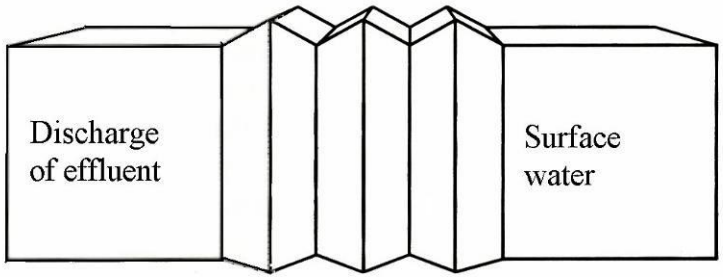
The Waterharmonica

Use of Treated Wastewater for Nature



Visit to Texel on 14 April

urbanwatercycle

International Workshop ***Purification***
of Interreg Urban Water Cycle project
Leeuwarden, The Netherlands 13 and 14 April 2005

The Waterharmonica:
a tool to convert used water into surface water

Ruud Kampf

Waterboard

Hollands Noorderkwartier

hoogheemraadschap
Hollands
Noorderkwartier

Theo Claassen

WETTERSKIP
FRYSLÂN

This presentation:

- ***do not throw treated waste away ?!***
- ***why is treated waste water not surface water??***
- constructed wetlands to make a “living water” from waste water
- Texel: the Everstekoog constructed wetland
  - Texel: “kwekelbaarsjes” or “grickelbacks”, food chains and the Waterharmonica
- Membrane filtration or biological post – treatment ??: WFD !

The Waterharmonica:

the link between treated waste water and surface water

Is a sewer system clever ??!!

Per inhabitant per year:

50 l faeces, 500 l urine plus 100 l kitchen wastes

+ 15.000 l drinking water, mainly for “transport”

+ 15.000 l rain

➡ large and expensive sewers

But as we will learn:
every **disadvantage** has his own **advantage**

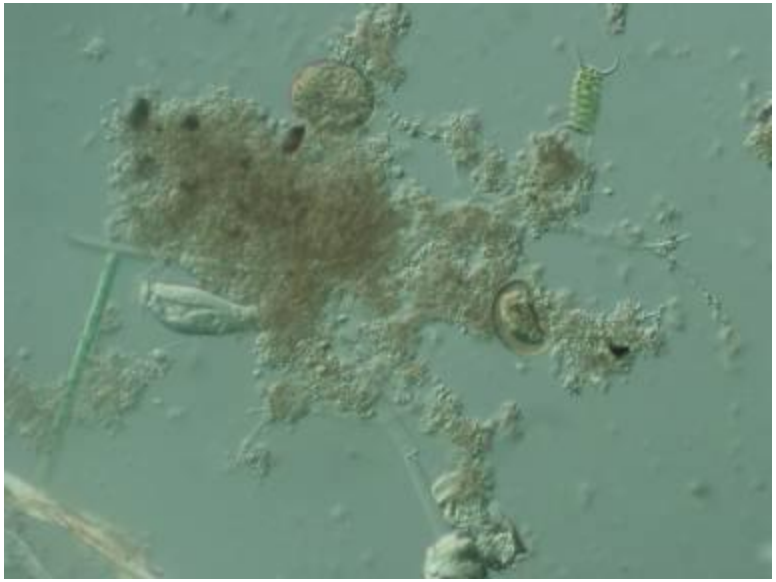
“Clear effluents”

It used to be the finest water we had:

Originally
drinking water and rain water

Treated wastewater

- improvements: C, N, P
- regional STP's
- influence at effluent discharge:
  - sludge particles, flocs
  - loose bacteria
  - odor, foam
  - low O_2



- "Dead water", not satisfied with quality

Typical effluent quality oxidation ditch STP

- BOD: 2 - 3 mg/l
- NH4: 0.1 - 1 mg/l
- NO3: 3 mg/l

- Suspended solids: low

Better than many surface waters !!!

But faecal coli: 400 - 800 per ml !

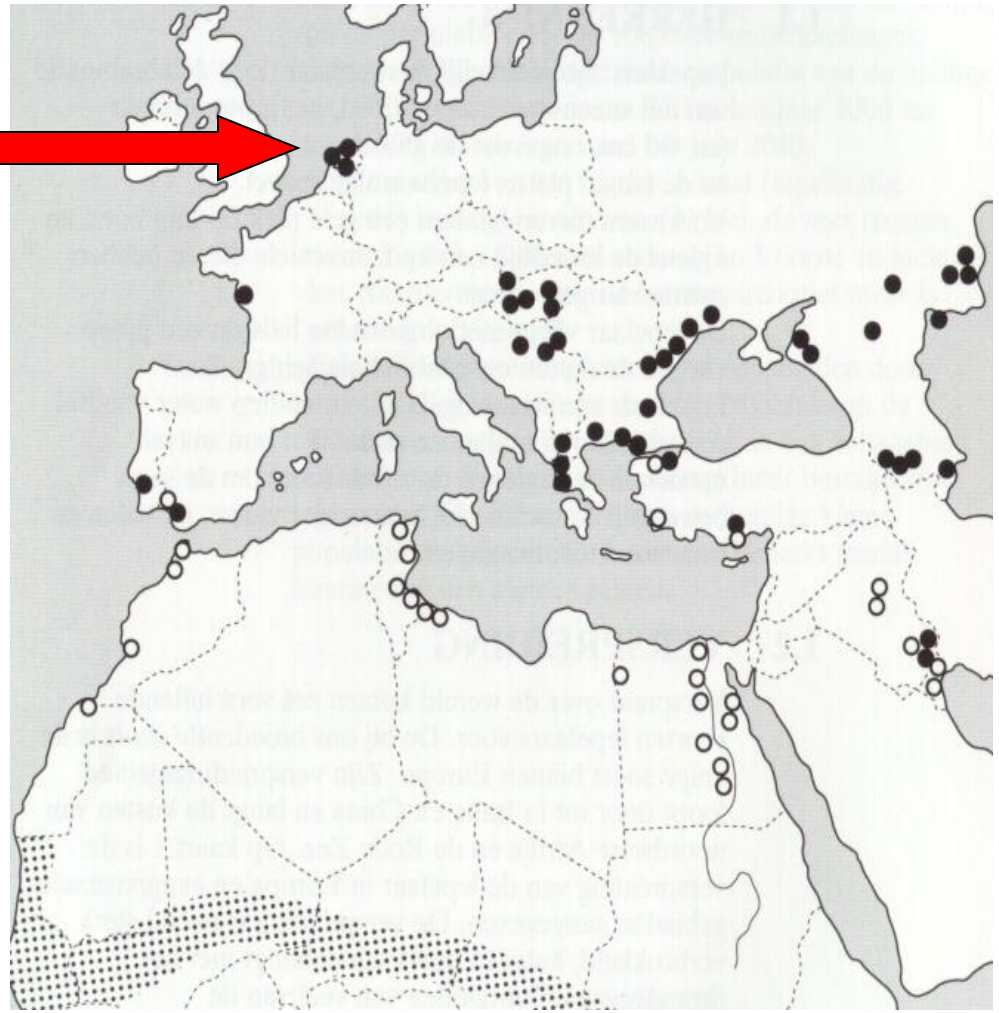
Texel

- Is a beautiful island
- A tourist resort
- A bird island
- Still a strong agricultural stronghold

