Examples of Water protection measures in Lake Pyhäjärvi (Southwest Finland)

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Vattendag
16.11.2017

Water Chain

EUROPEAN UNION
European Regional Development Fund

Interreg
Central Baltic

PYHÄJÄRVI INSTITUTE

Started 1989

Food production and **water protection**

Implementing research and development projects, further education and expertise services

Maintained by a foundation established by the local municipalities and companies

WATER PROTECTION

Themes in projects

- **Agricultural runoff treatment**
- **Lake and river restoration**
- **Wastewater treatment**

Intensive co-operation with stakeholders

National and international research projects

Customers: primary producers, entrepreneurs, authorities, inhabitants

Various lakes and rivers

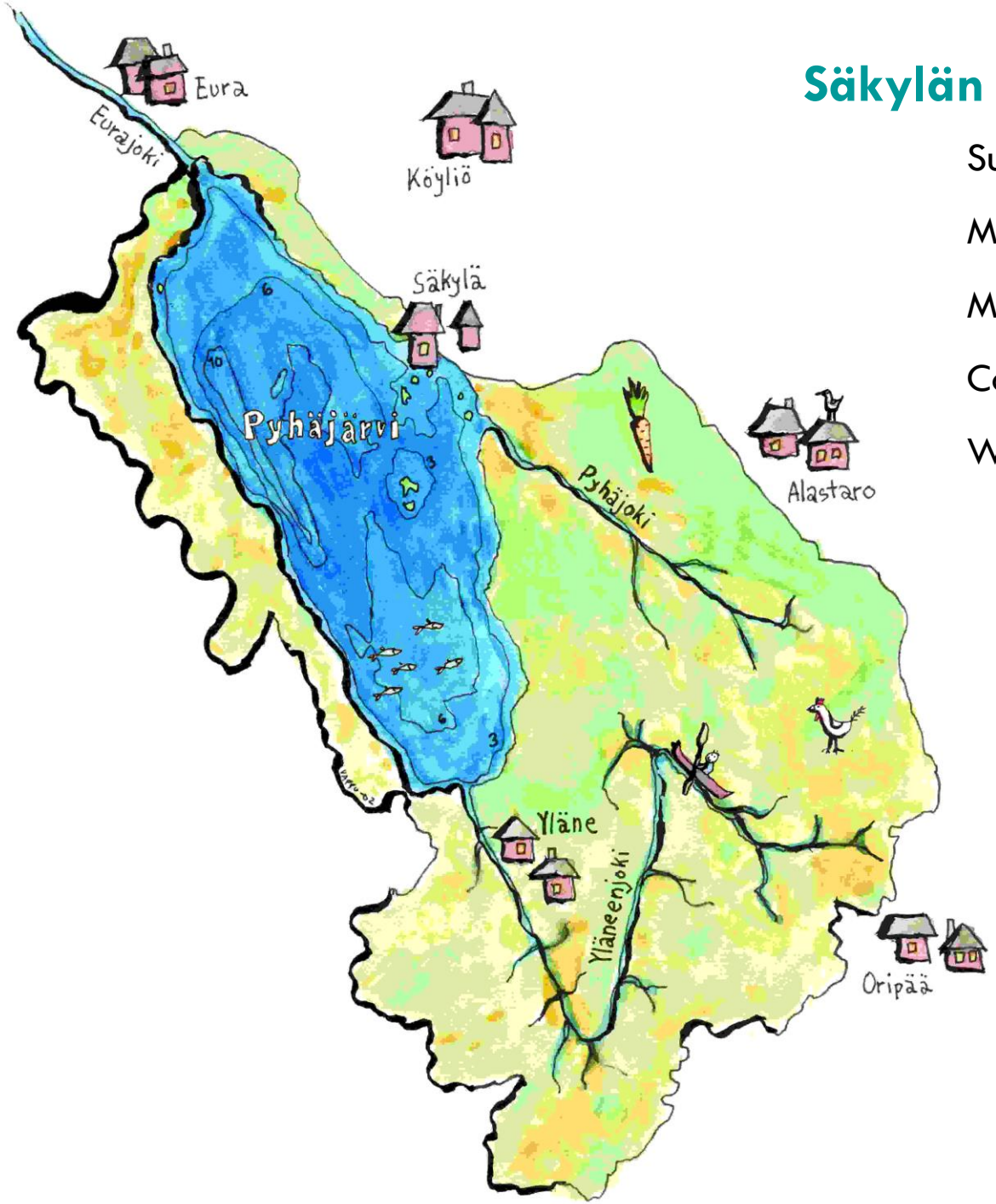
Pyhäjärvi Restoration Program (Pyhäjärven suojeluohjelma)

