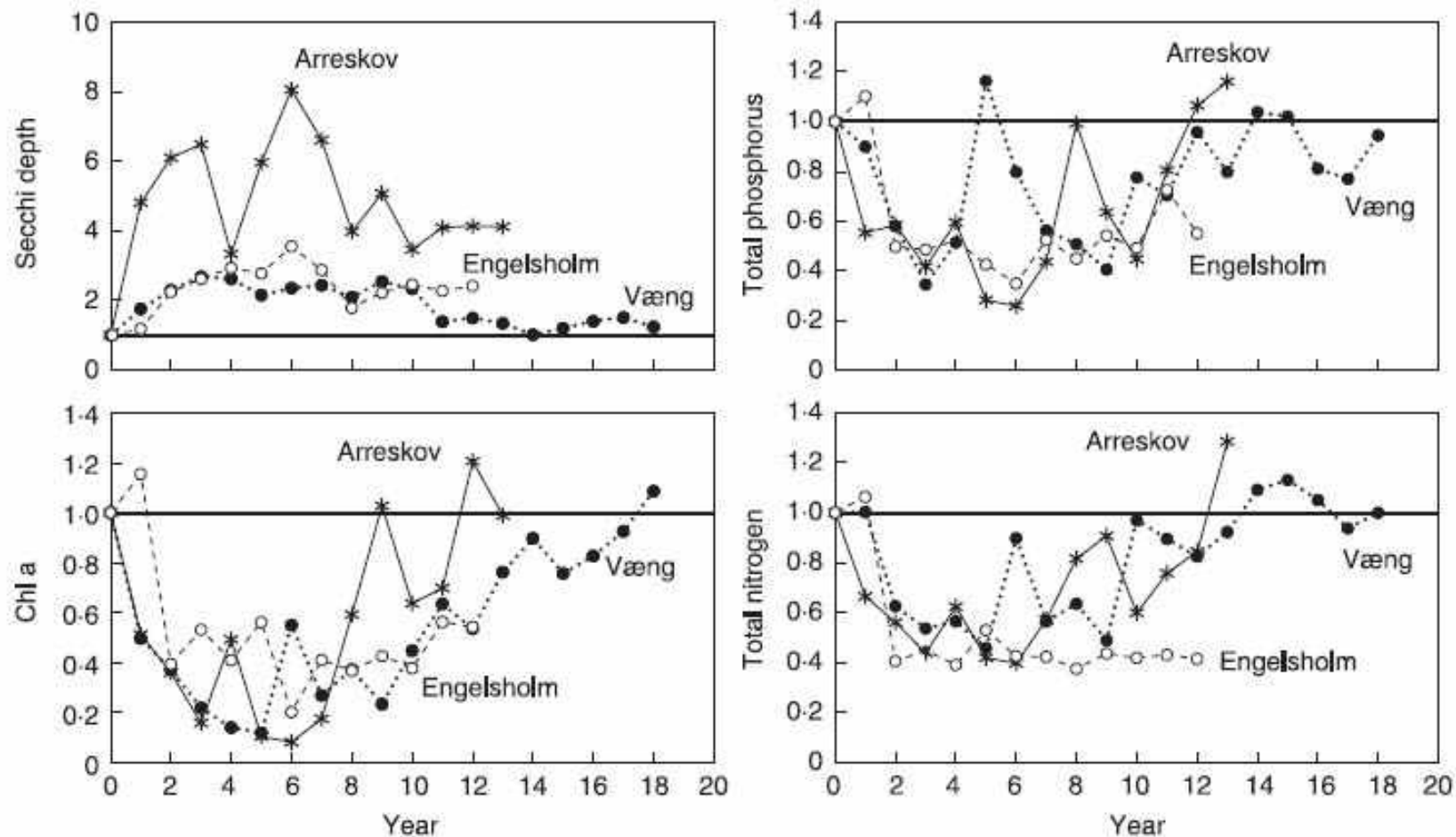
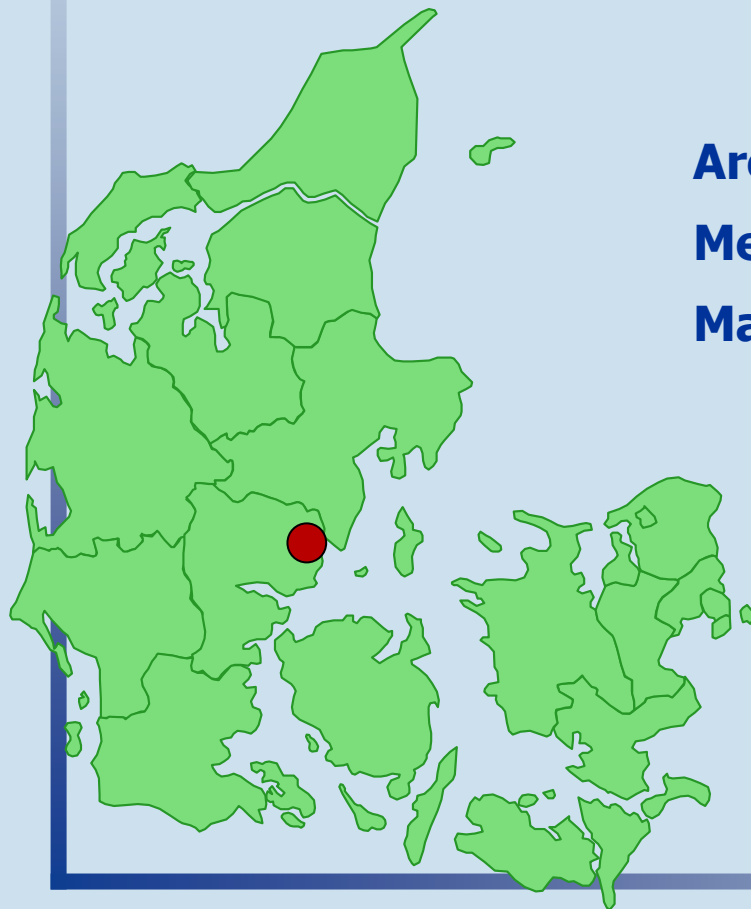


Fig. 1. Long-term changes in Secchi depth, chl a, TP and TN in three shallow Danish lakes, where at least 50% of the zooplanktivorous fish stock was removed within 1–3 years. The changes are relative and shown as the ratio of the value the current year to the pre-manipulation value. The pre-manipulation value is the mean of 1–4 years before the fish removal (= year 0) and based on summer means. The lakes are: Lake Arreskov (mean depth 1.9 m, area 317 ha, TP (year 0) 0.235 mg P L⁻¹, year 1 = 1992, submerged macrophytes reached a maximum of 60% in year 6); Lake Engelsholm (mean depth 2.6 m, area 44 ha, TP (year 0) 0.197 mg P L⁻¹, year 1 = 1993, submerged macrophytes largely absent throughout the period); Lake Væng (mean depth 1.2 m, area 16 ha, TP (year 0) 0.124 mg P L⁻¹, year 1 = 1987, for macrophytes see Fig. 2).

Lake Væng – fish removal

**180,000 (2.5 t) roach and bream removed
from 1986-88**

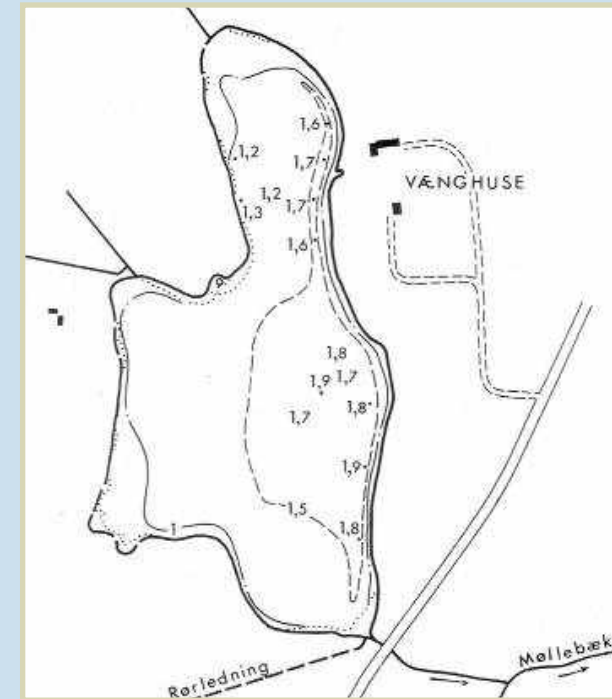
(= 50% of the total fish biomass)