Spoonbills

Spoonbills in Europe

The Netherlands



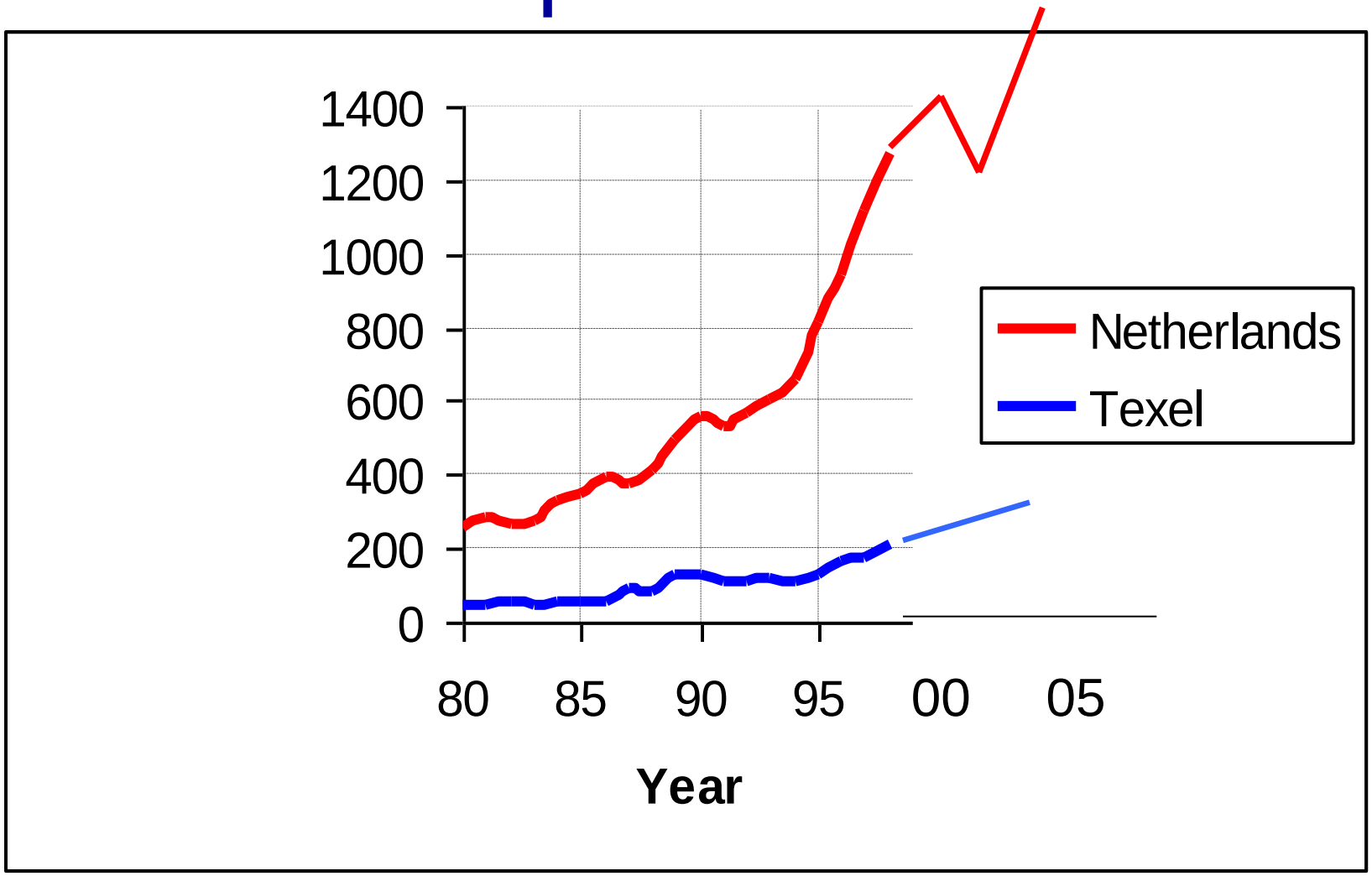
One of the rarest birds in Europe

95 % West-European population
in the Netherlands

Annex I European Bird directive

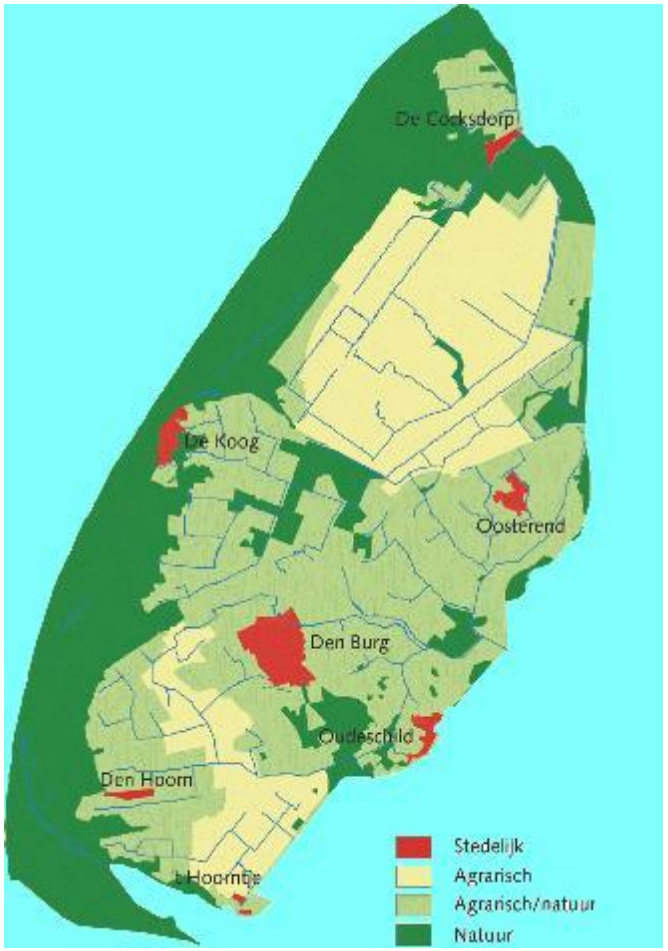
Symbol of good
water management

Breeding population Spoonbills

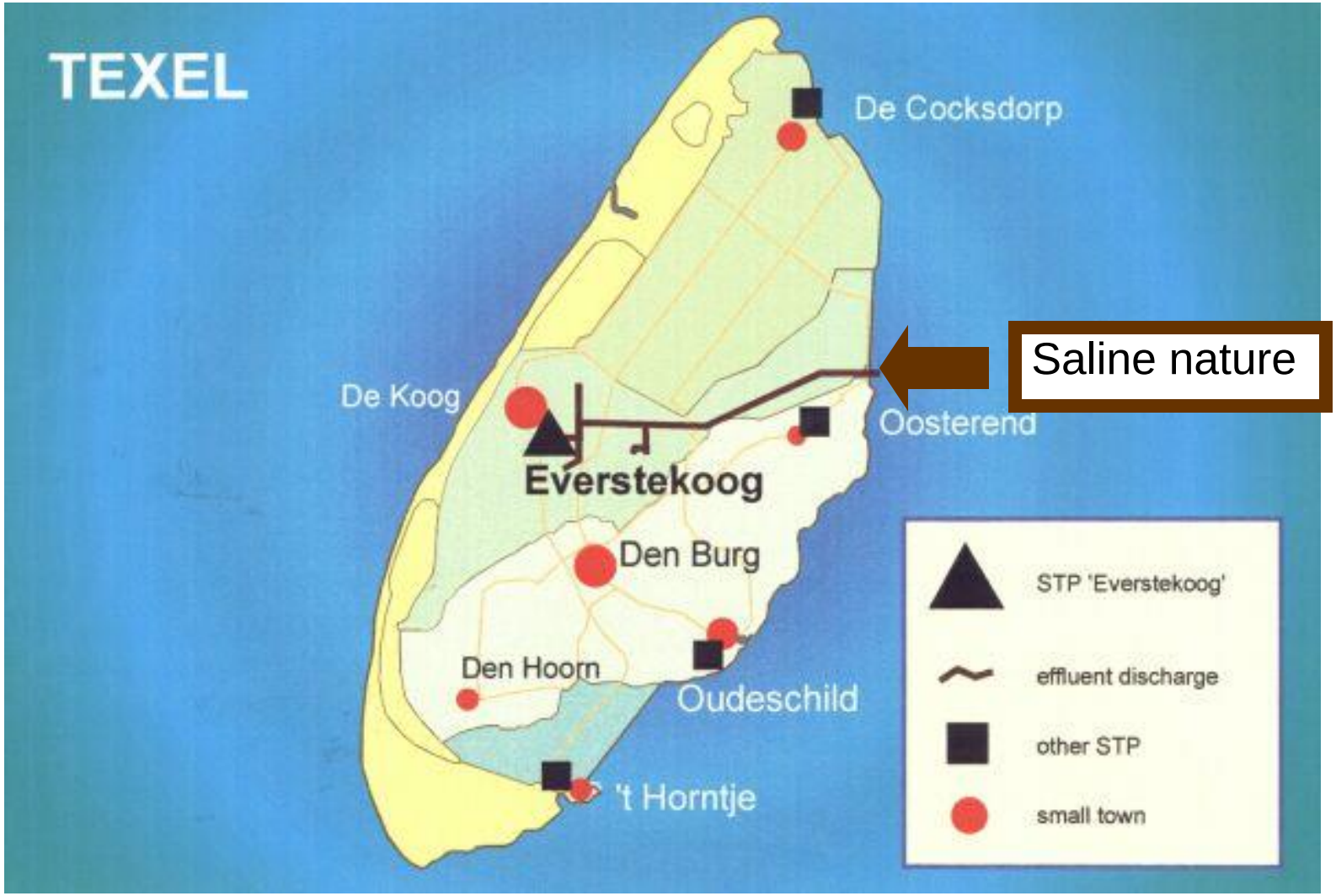


Water on Texel

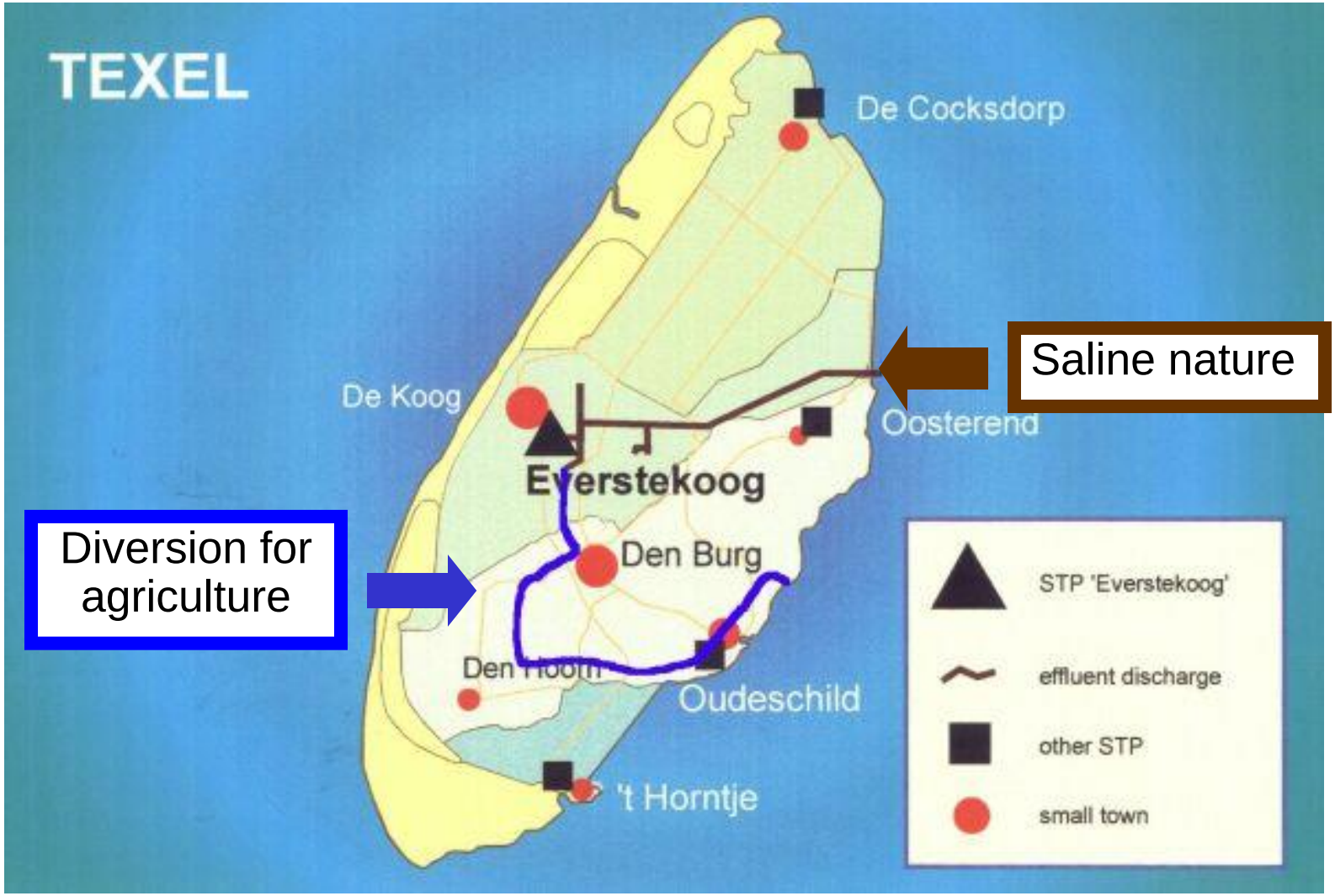
- Scarce
- Drinking water from mainland
- Masterplan Water Texel
- Projects like effluent diversion, etc



Effluent discharge to the sea



Effluent use on the island



Plans for Texel under development

Basis:

-•Masterplan Water Texel

–Constructed wetland

–Food chain approach Kwekelbaarsjes / Gricklebacks

–Waterharmonica

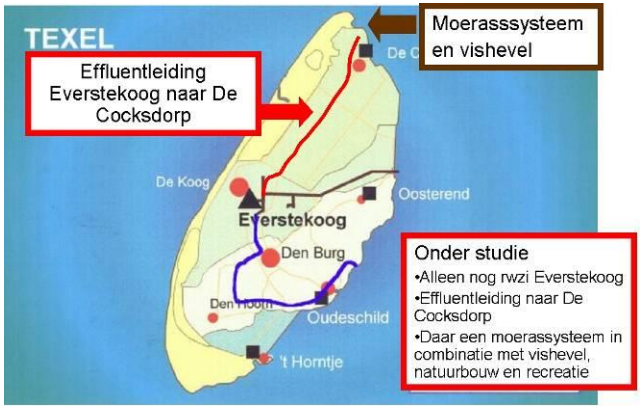
Development

• Centralisation 5 STP's in Everstekoog

• Use of the effluent elsewhere on the island` –

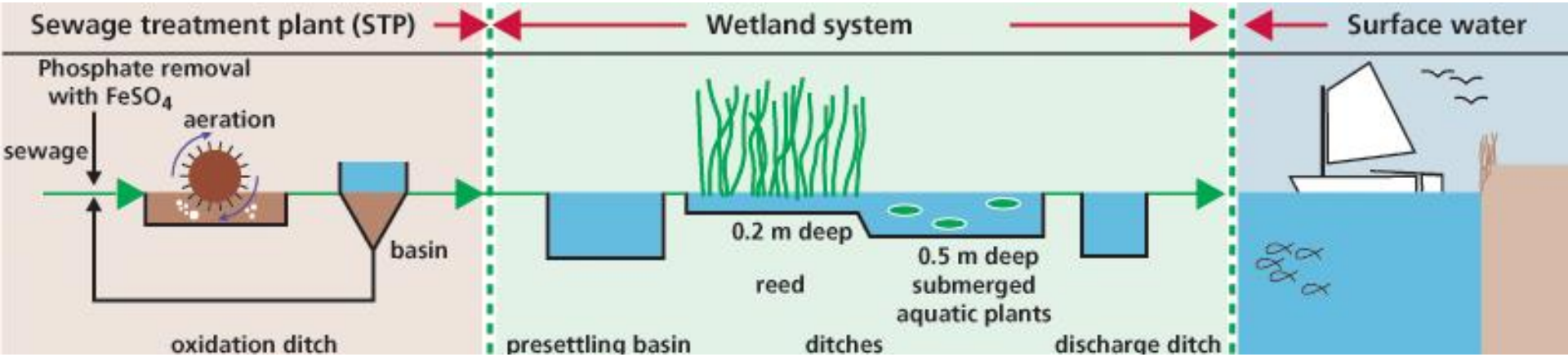
Constructed wetland Evertsekoog or several more?