Eurajoki-Köyliönjoki Program (JOKI ohjelma)

PYHÄJÄRVI RESTORATION PROGRAM

- First signs of eutrophication were observed in the beginning of 1990's.
- In order to guarantee the necessary actions and funds for the restoration of Pyhäjärvi, the local municipalities, companies and other organisations founded Pyhäjärvi Protection Fund in 1995.
- Voluntary participation.

- The fourth term 2014-20
  - 18 members



Säkylän Pyhäjärvi

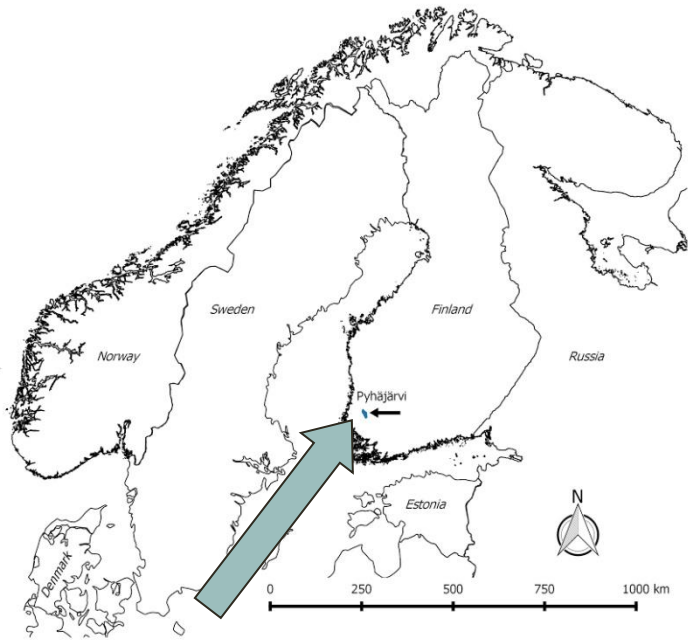
Surface area 155 km^2

Mean depth 5.4 m

Maximum depth 26 m

Coastline 80 km (47.71 mile)