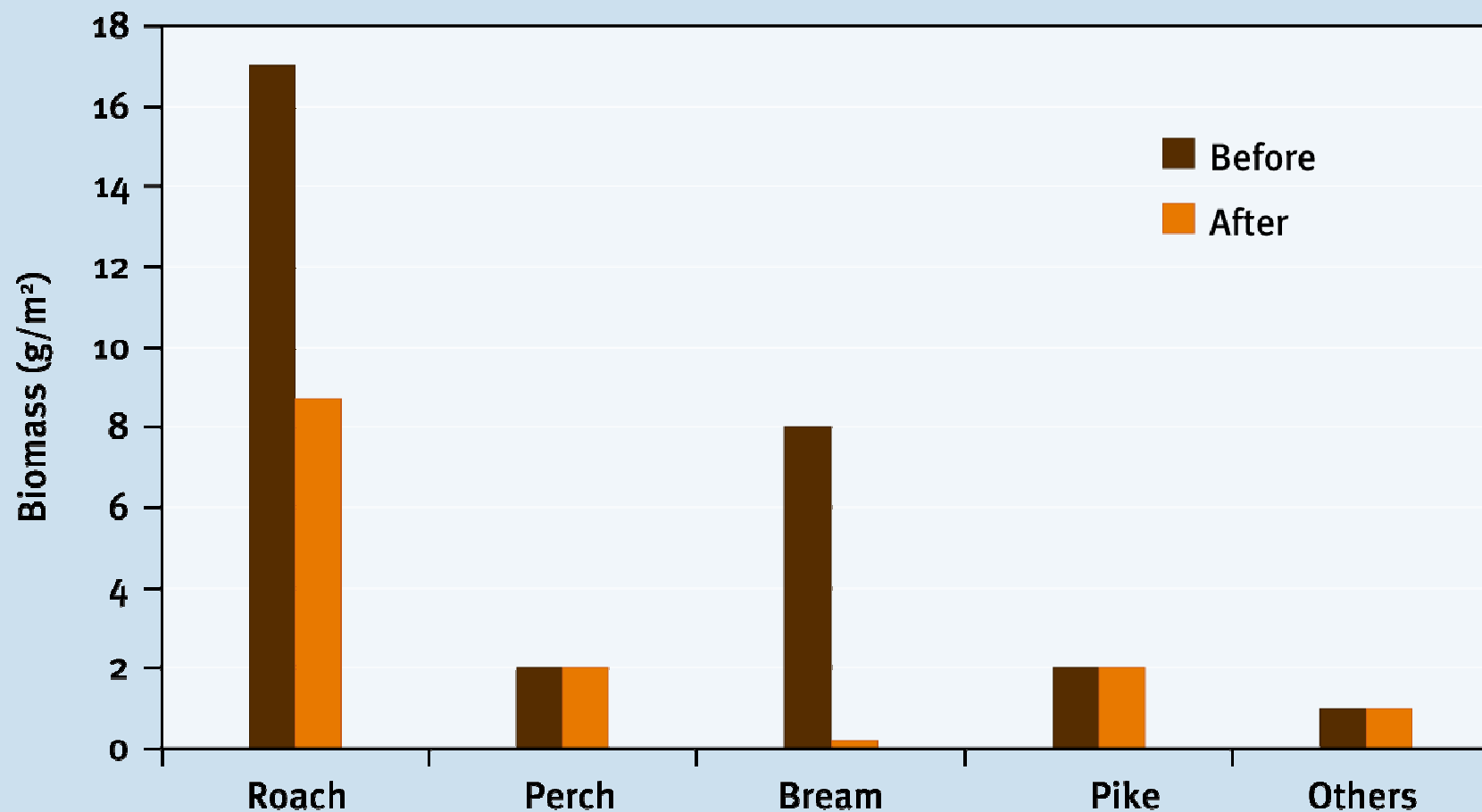
Area: 16 ha

Mean depth: 1.2 m

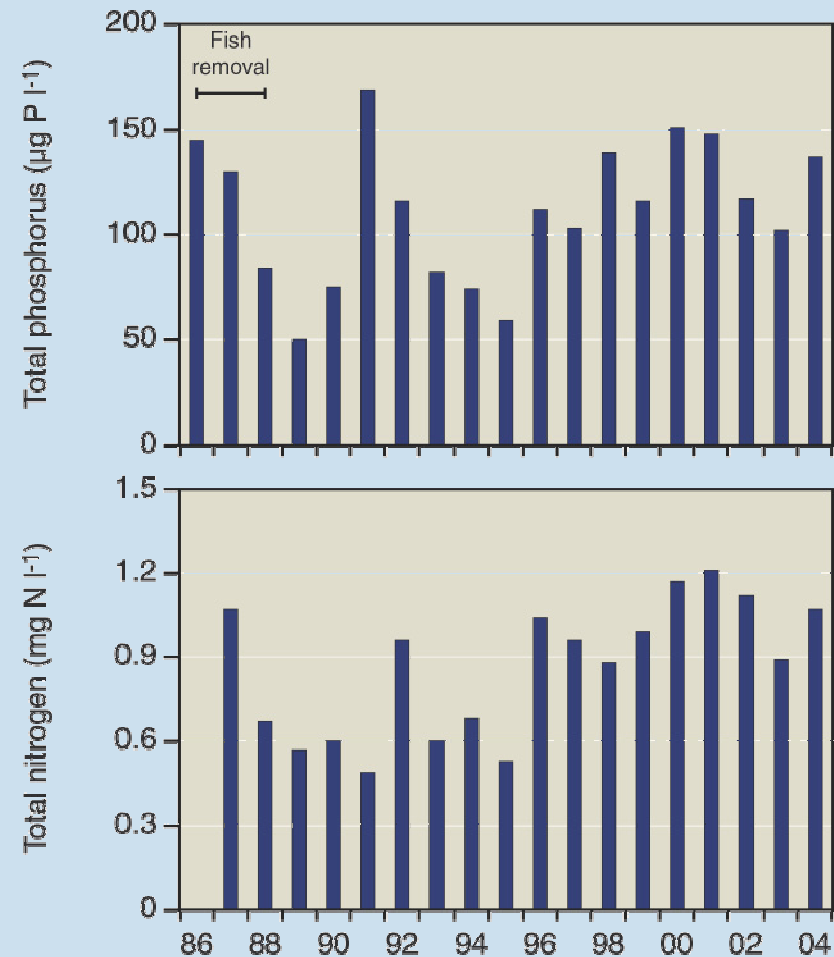
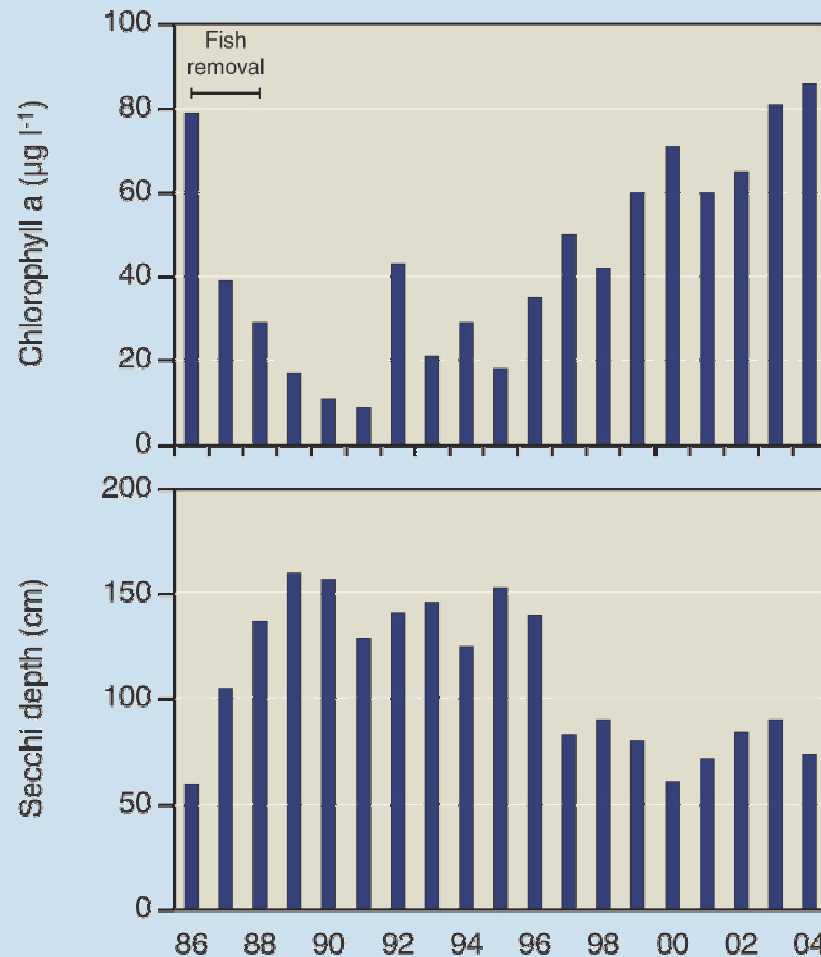
Max. depth: 1.8 m