Now:
effluent use on the island



Study:
Effluent use together with fish ladder

From wastewater to surface water



STP Oxidation Ditch

Constructed wetland

Surface water

A constructed wetland to make a “living water” from treated waste water

Aerial view STP Everstekoog

sewage
treatment plant

presettling basin

9 ditches
with reed/cattail
and aquatic plants

discharge ditch

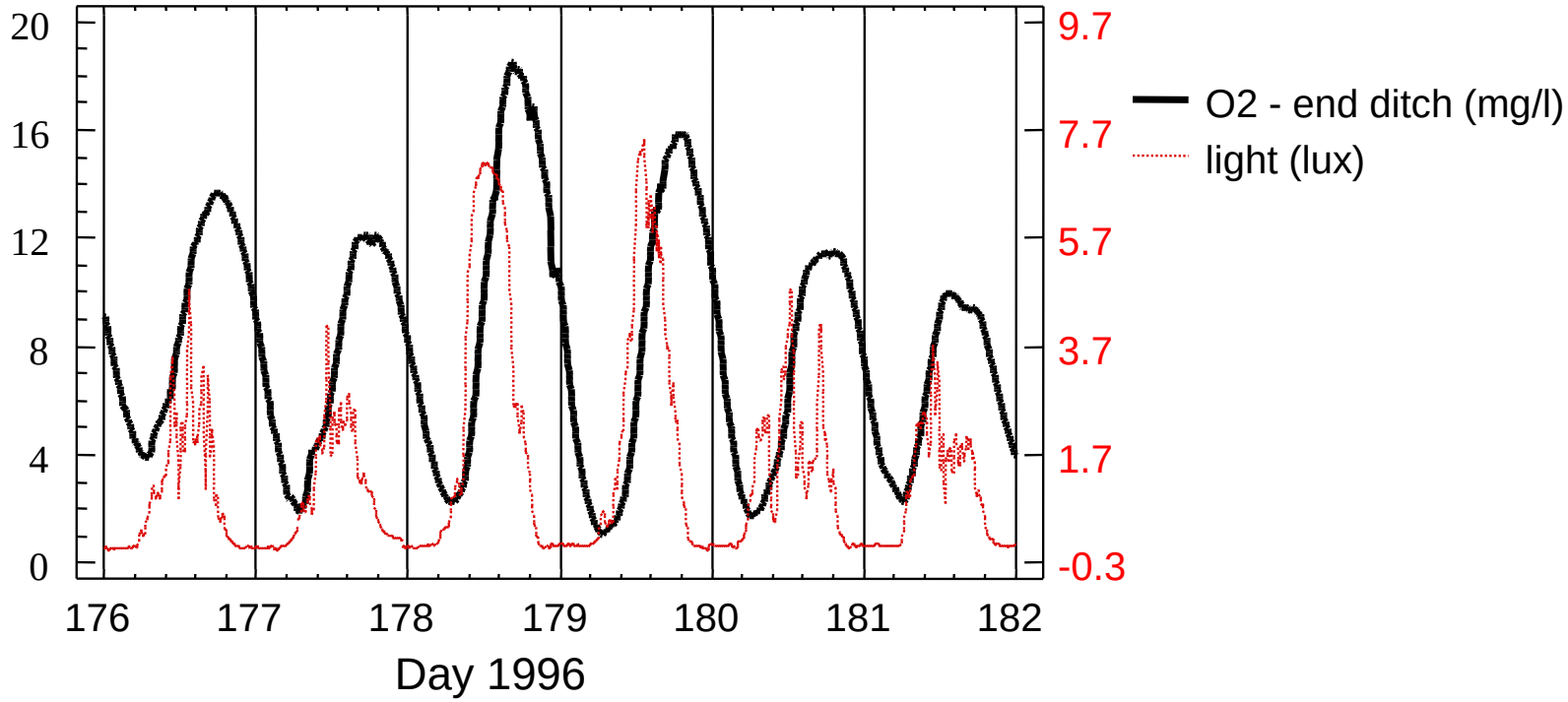
Research project
1995 - 1999

Constructed wetland

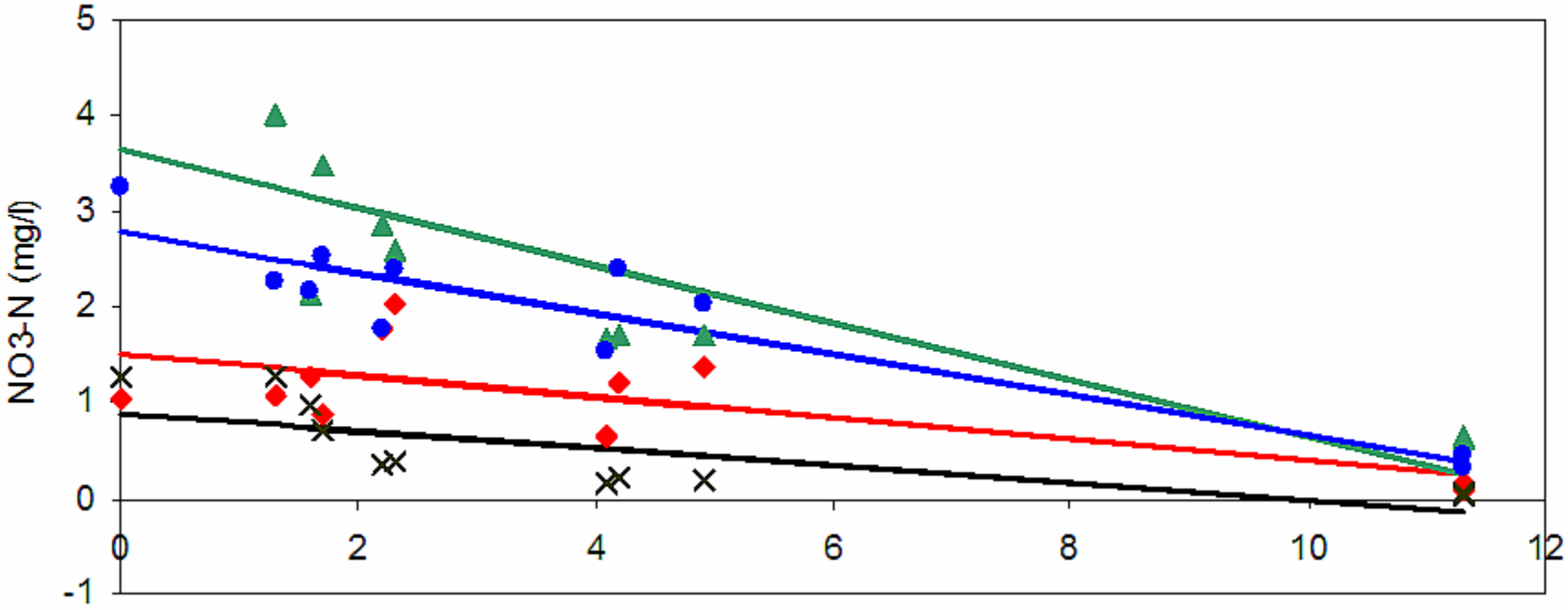
- a constructed, optimised water system
  - helophytes: reed, cattail
  - (submerged) water plants
  - plants on the banks
  - sediments
  - algae, Daphnia, etc
- works on solar energy

A constructed wetland to make a “living water” from treated waste water

Diurnal oxygen pattern



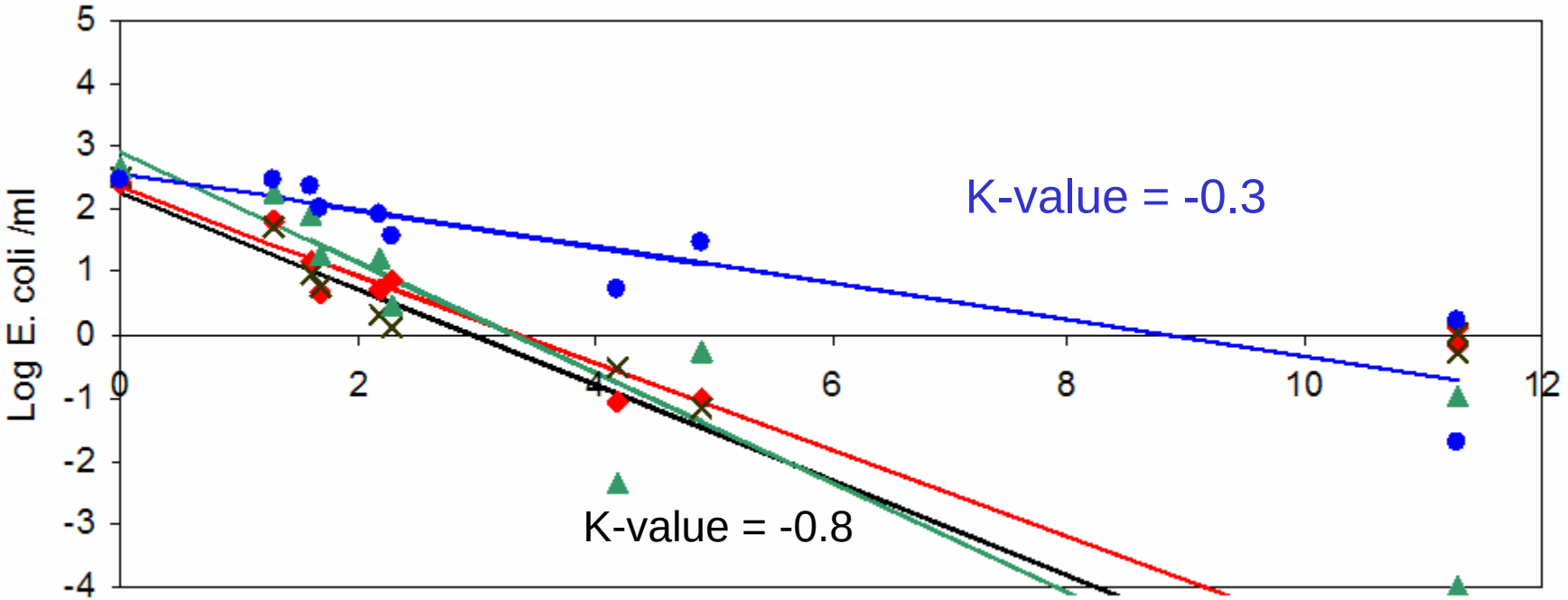
Nitrate (mg/l) vs retention time



Hydraulic retention time (days)