Water residence time 3-5 y



Drainage basin area

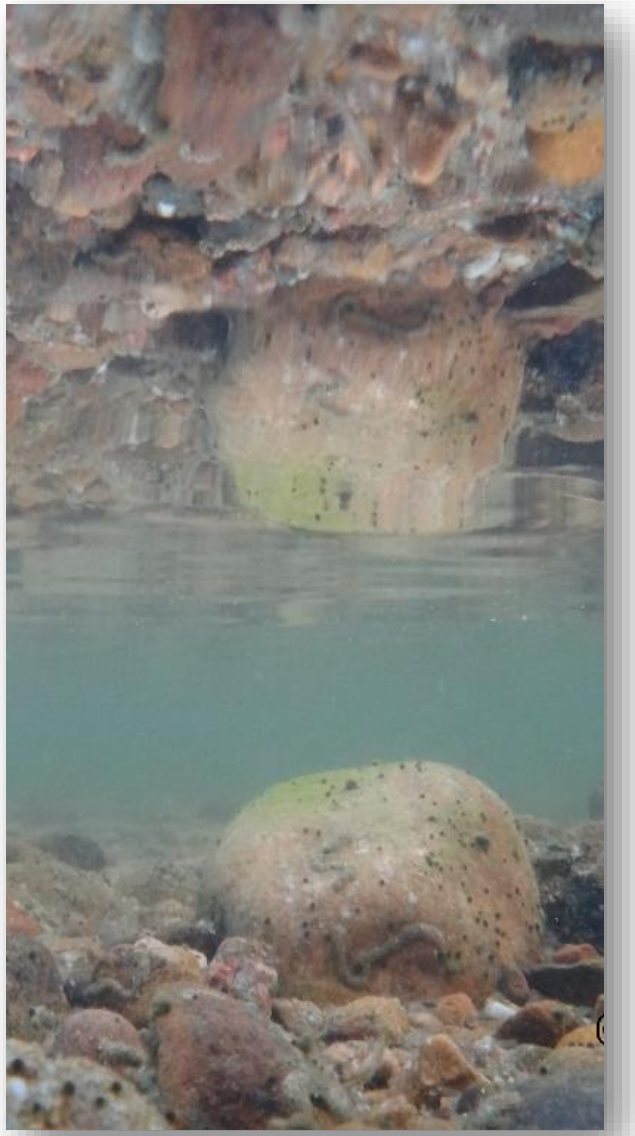
Total 615 km^2

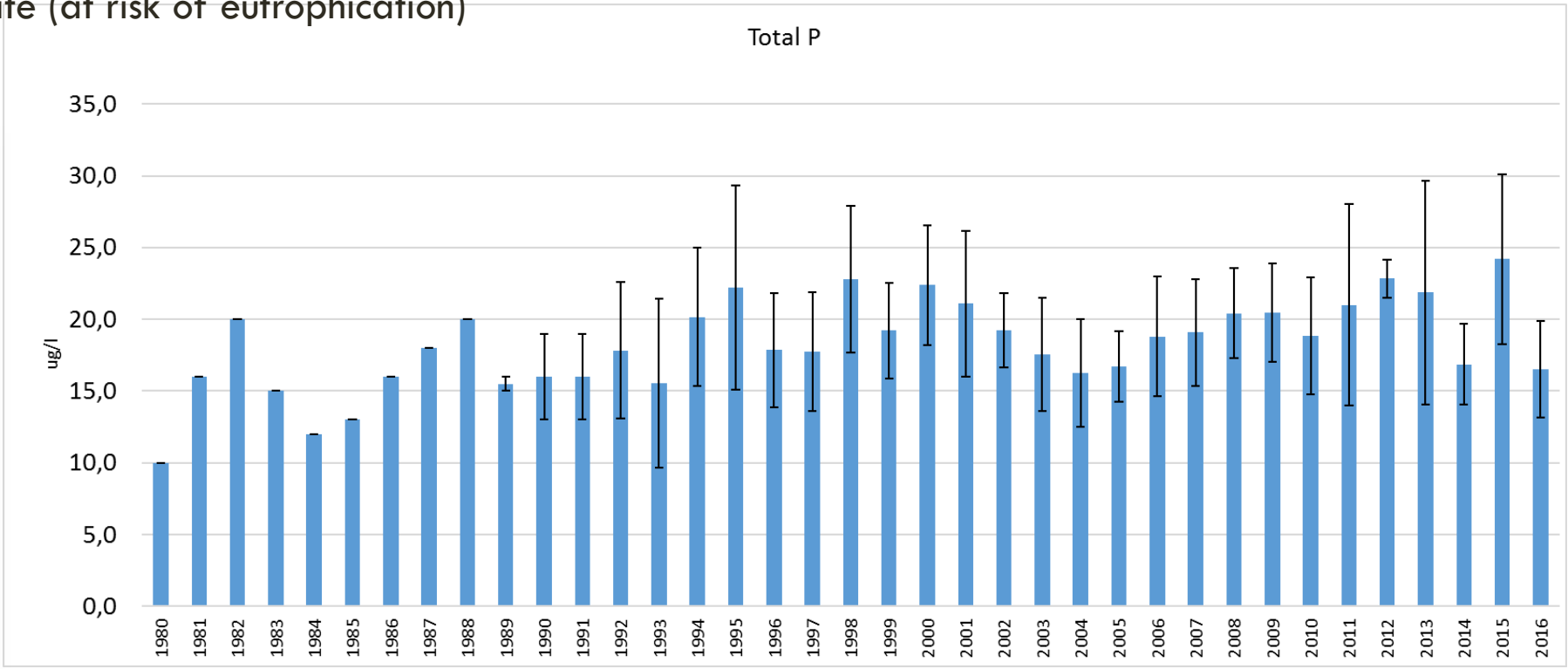
River Yläneenjoki 234 km^2