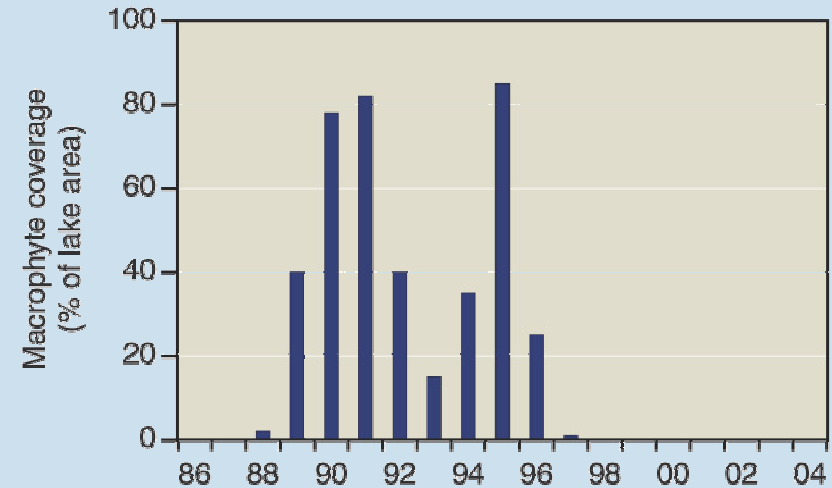
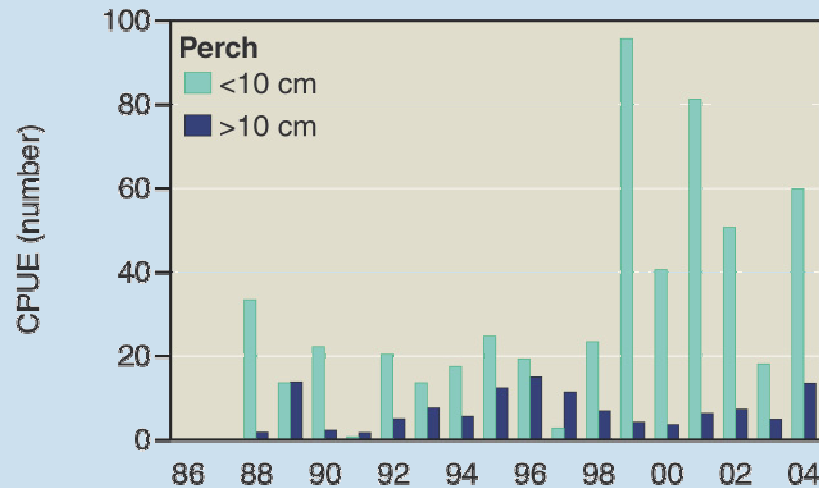
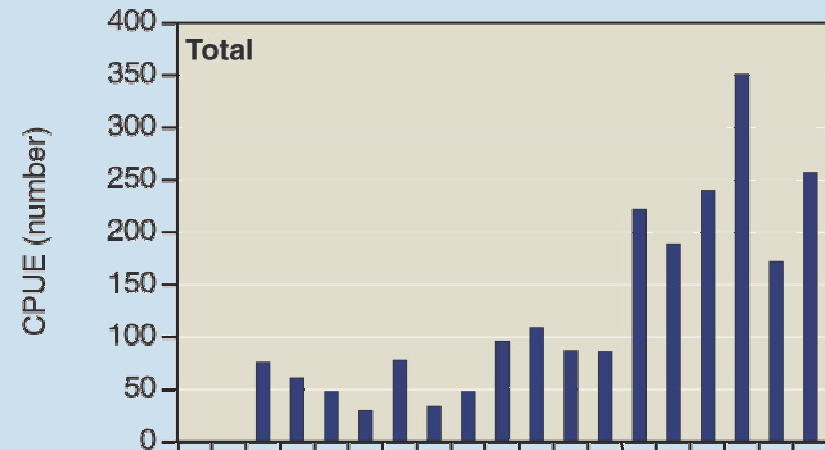
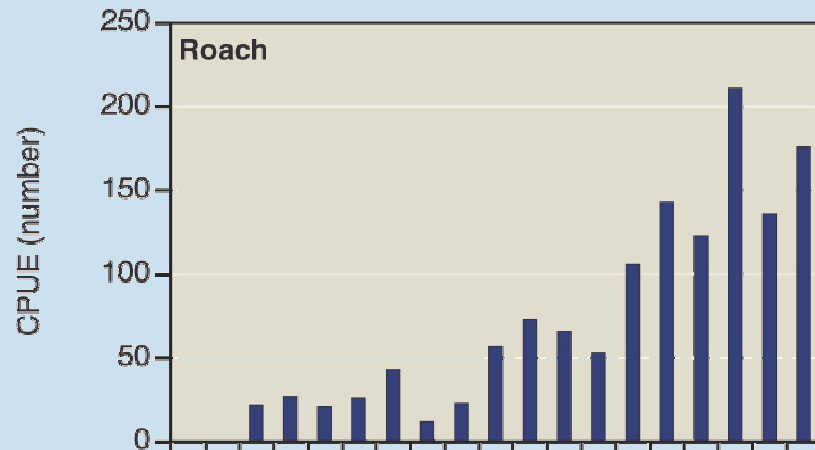
Fish biomass in Lake Væng before and after removal



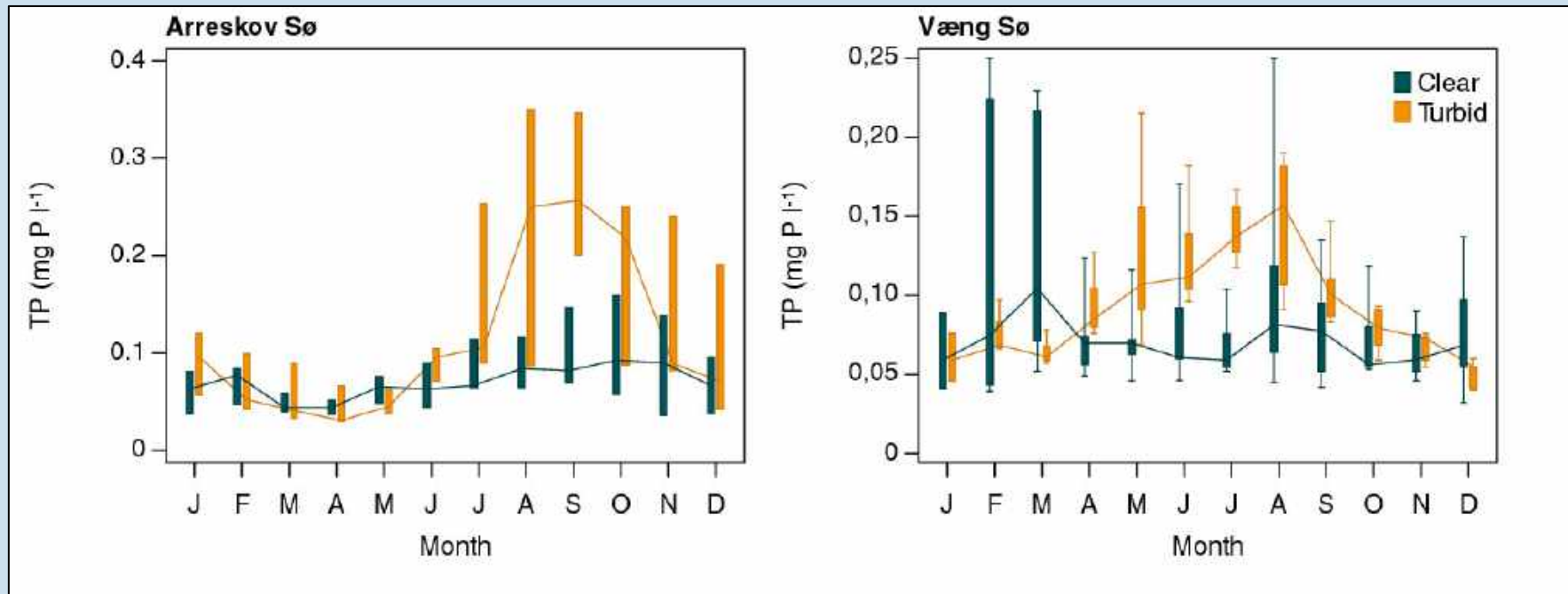
Chlorophyll, Secchi depth, TP and TN



Fish and submerged macrophytes



Seasonality of TP when going from clear to turbid conditions (absolute units)



Reasons for failures (fish removal)

- **Insufficient loading reduction**
- **Rapid return of zooplanktivorous fish, particularly roach**
- **Invertebrate predators (*Neomysis/Leptodora*)**
- **High resuspension of loose sediment**
- **Internal P loading from a sediment pool**
- **Instability due to low macrophyte coverage**

Biomanipulation suuuuucks.....

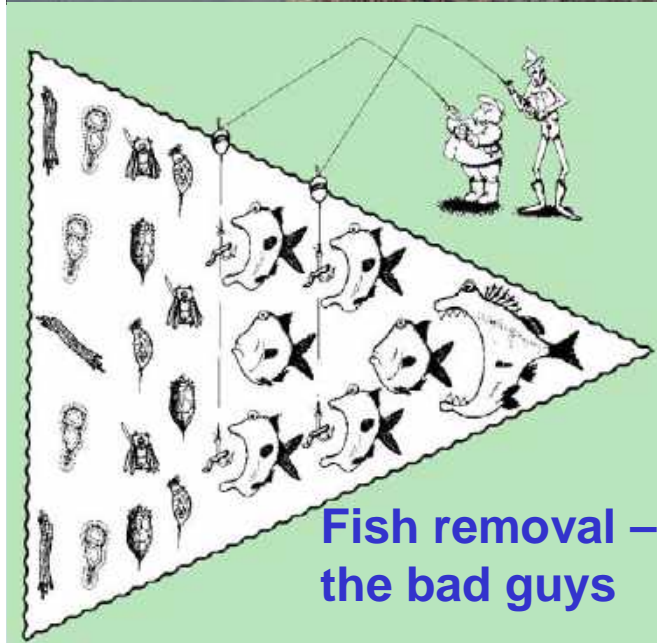
not fully --repeated measures

Lake restoration – several talks this week

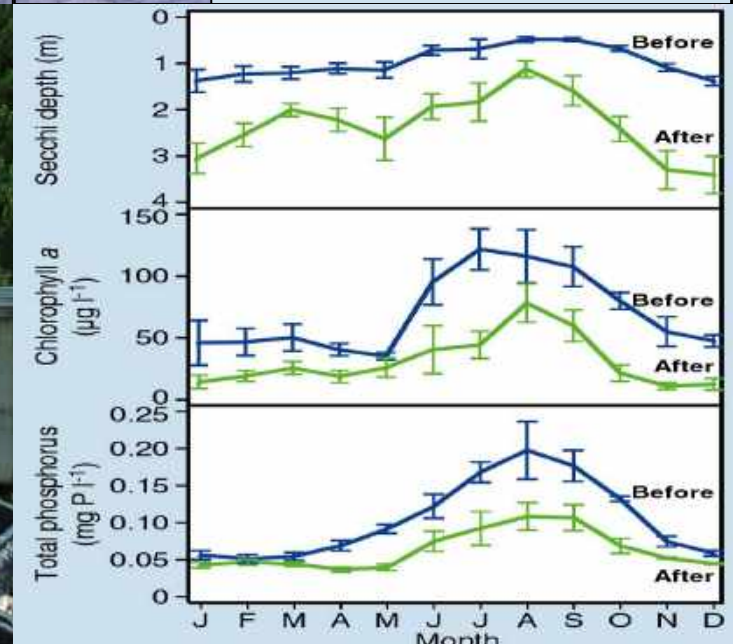
Removal of sediment



Adding Aluminium



Fish removal –
the bad guys



Alum addition

Lake	Year
Lyngby Sø	1974
Sønderby Sø	2001
Kollelev Mose	2003
Frederiksborg Slotssø	2005
Nordborg Sø	2006