Spring Summer Autumn Winter

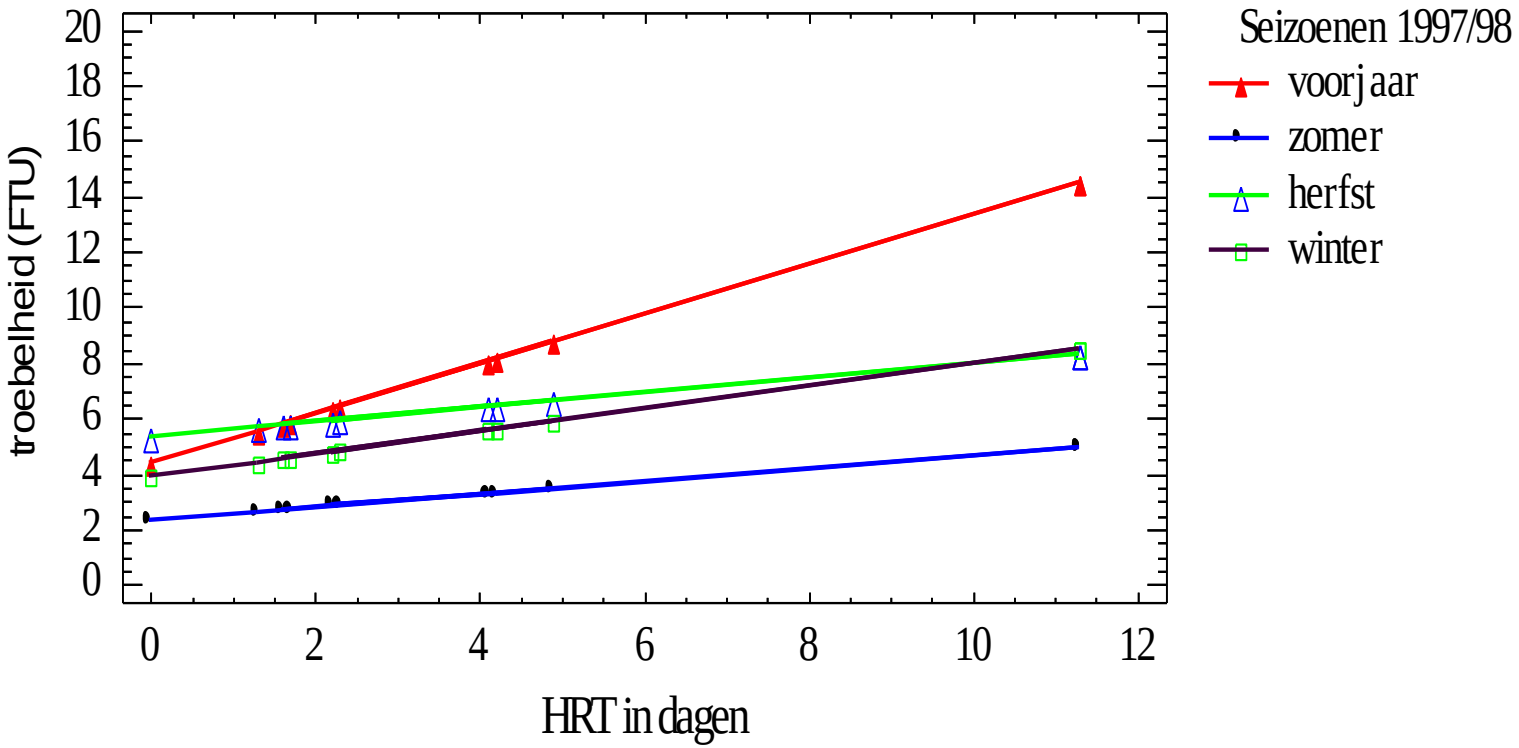
Log E.Coli (per ml) vs retention time



Hydraulic retention time (days)

Spring Summer Autumn Winter

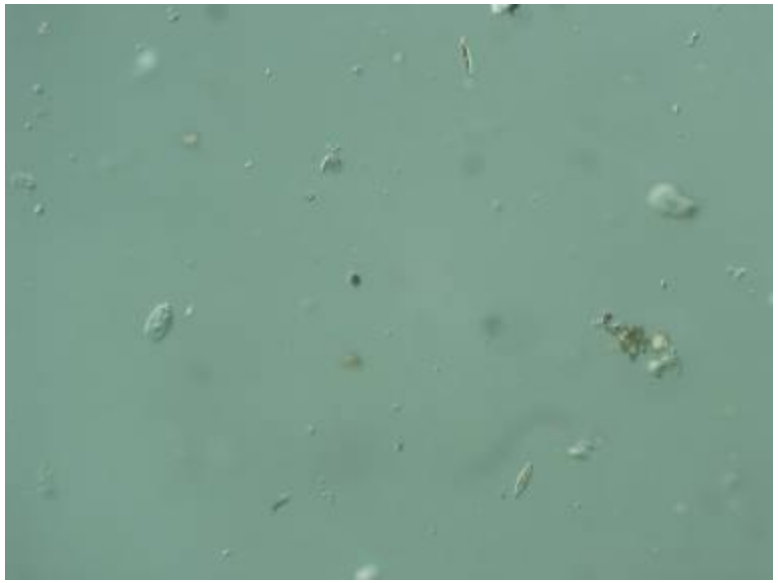
Turbidity



More but different suspended solids

After constructed wetland different water

- Natural oxygen regime
- No odour
- Less sludge particles lead to desinfection
- More, but different suspended solids
- Living water:
  - algae, daphnia
  - all kind of “waterlife”
  - fish
  - birds



Biodiversity

- A wealth of material (partly in the data vaults)
  - Constructed wetland Everstekoog (o.a. Sylvia Toet)
    - Algae mats (phototrofic biofilms, PHOBIA)
    - Daphnia (increasing number of species)
    - Macro-fauna
    - Zoöplanton
    - Phytoplankton
    - Fish
    - Birds
- Biodiversity increases
  - Implications Water Frame Work Directive?

Ecotox effluents

- Growth of algae inhibited
- Daphnia
- New test method!

Toxicity effluents normally no problem for growing biomass on wastewater

But:

do not overload your STP

stay alert and use the test method

Texel

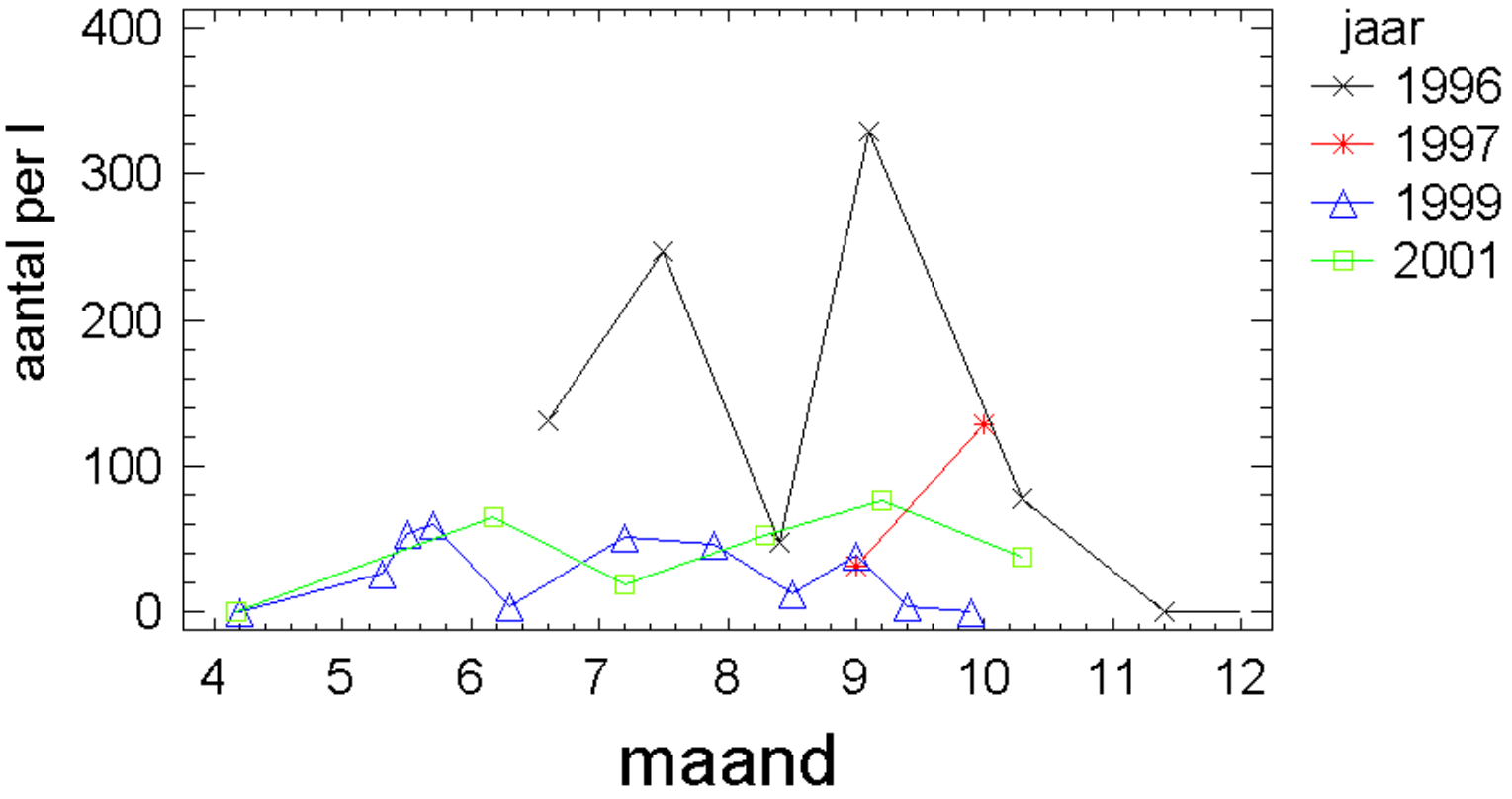
Learning the process by doing

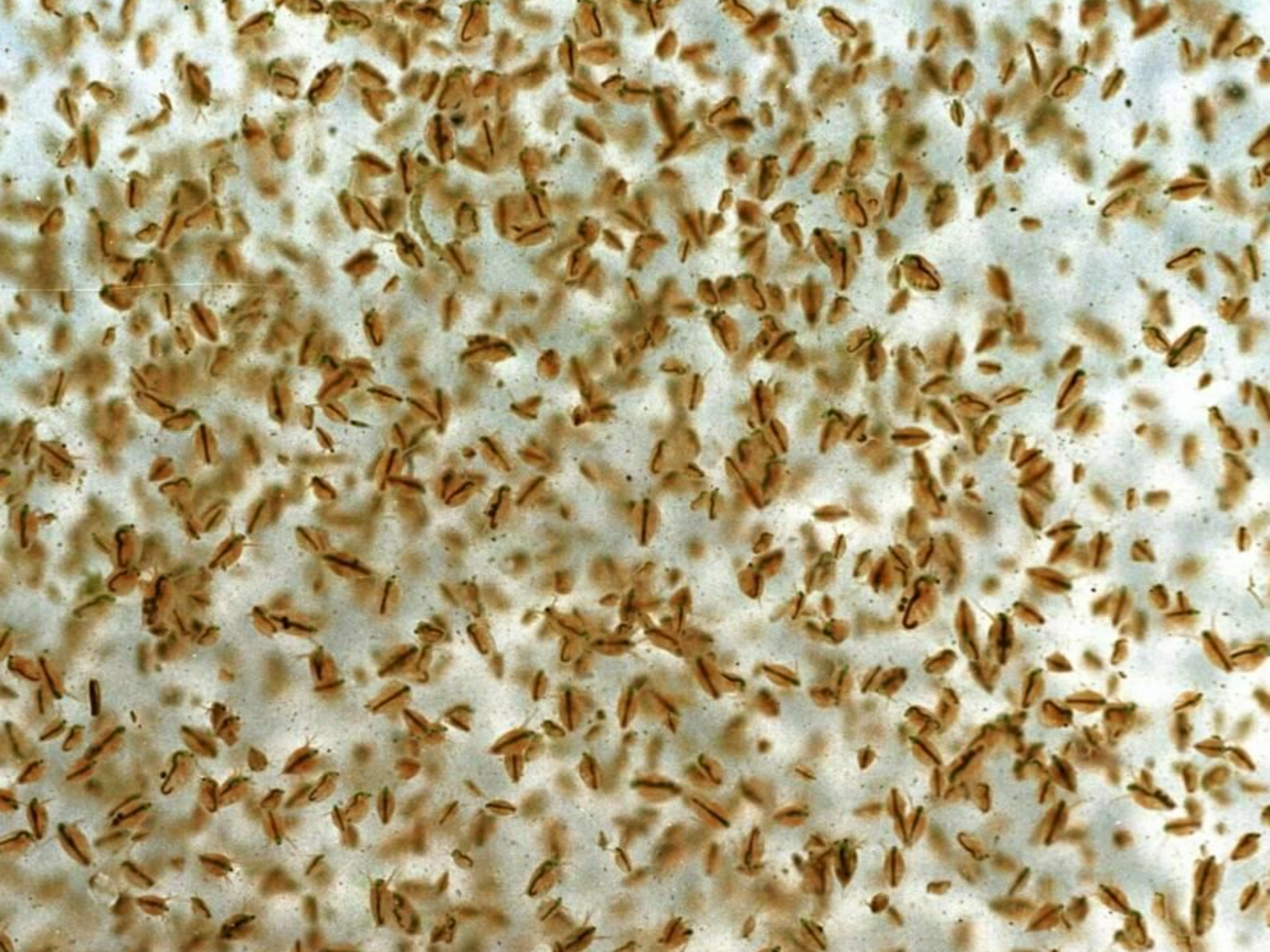
Resulted in a lot of knowledge and ideas!!

well treated wastewater
can be a good source of life!

More sustainable, natural water systems

Daphnia in presettling basin constructed wetland





Harvesting Daphnia for research

Daphnia - trivia

- Length: 0.3 - 5 mm
- Wet weight: 0.5 - 2 mg
- Filtration capacity: 4 ml/ind.hour

(1000 Daphnia/l filtrates water 4 times per hour)

- Size of food particles between 1 - 40 μm

Protein: 60 %

Fat 10 %

Carbohydrates 6 %

C = 44 %

N = 8 %

P = 1.4 %

Fish in the Everstekoog constructed wetland

- in first pond no fish
- fish in ditches:
  - but only after 3 days retention time
    - after 10 days a lot of fish

up to 15 Stickleback per m^2

Sticklebacks

“Kwekelbaarsjes”

growing **Daphnia**

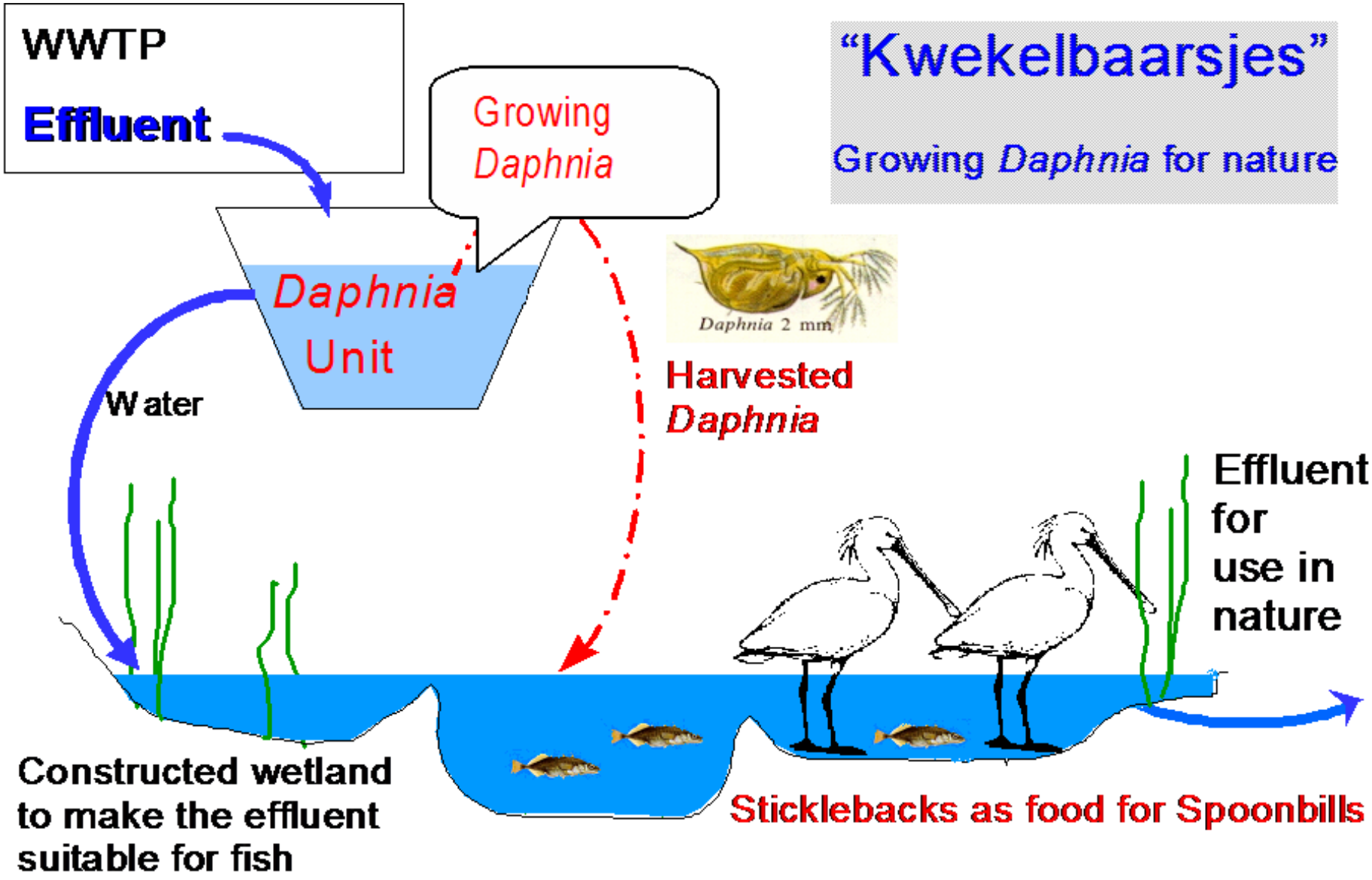
on treated wastewater

to grow **Sticklebacks** *Grickelbacks*

as food for **Spoonbills**

"Kwekelbaarsjes"