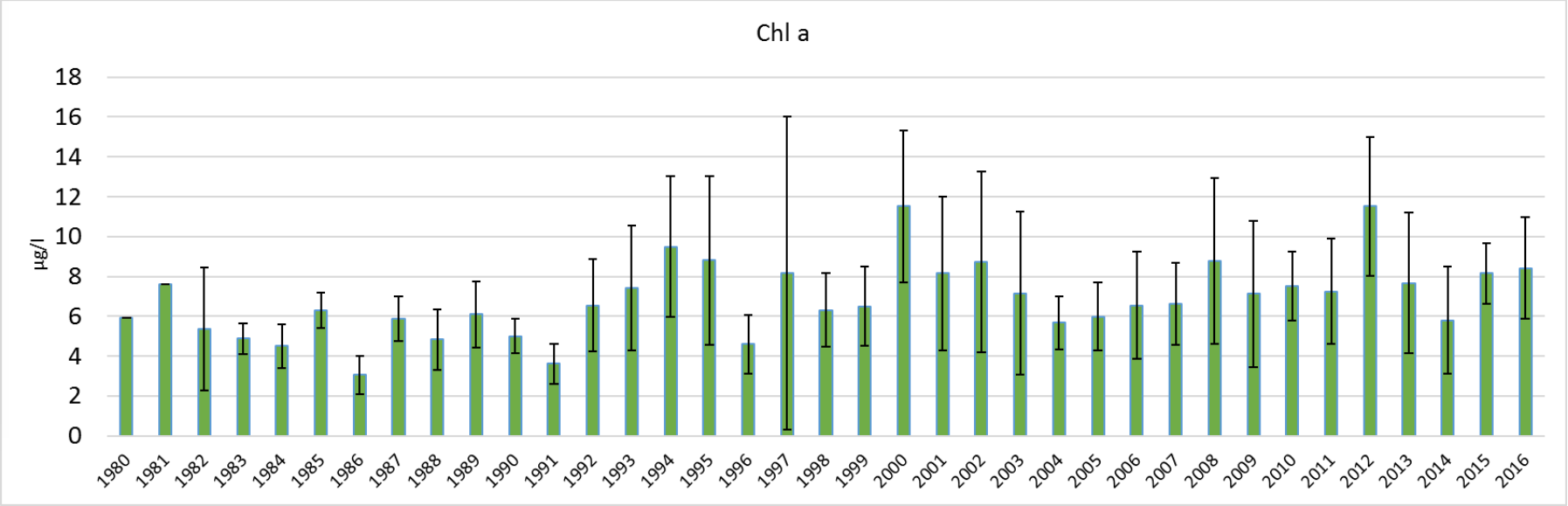
River Pyhäjoki 77,5 km^2

Remaining area (small sub-basins) 149,5 km^2

Mesotrophic, **GOOD** ecological state (at risk of eutrophication)