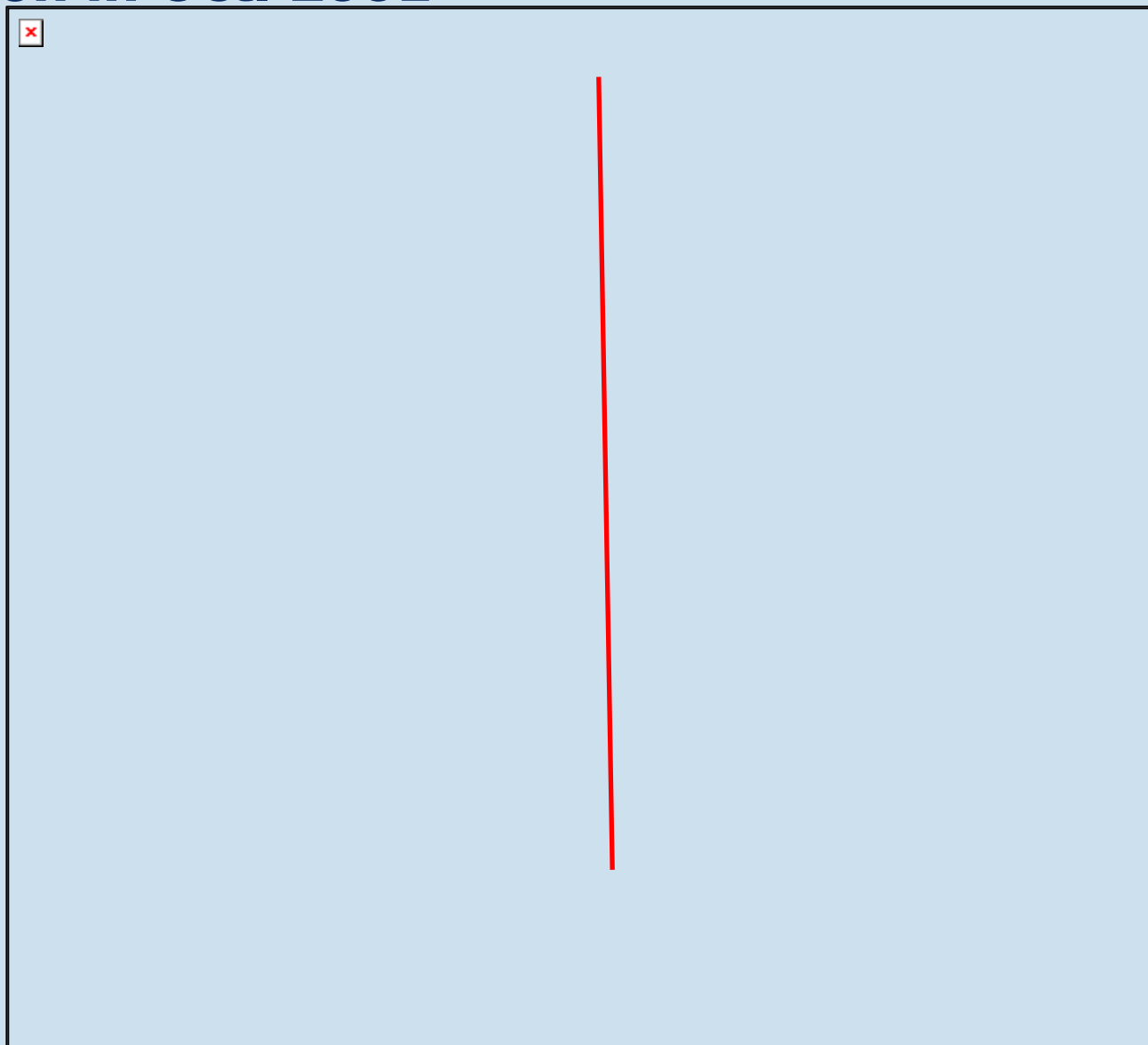


Principle: Al is added to increase the sorption of phosphorus in the sediment and decrease the internal loading of phosphorus

Different methods of AI adding. Here after a small boat

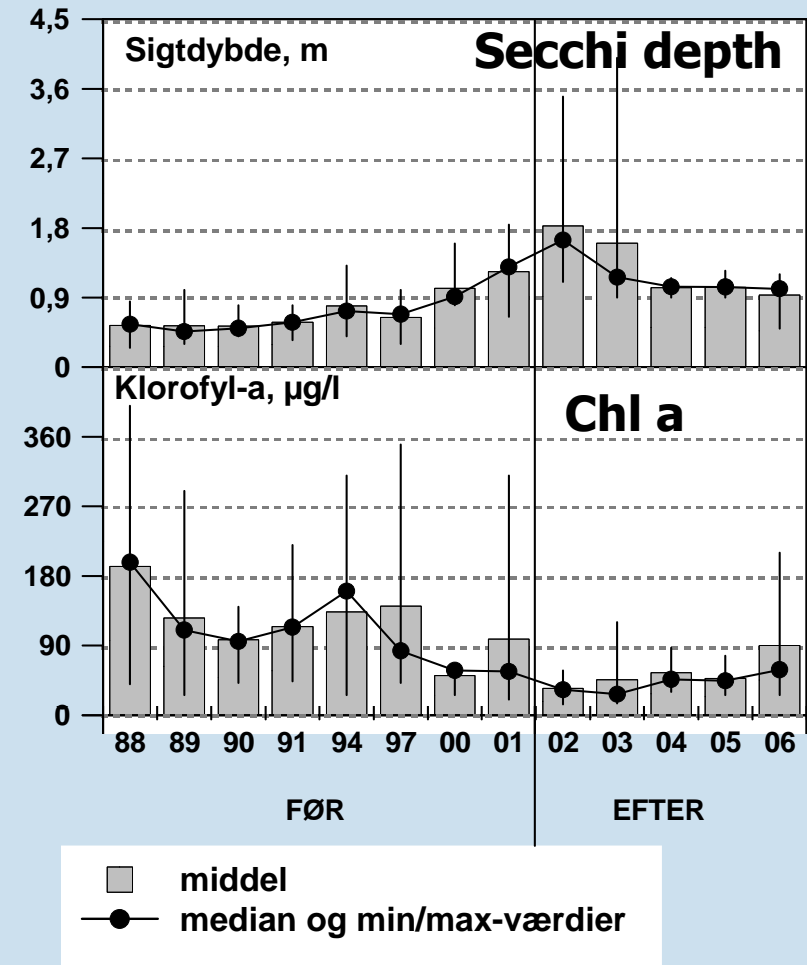
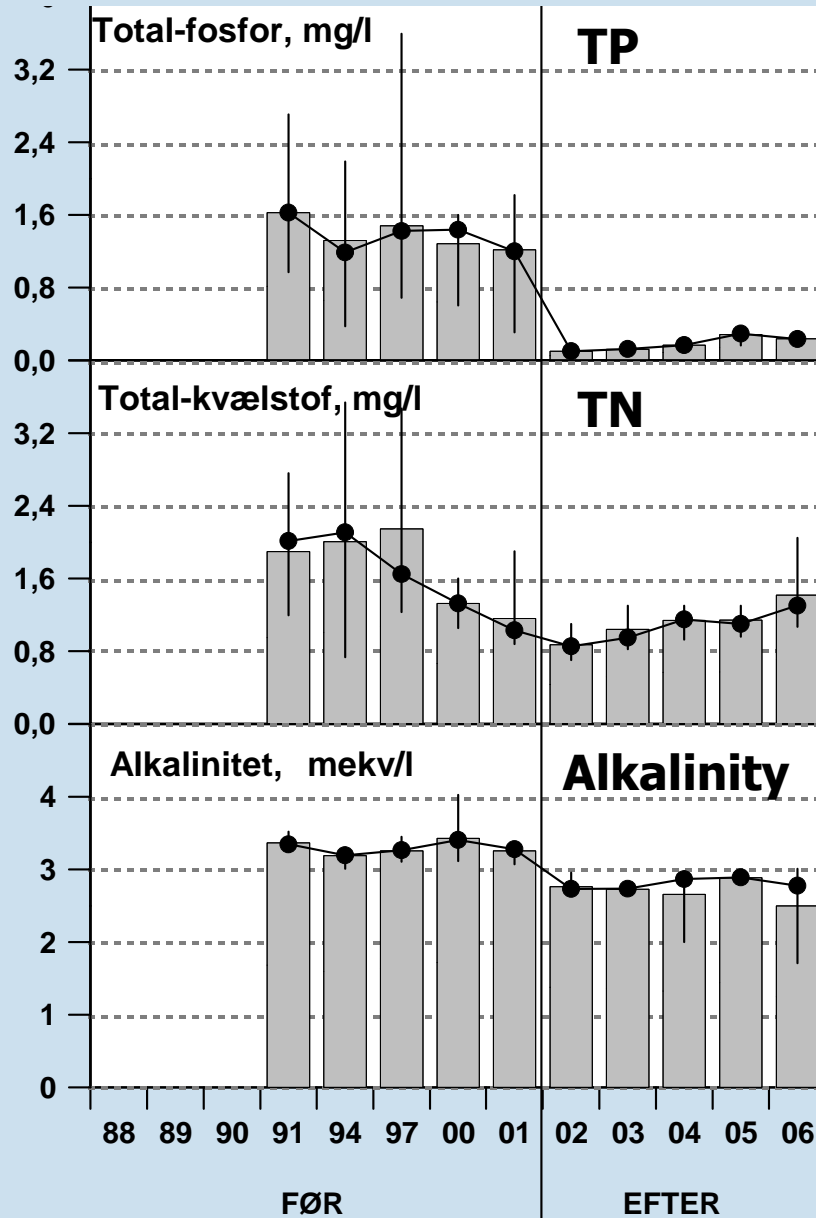