Growing *Daphnia* for nature

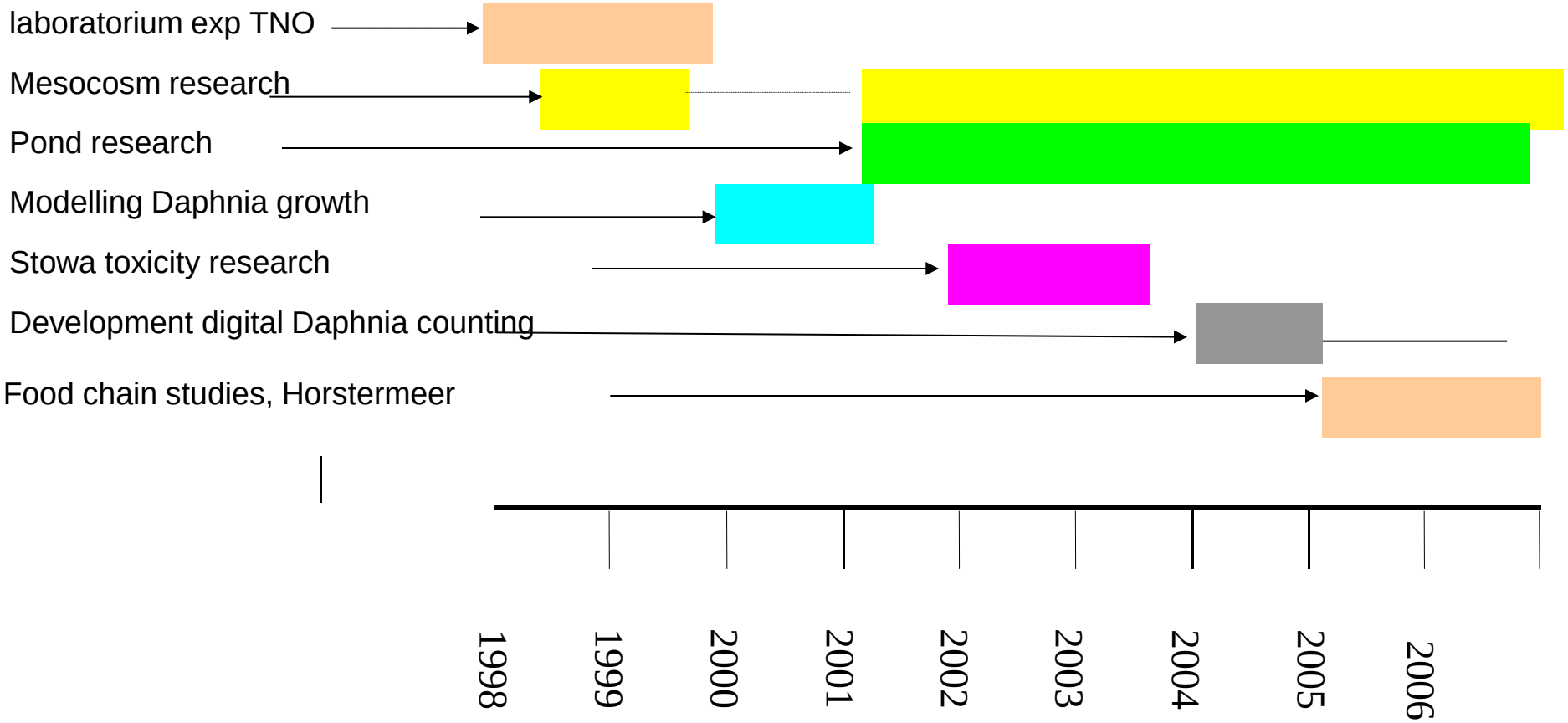


Experimental set-up Everstekoog

4 ponds

4 mesocosms

Research
1998-2004 – plus



Ponds

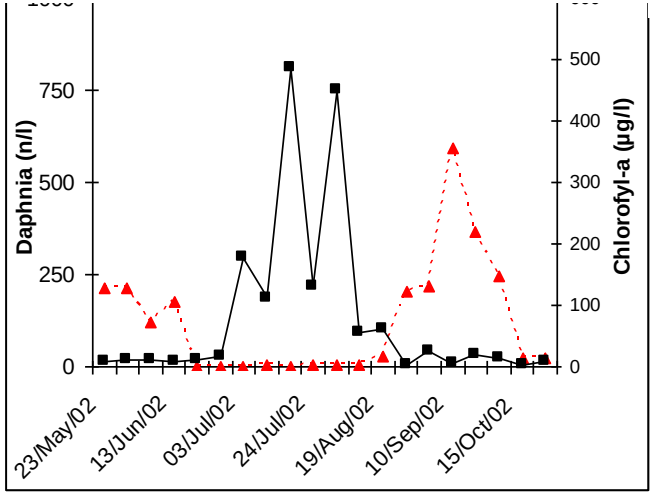
May – October

2002

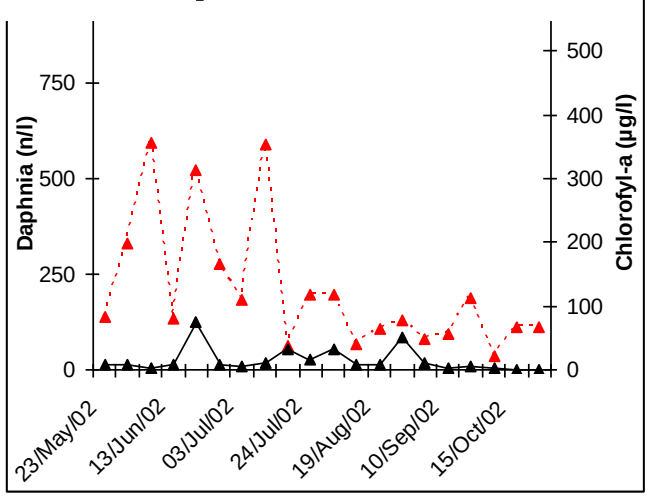
Daphnia

algae

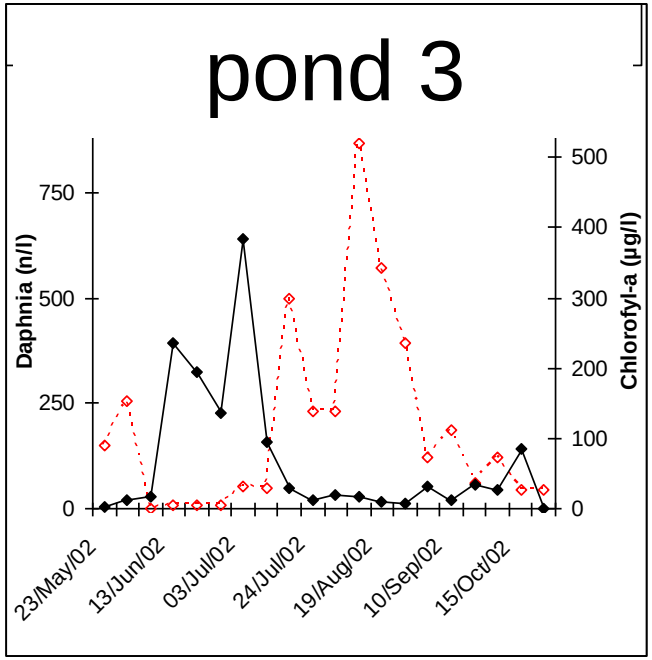
pond 1



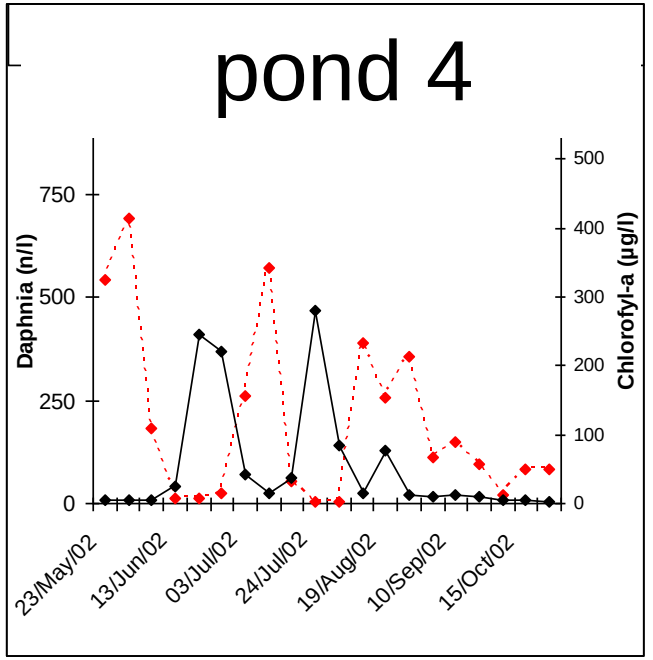
pond 2



pond 3

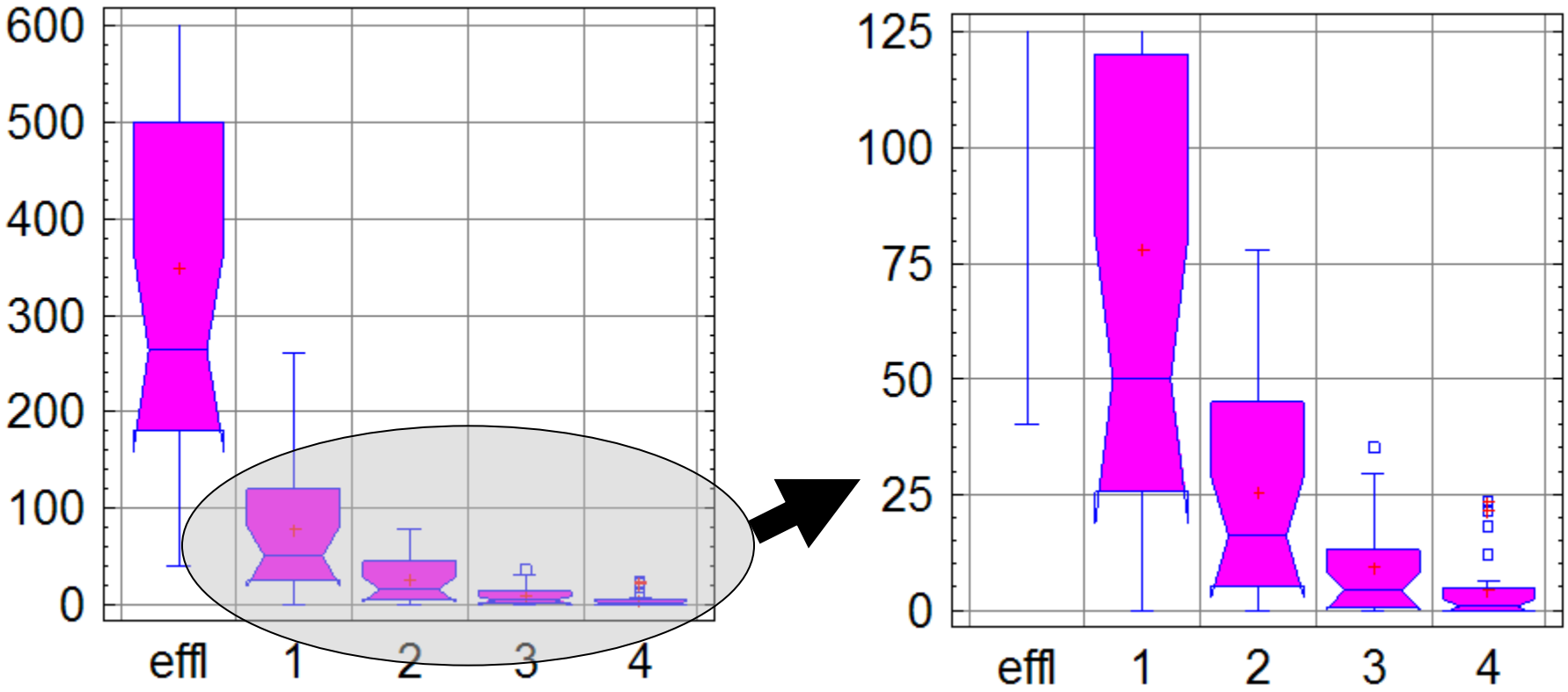


pond 4



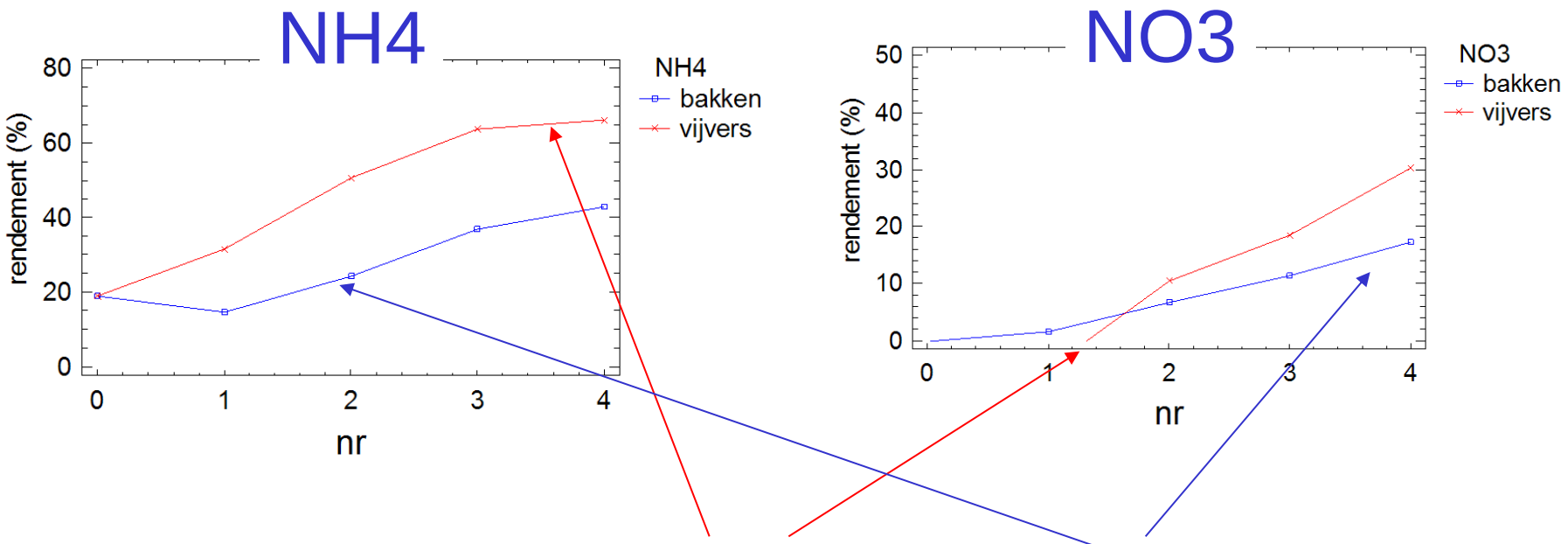
Fecal Coli removal

mesocosms 2003-2004



Nr of fecal coli/ml vs hydraulic retention time

2003 - 2004

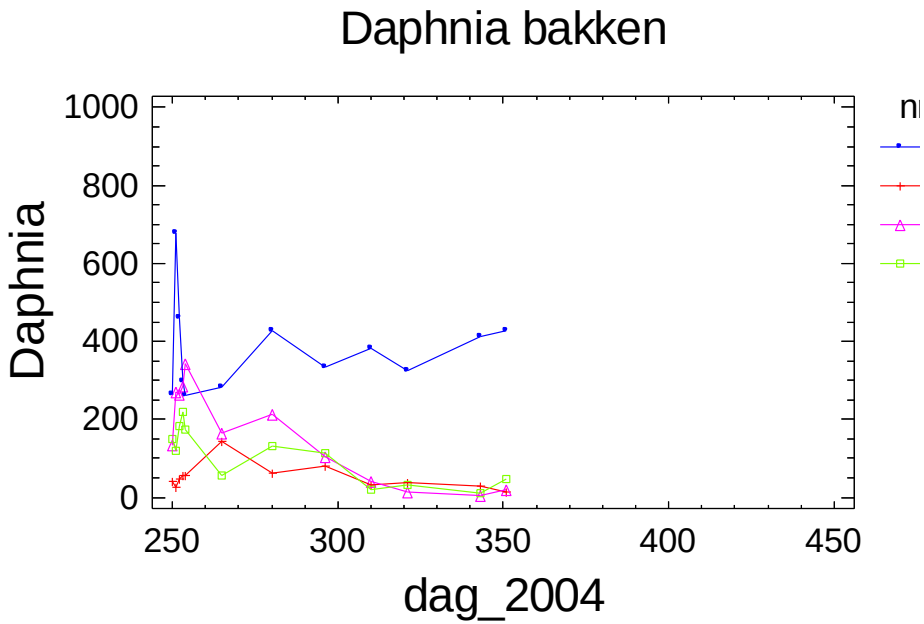