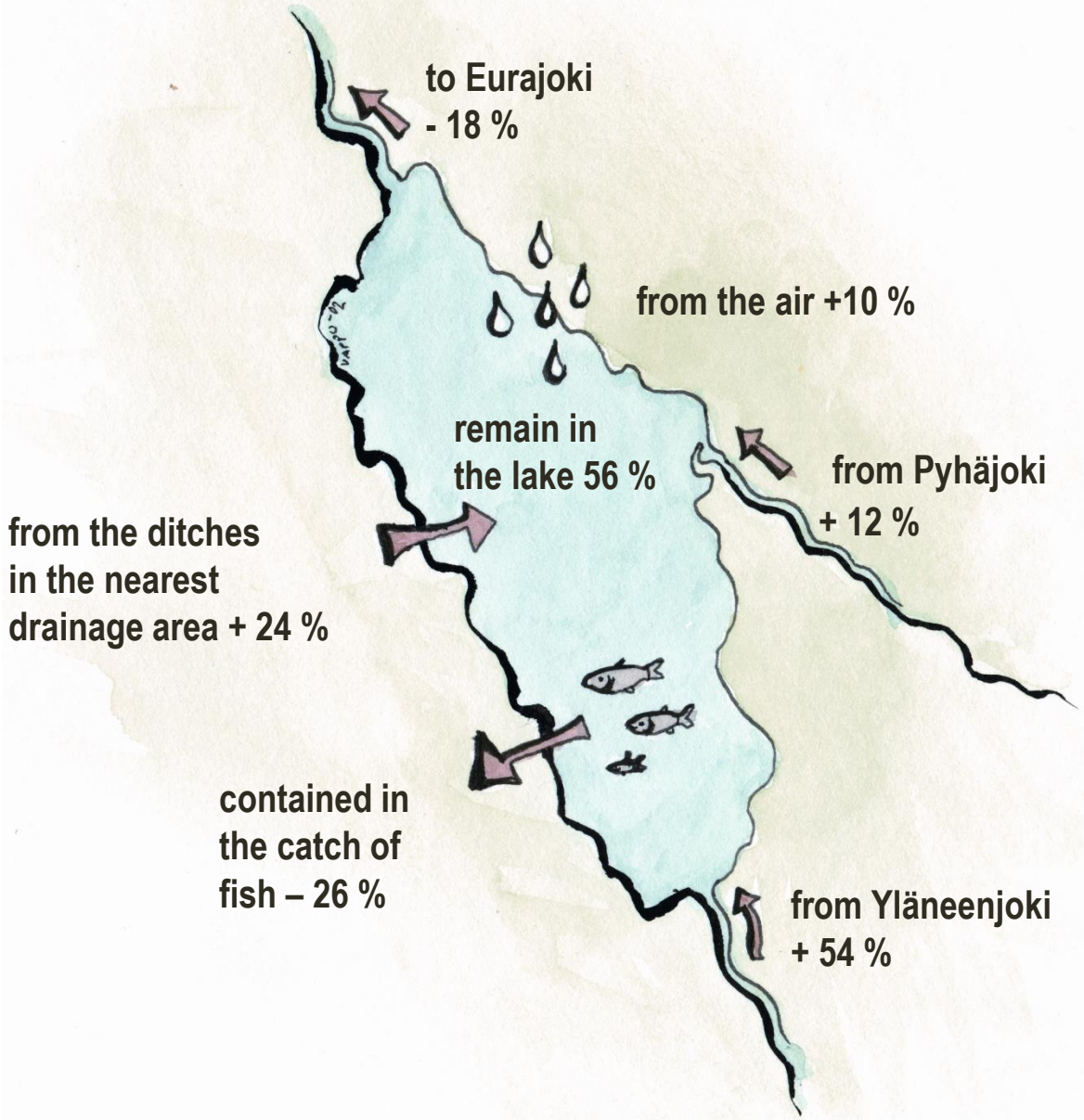


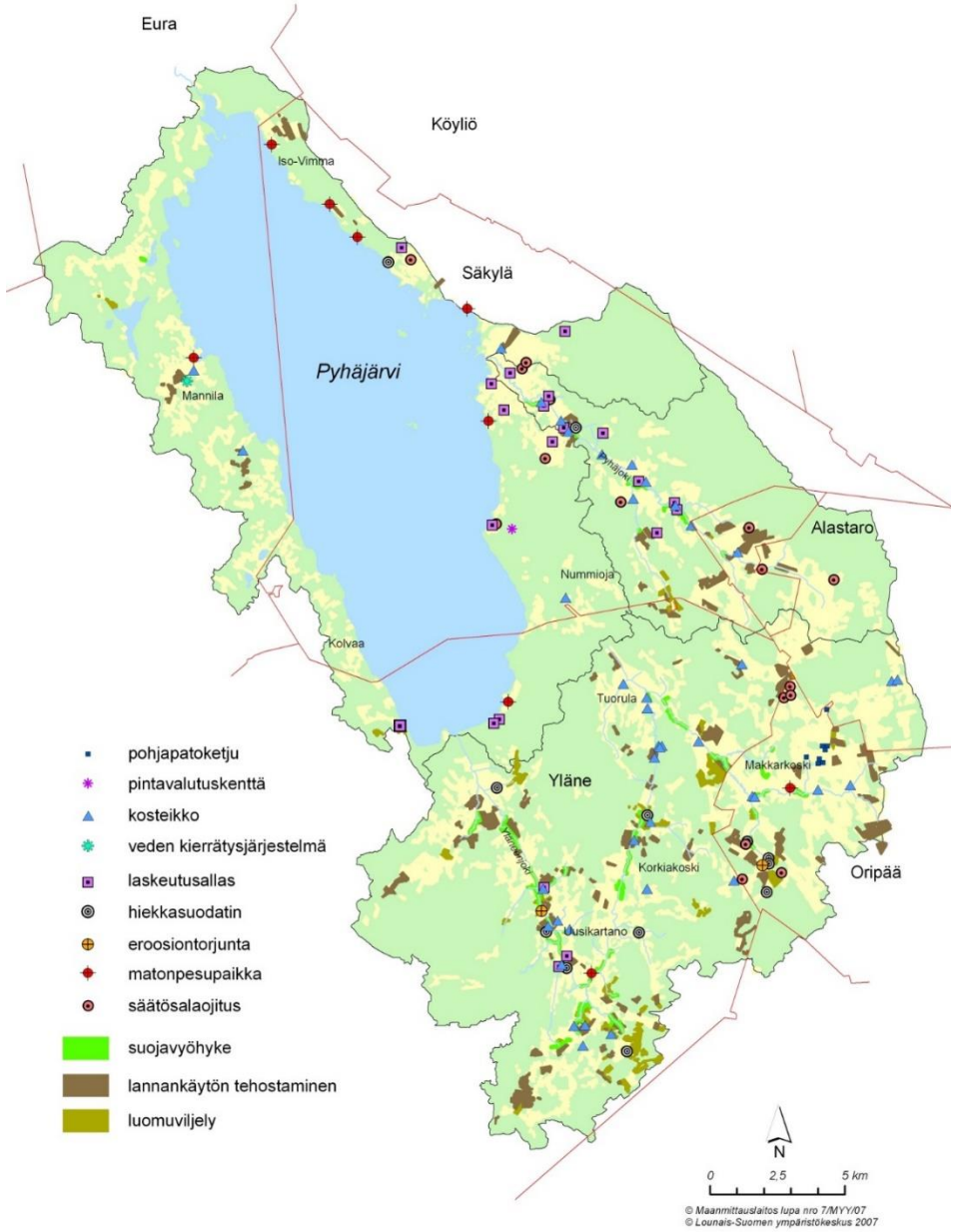
PYHÄJÄRVI RESTORATION PROGRAM 1995 -

1. **Management of the catchment area**
   - basic water protection measures
   - new innovations tested
   - rural area waste water treatment
   - Local people are participating
2. **Management of the lake**
   - commercial fishery
   - biomanipulation
3. **Education and communication**
4. **Research and monitoring**

MANAGEMENT OF THE CATCHMENT AREA

LAKE PYHÄJÄRVI PHOSPHORUS BALANCE





Water protection measures taken in the Lake Pyhäjärvi catchment

- Tens of wetlands
- Tens of sedimentation ponds
  - single, small sedimentation ponds
  - chain of small dam ponds
- Large areas of buffer zones
- Sand filters
  - Phosphorus binding amendments and sand
- Combination of ponds, wetlands and filters
- On-site wastewater treatment units
- Cattle yard renovations
- etc.