TP and PO₄-P in Lake Sønderby before and after Al addition in Oct. 2001



Fra: Jonas Hansen (Fyns amt)

Surface water of Lake Sønderby during summer 1988-2006



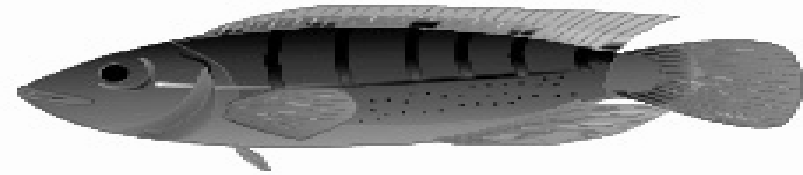
Fra: Jonas Hansen (Fyns amt)



2/3 sep

Allied attack (Moss et al)

**Eutrophication and climate change
goes hand in hand – synergistic
effects**



Length breeding and growing seasons
Annual reproductive investment
Reproductive events per year
r-strategists

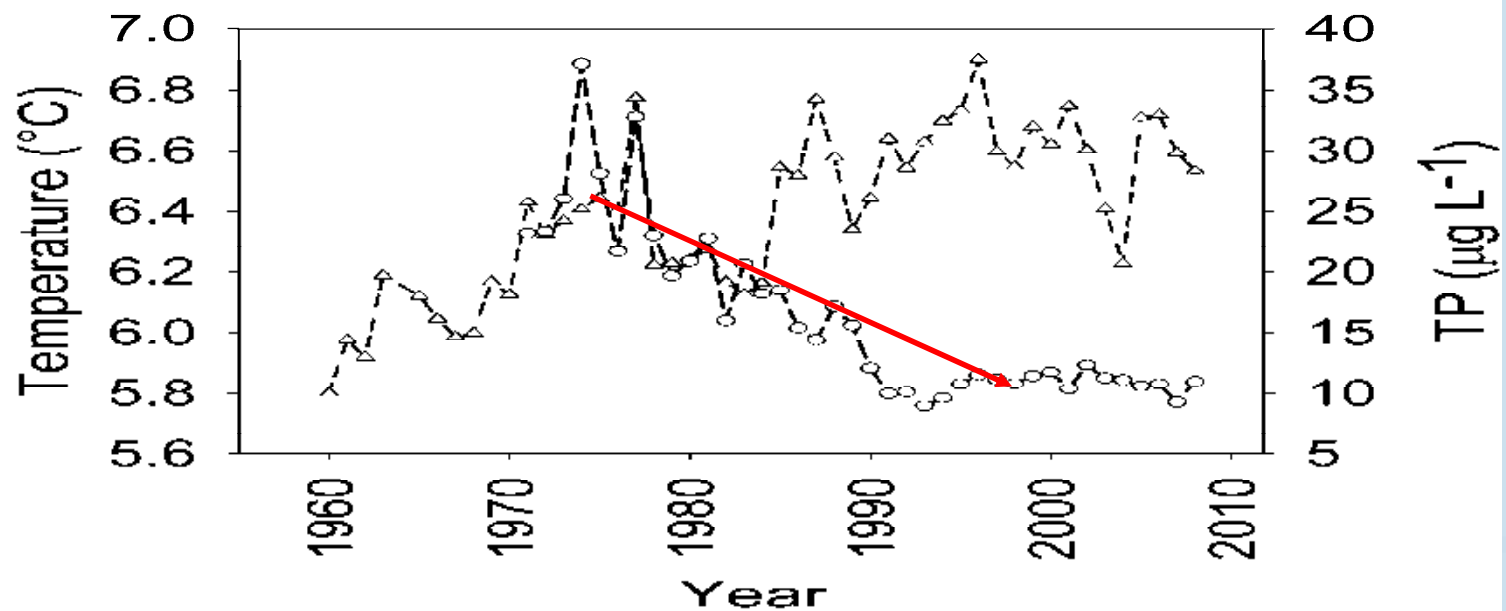
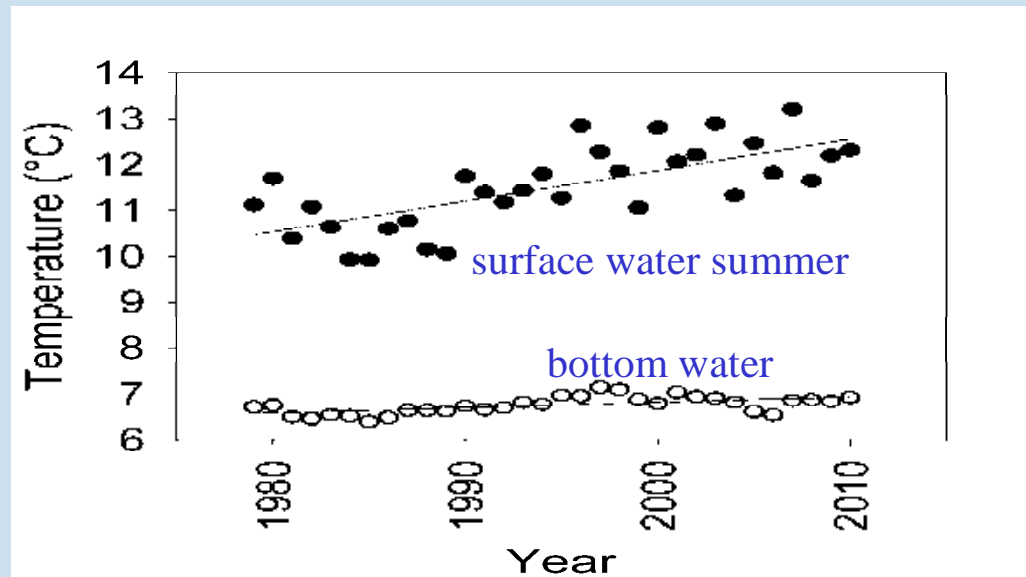
Reproductive lifespan
Age and size at maturity
Longevity
K-strategists



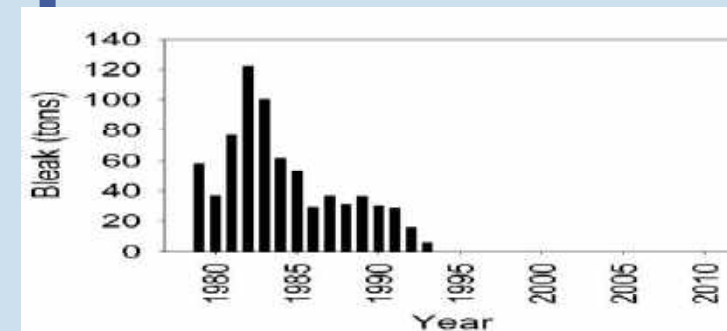
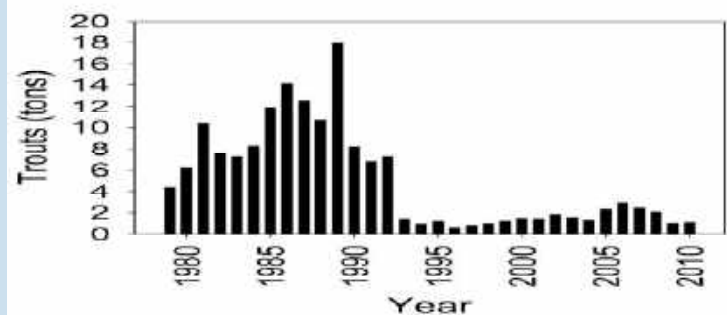
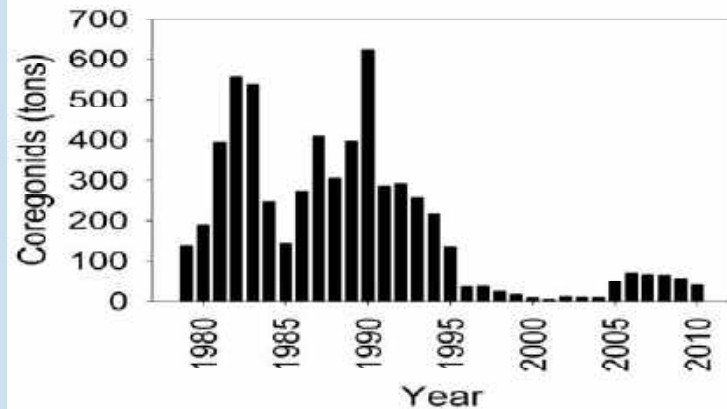
Latitude