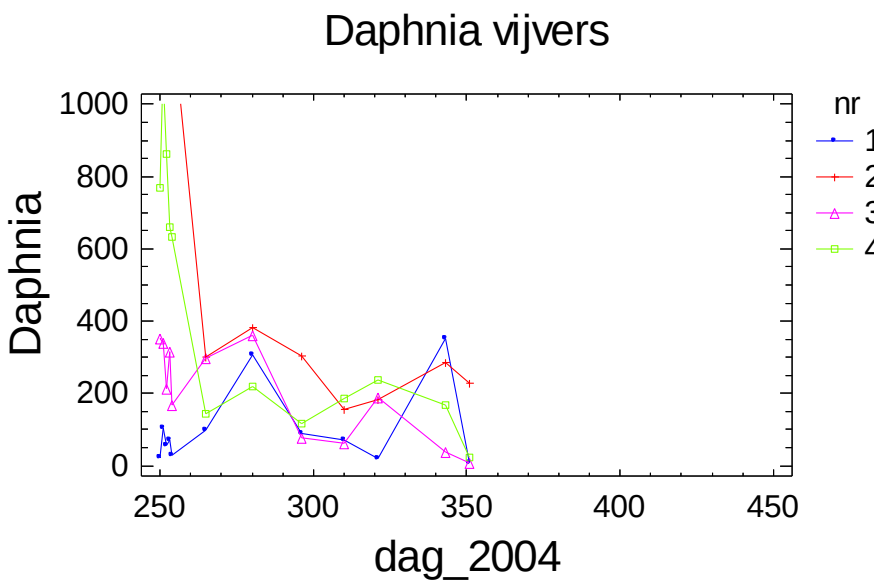
- N-removal better in ponds then mesocosms

Influence of submerged water plants in ponds 2, 3 en 4

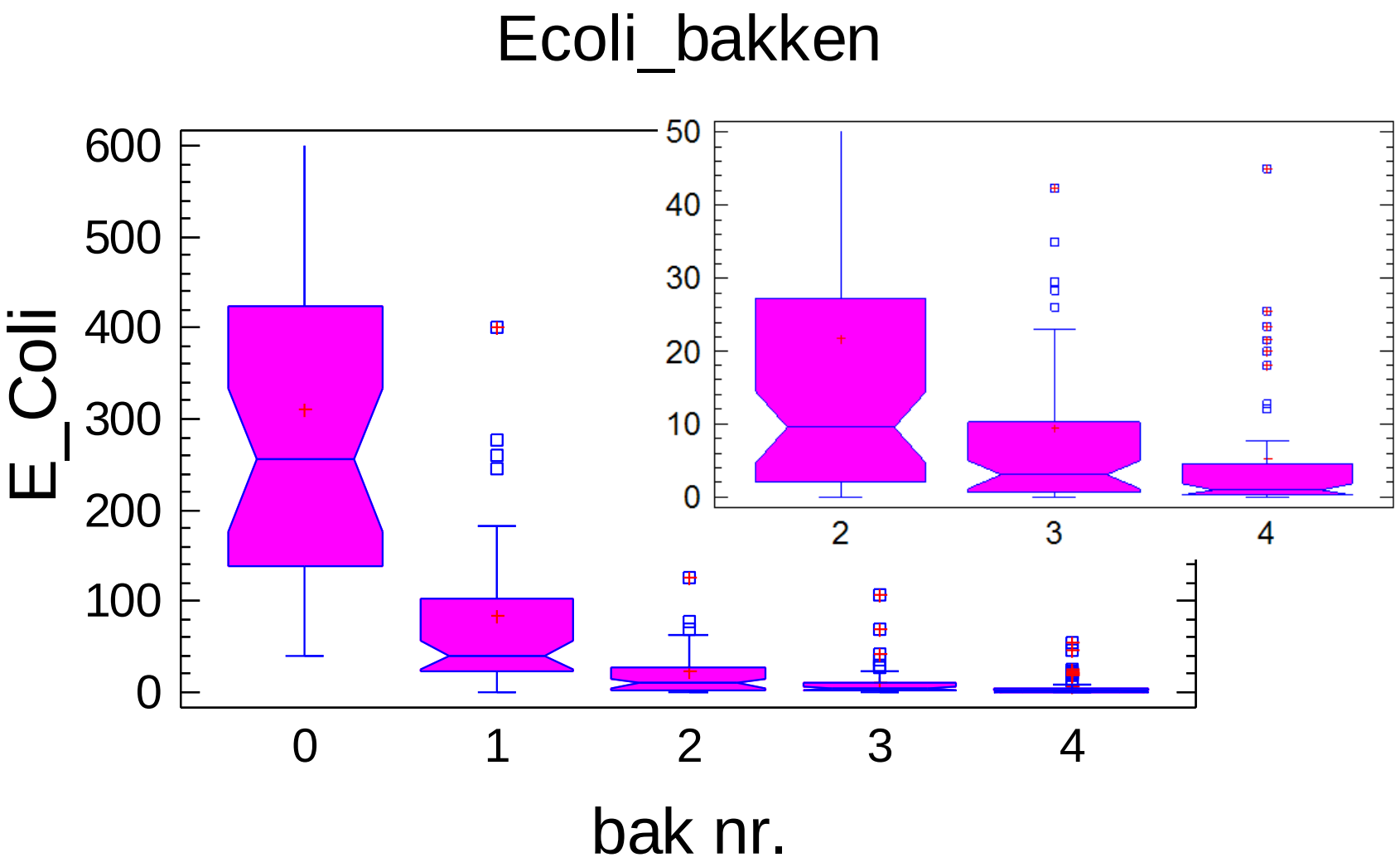
- NH4-removal up to 60 %
- NO3-removal up to 30 %

Stop press: winter 2004 - 2005

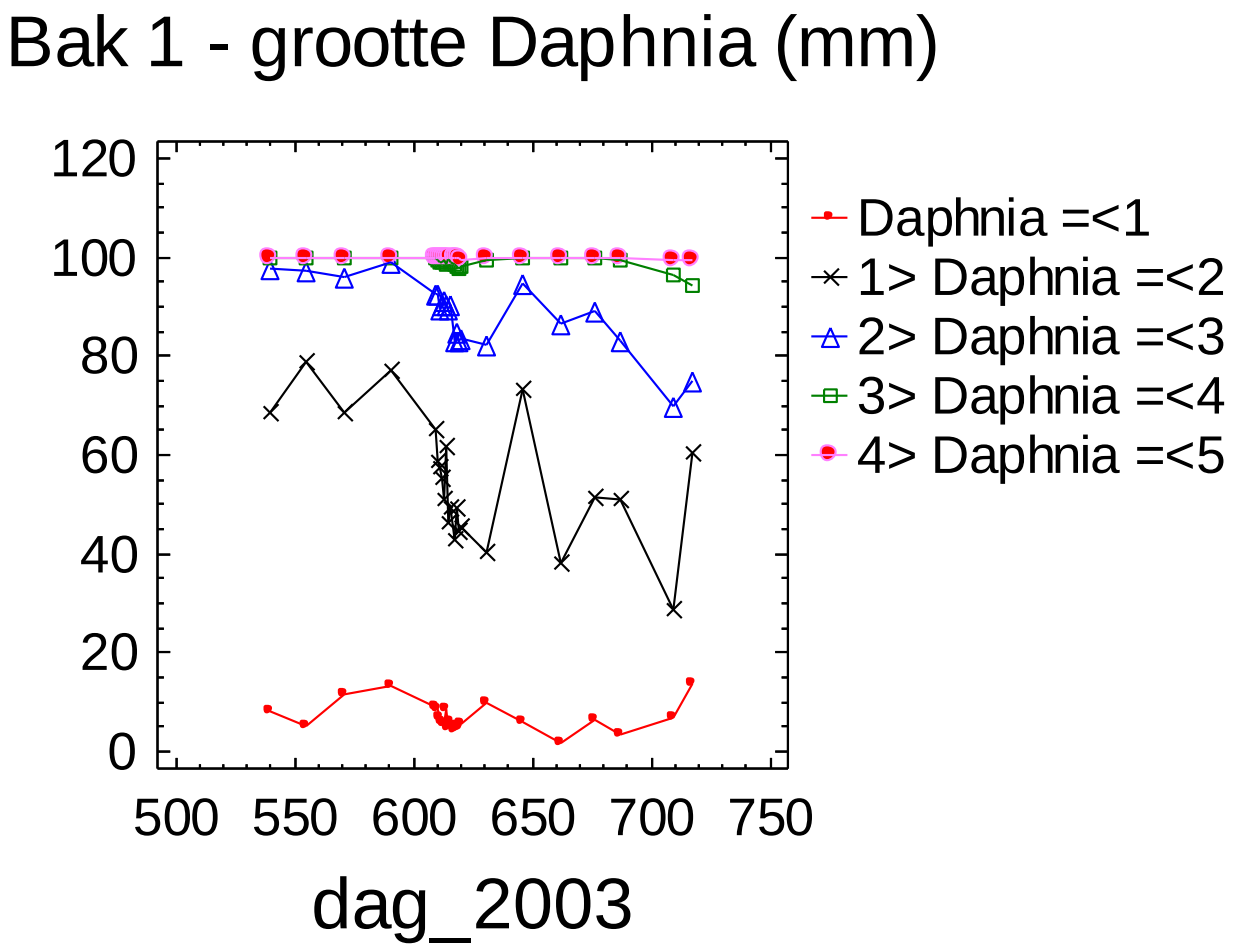




Winter 2004 - 2005



Daphnia size distribution

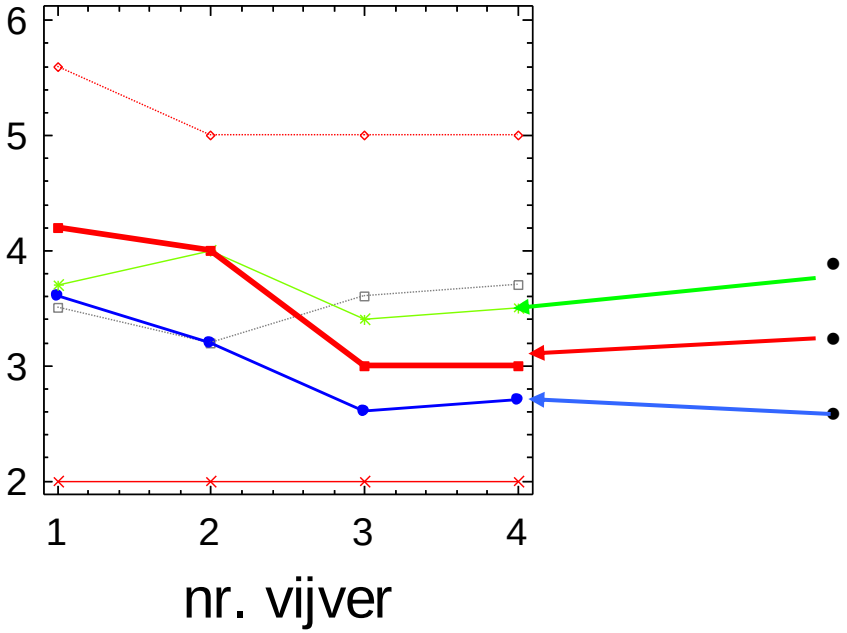


Biological assessment of water quailty

- HHNK: decades of experience
  - Microscopic
    - Diatoms (van Dam index)
    - Quick scan phytoplankton
  - Moving, Observable with the naked eye
    - Zooplankton
  - Abiotics, water plants, etc