Temperature

Lago Maggiore

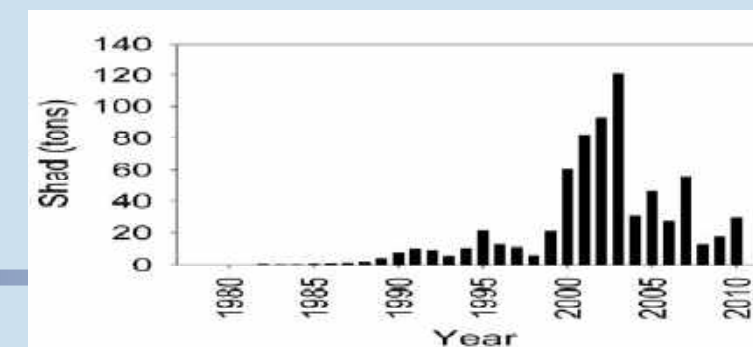
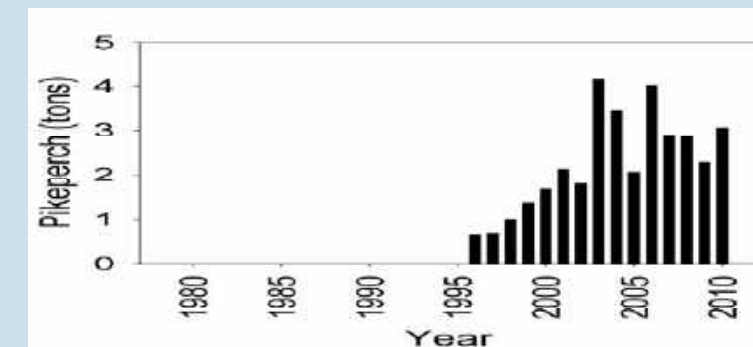
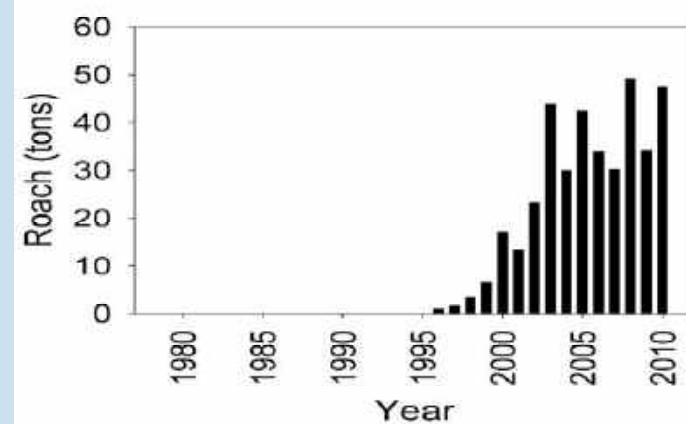


cold water
low nutrient taxa

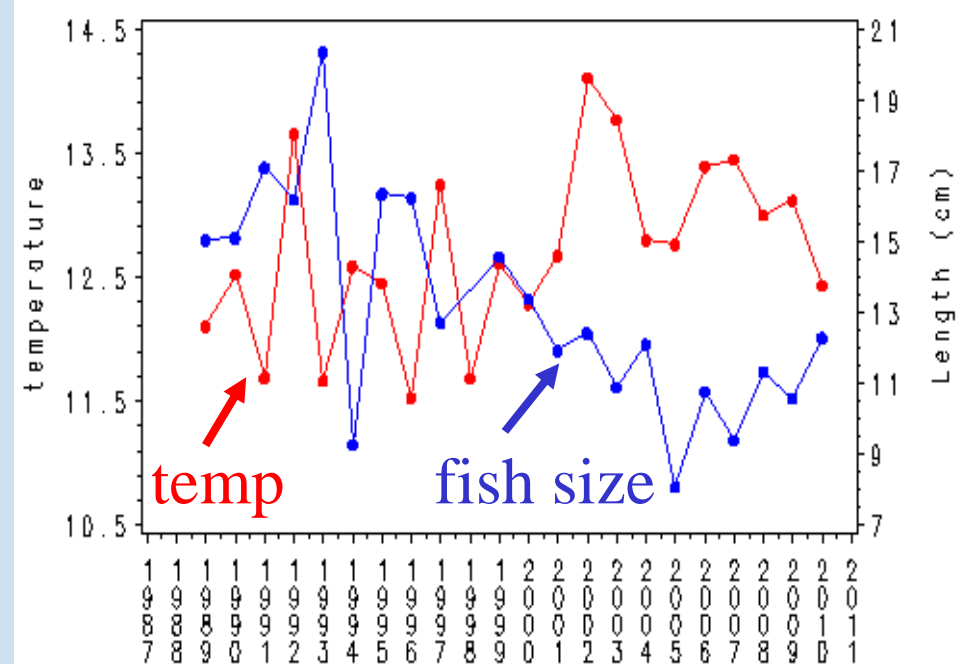
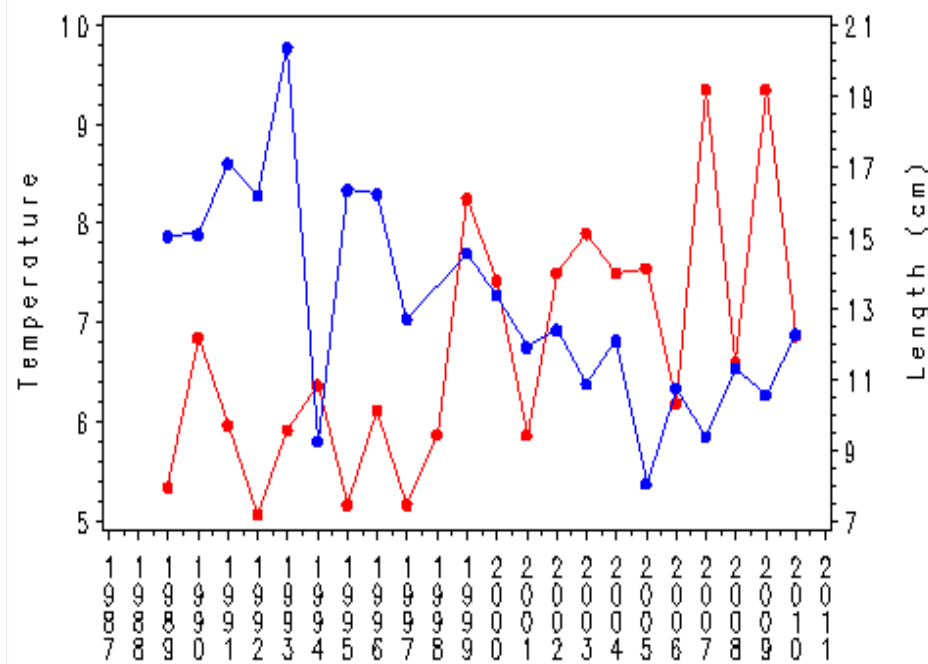
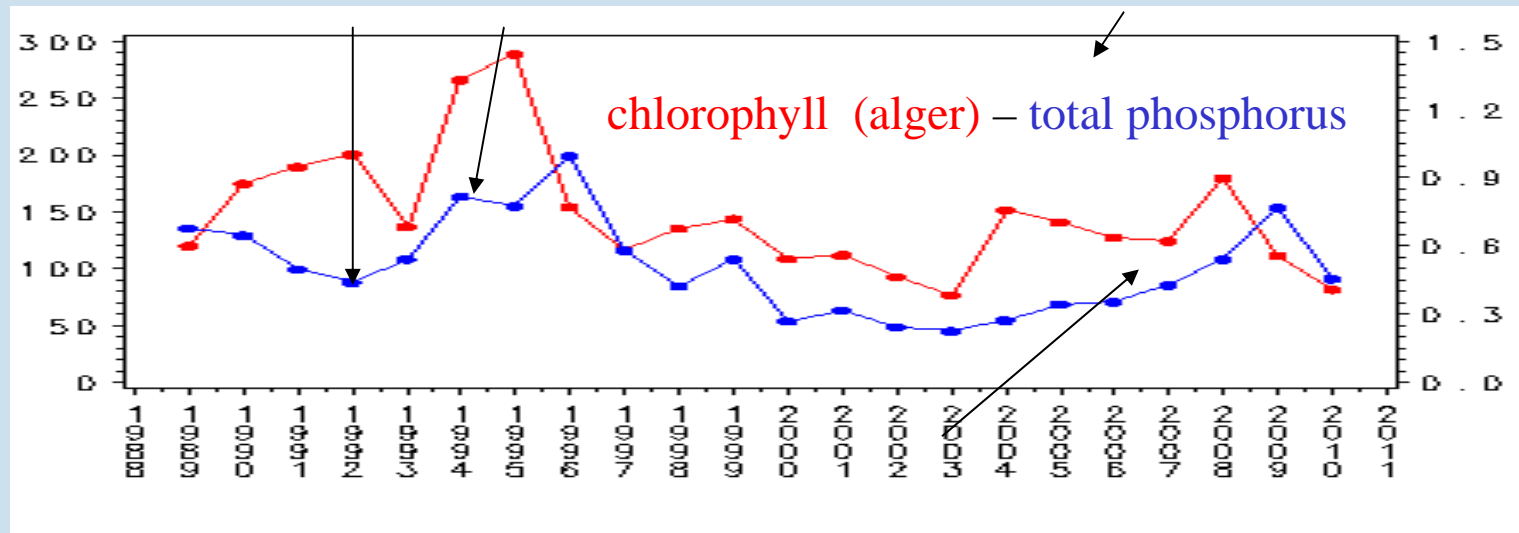


,

warm water
high nutrients taxa



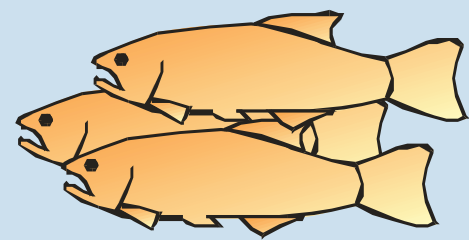
Lake Søbygård, Denmark



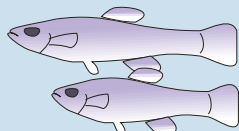
Many small fish in warmer countries (Uruguay)



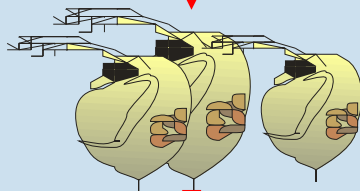
Danish lake in balance



fish eating
fish



prey fish



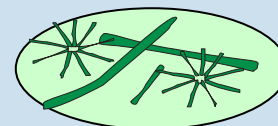
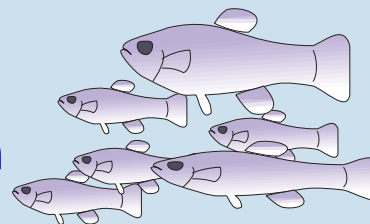
water flea



algae



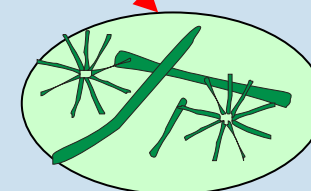
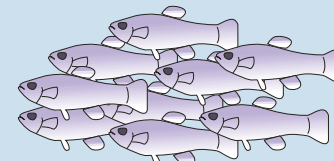
Degraded Danish lake



Nutrients



Warm lake



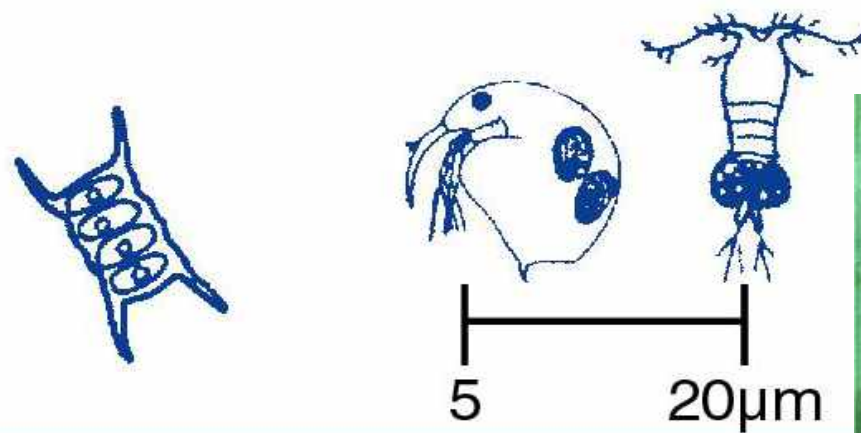
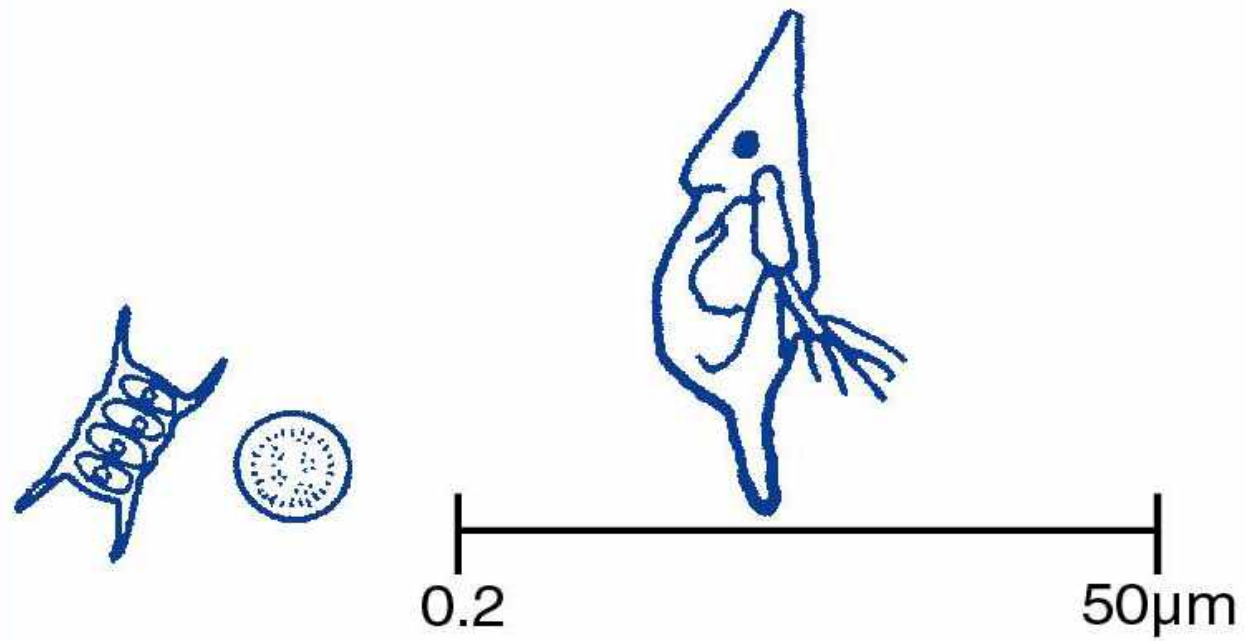
Many small fish

**Few piscivores
fish**

**Then life is bad
for the large**

Daphne

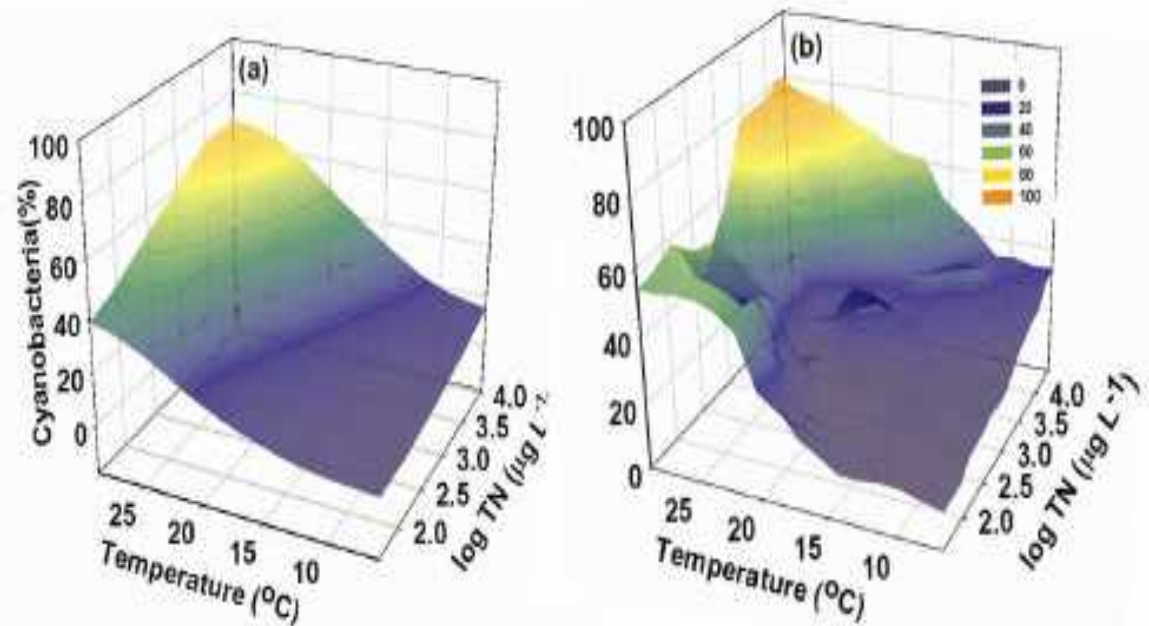
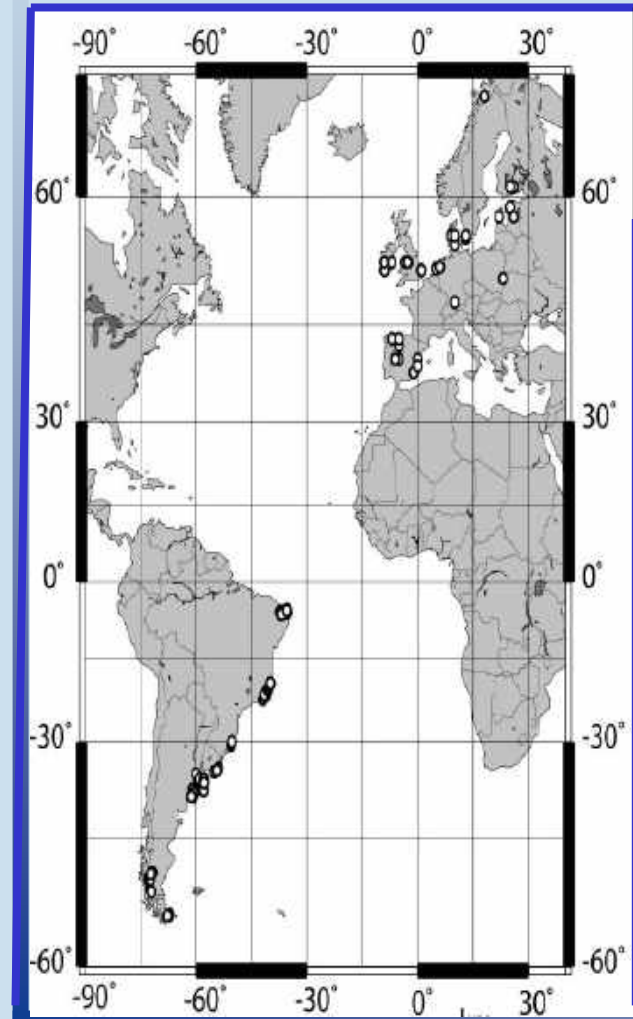