Ponds 2004: van Dam-index

Diatom index,
biological scan:



- Number of species
- Impression of abundancy

- Oxygen response
- " Saprobie" ("degree of pollution")
- org. N

Improvement of biological water quality

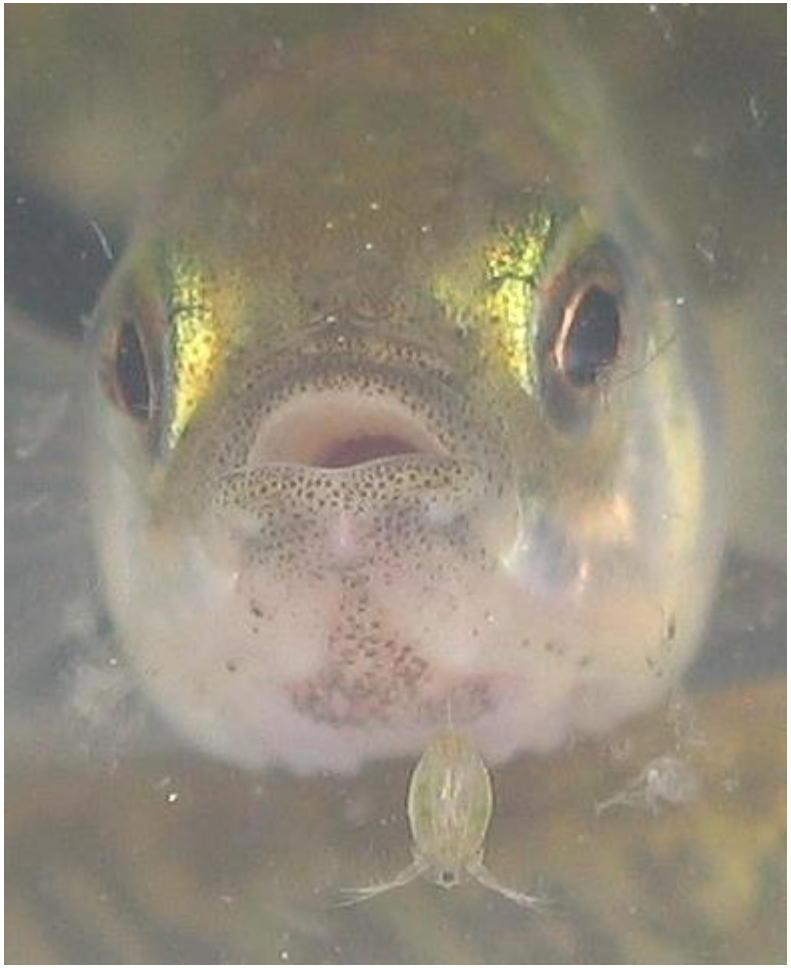
Kwekelbaarsjes ?

”Daphnia, Fish, Spoonbills and treated waste water”

- Feasible:
  - growing Daphnia:
    - Daphnia feed on sludge particles: disinfection!
    - Daphnia keep the ponds clear: no algae
  - Sticklebacks come to the constructed wetland
  - it attracts Spoonbills

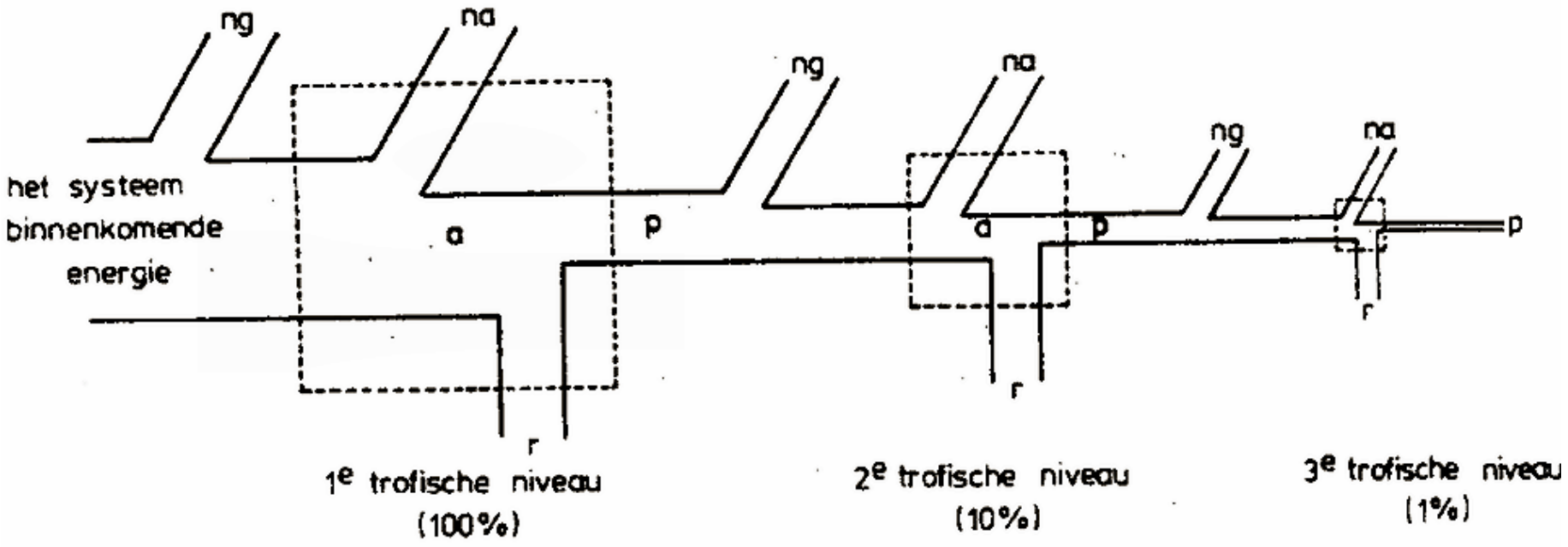
Fits in the EU Water Framework Directive

Food chains!



http://www.intarttiles.com/robertekennedy.htm

Food chains + energy flows



Conclusions Texel

A more natural constructed wetland:

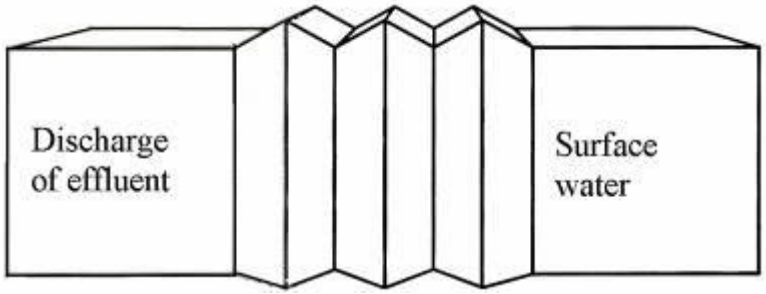
different, living water

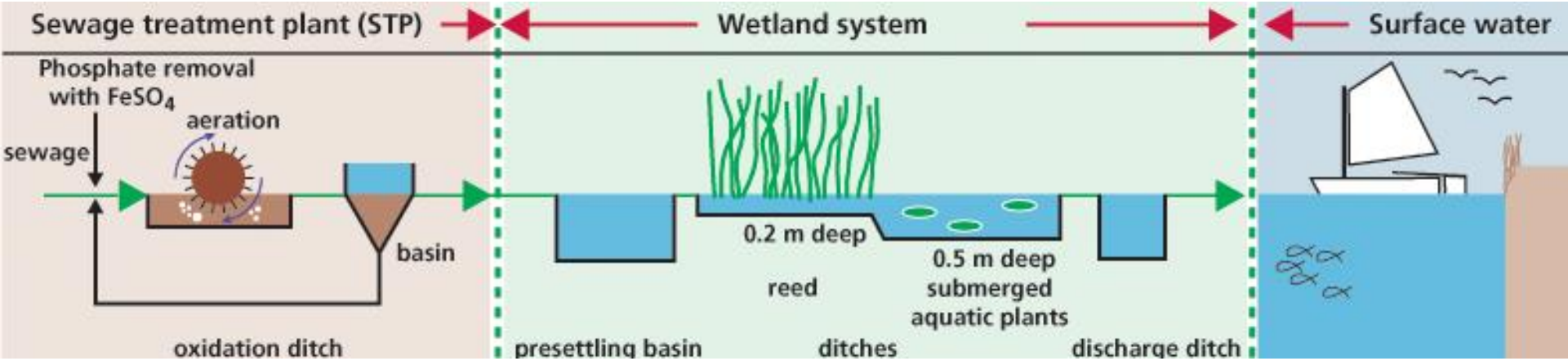
disinfection

nutrient removal

natural values

After treatment of waste water
or
pre treatment of surface water?!





www.waterharmonica.nl

Thank you !!

The Waterharmonica:

the link between treated waste water and surface water

Recent development

Evolving interest in filtration techniques

STP Horstermeer

TU Delft

dwr

Witteveen Bos

Uitgangspunten

MTR kwaliteit voor gekozen stoffen

Stoffen	Eenheid	MTR kwaliteit
Nutriënten		
P_{tot}	mg/l	0,15
N_{tot}	mg/l	2,2
Zware metalen		
Koper	µg/l	3,8
Nikkel	µg/l	6,3
Zink	µg/l	40
Andere prioritair (gevaarlijke) stoffen	µg/l	0,08
Antraceen	µg/l	0,50
Fluorantheen	µg/l	0,20
Benzo(a)pyreen	µg/l	0,20
Benzo(k)fluorantheen	µg/l	1,20
Naftaleen		

Horstermeer proefhal

2005 – 2008

TU Delft

dwr

Witteveen+Bos

“zelfde opstelling als Beverwijk, Utrecht”

Joint research project polishing effluent STP Horstermeer

2005 – 2008

a. Effluent

- process steps:
  - b sand filtration (bacteria, sludge particles, EPS)
  - c. ultra filtration (no particles)
  - d. biological active carbon filtration

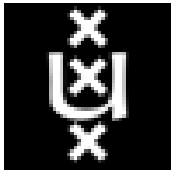
• but: Daphnia are also good in filtration of small particles !!!

• combination of engineering and natural methods

•*Ecological engineering is an attractive option!*

In preparation on Horstermeer:

How can we use the Texel knowledge as an alternative to fullfill the Water Frame Work directive ??



•Partners wanted!, combination with the PHOBIA-project (Phototrofic biofilms) ?

Process technology constructed wetlands

- Oxidation ditch / carrousel:
  - like polluted surface water
- Constructed wetland for effluent polishing:
  - like cleaner surface water
- Processes are comparable
  - settling, adsorption, (photo katalytic) biofilms, diffusion, growth, decay, etc.

➔ combination van (bio)procestechnology, agriculture, biology, etc.

[EcoEng-online]
International Ecological Engineering Society

➔ ecological engineering: www.IEES.CH