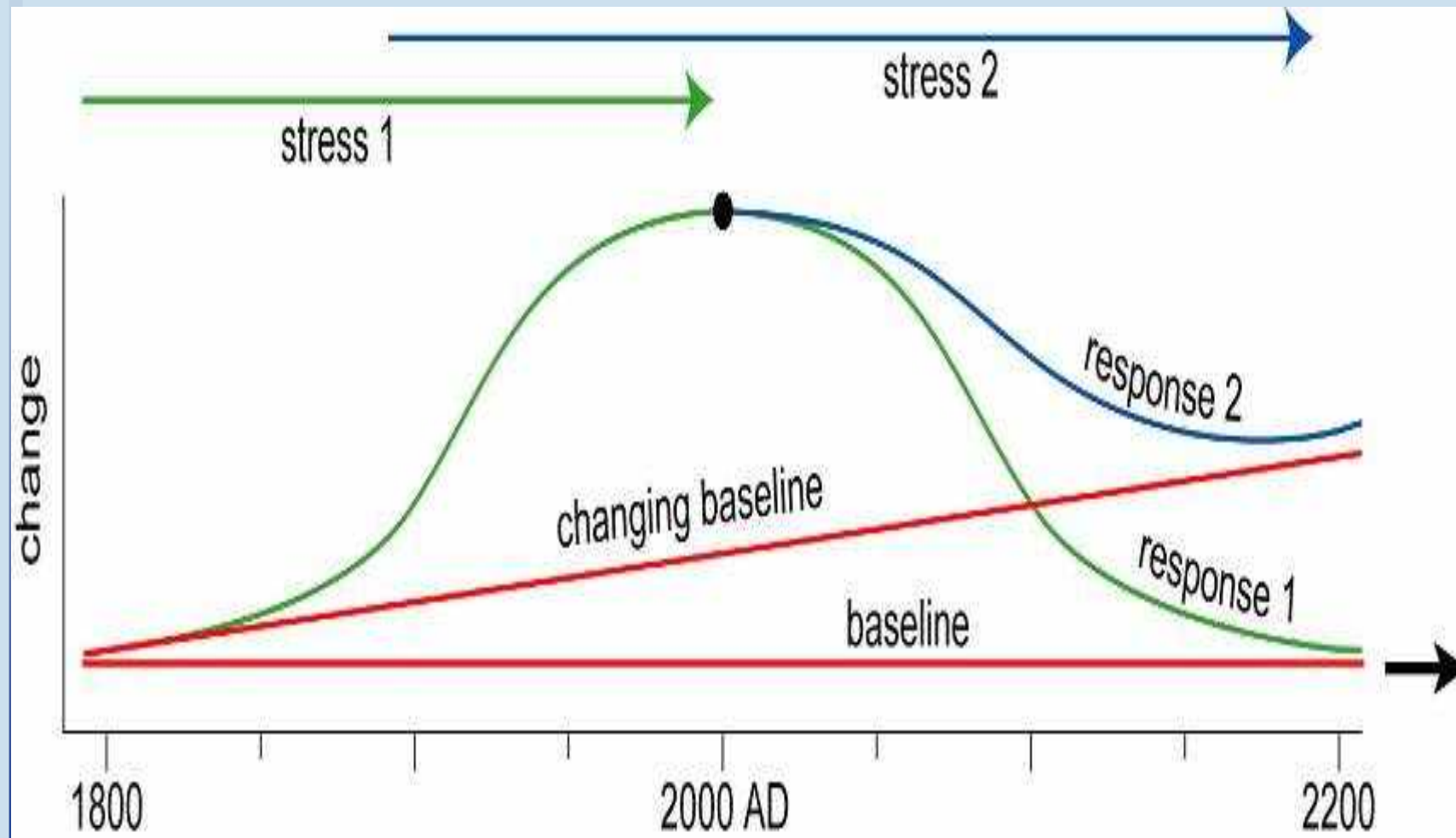
CE van Ginkel
Resource Quality Services
Department of Water Affairs &
Forestry

SALGA and ECOFRAME-lakes



Kosten et al , GCB, Jan 2012

Moving baseline or compensation needed?



**Time for a change
in behaviour –step
down 0.5-1 trophic
level.....**



Action folks!!!! – make it sustainable



Reduce the external loading, reduce the external loading, reduce the external loading,

reduce irrigation, reduce irrigation etc....

**Bring the river valleys
back to the rivers!!**



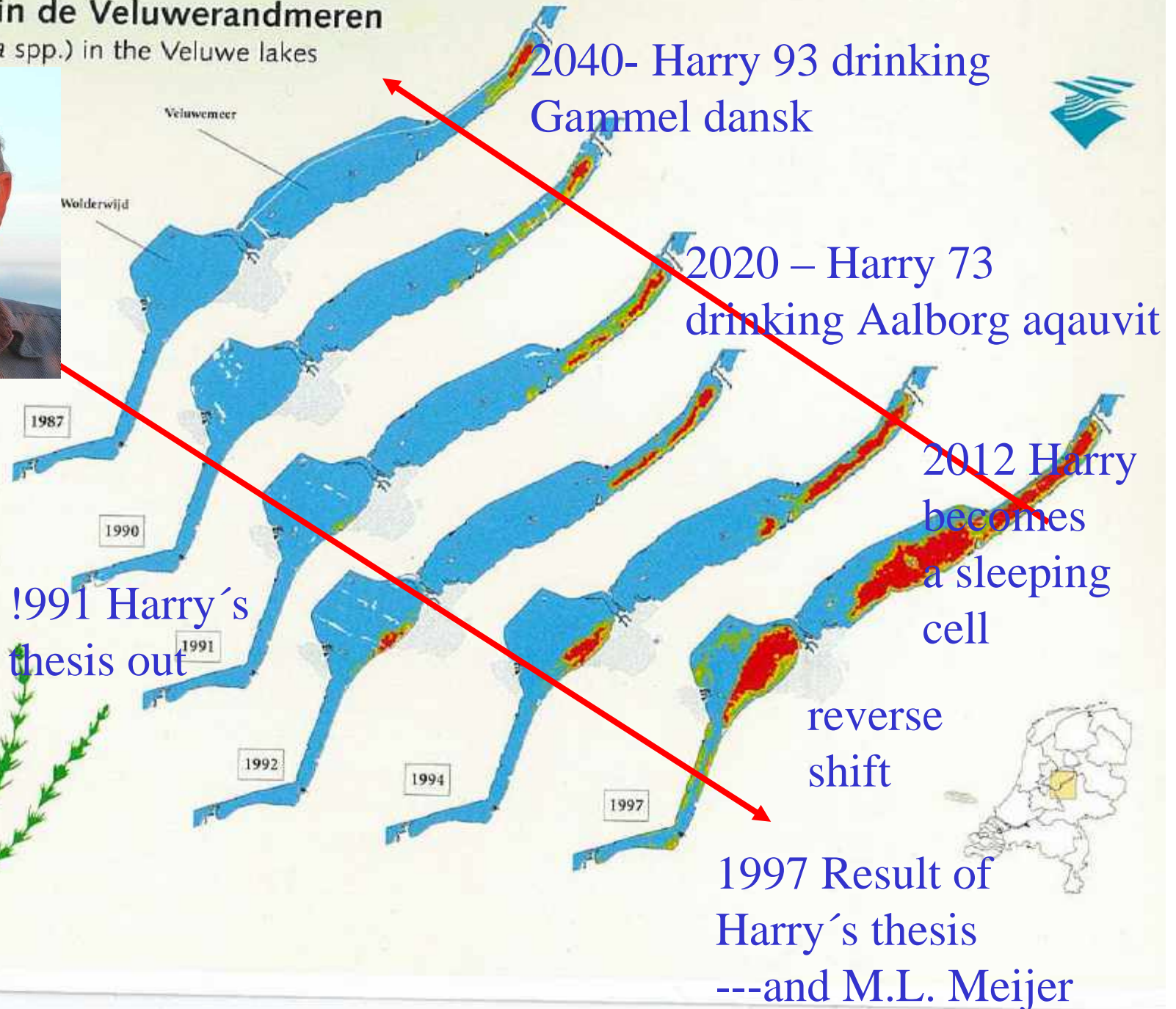
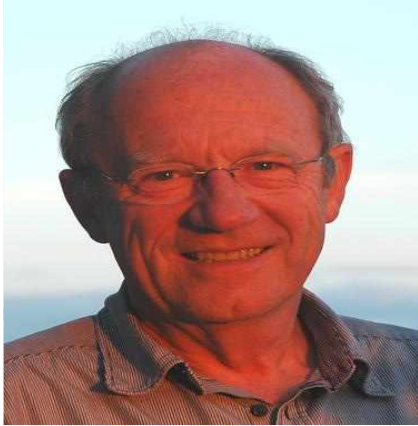


A photograph of a brown sea lion lying on its side on a rocky shore. The sea lion's head is resting on the rocks, and its flippers are visible. In the background, the ocean stretches to the horizon under a clear sky. A large, teal-colored thought bubble is positioned above the sea lion's head, containing the text "Why think about clear water when...". Three smaller teal circles lead from the main bubble to the sea lion's head.

**Why think
about clear
water when...**

Kranswieren in de Veluwerandmeren

Stoneworts (*Chara* spp.) in the Veluwe lakes



!991 Harry's
thesis out

Holland in 2157

A comple re-naturalisation

**The WFD authorities will be veeeeeeery happy
less modifed water bodies in EU.....**

Thanks for serious and funny days win the past 2.2 decades
It was great.....