COST-EFFECTIVENESS, EASY MAINTENANCE, RECYCLIBILITY OF MATERIALS

Treatment of agricultural runoff waters

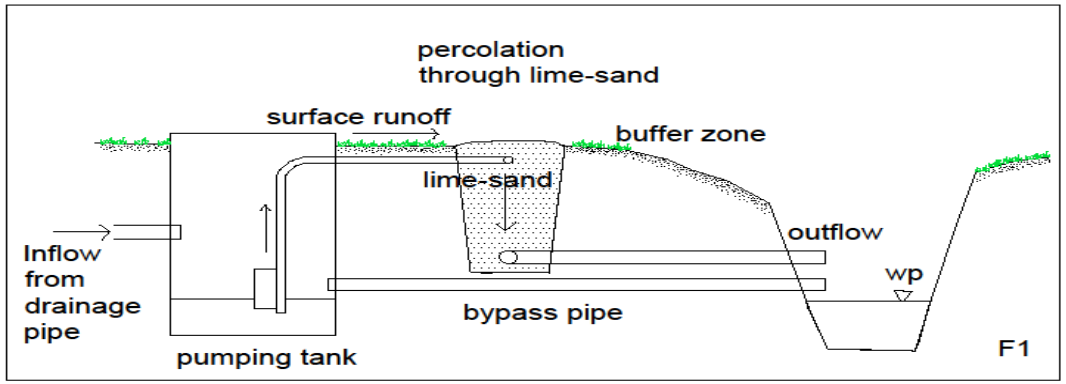
Maintenance and restoration of wetlands is needed!

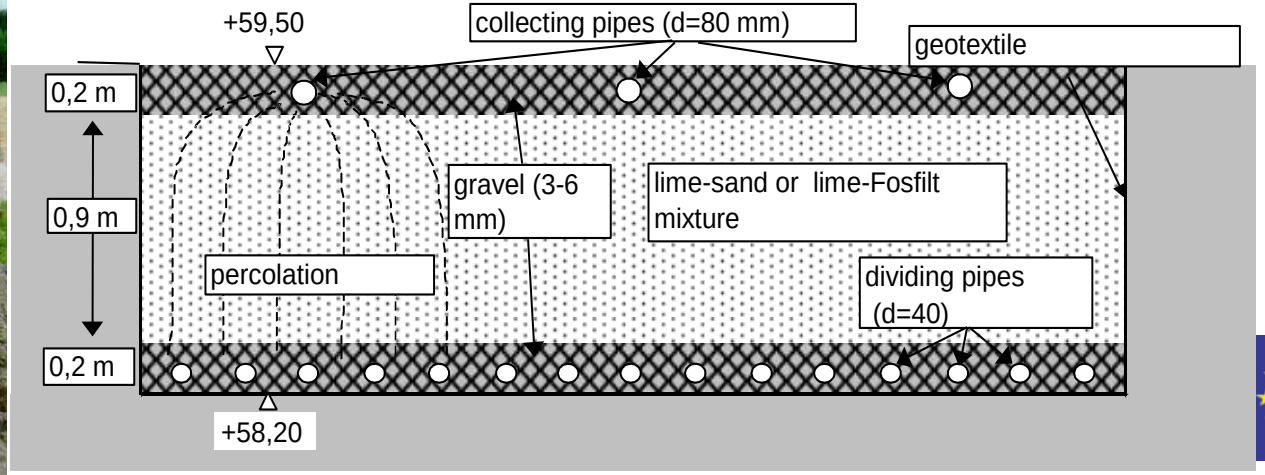
Wetlands and sediment traps/ponds

- From upstream to downstream
- SS and nutrient mitigation
- Water retention and flood control

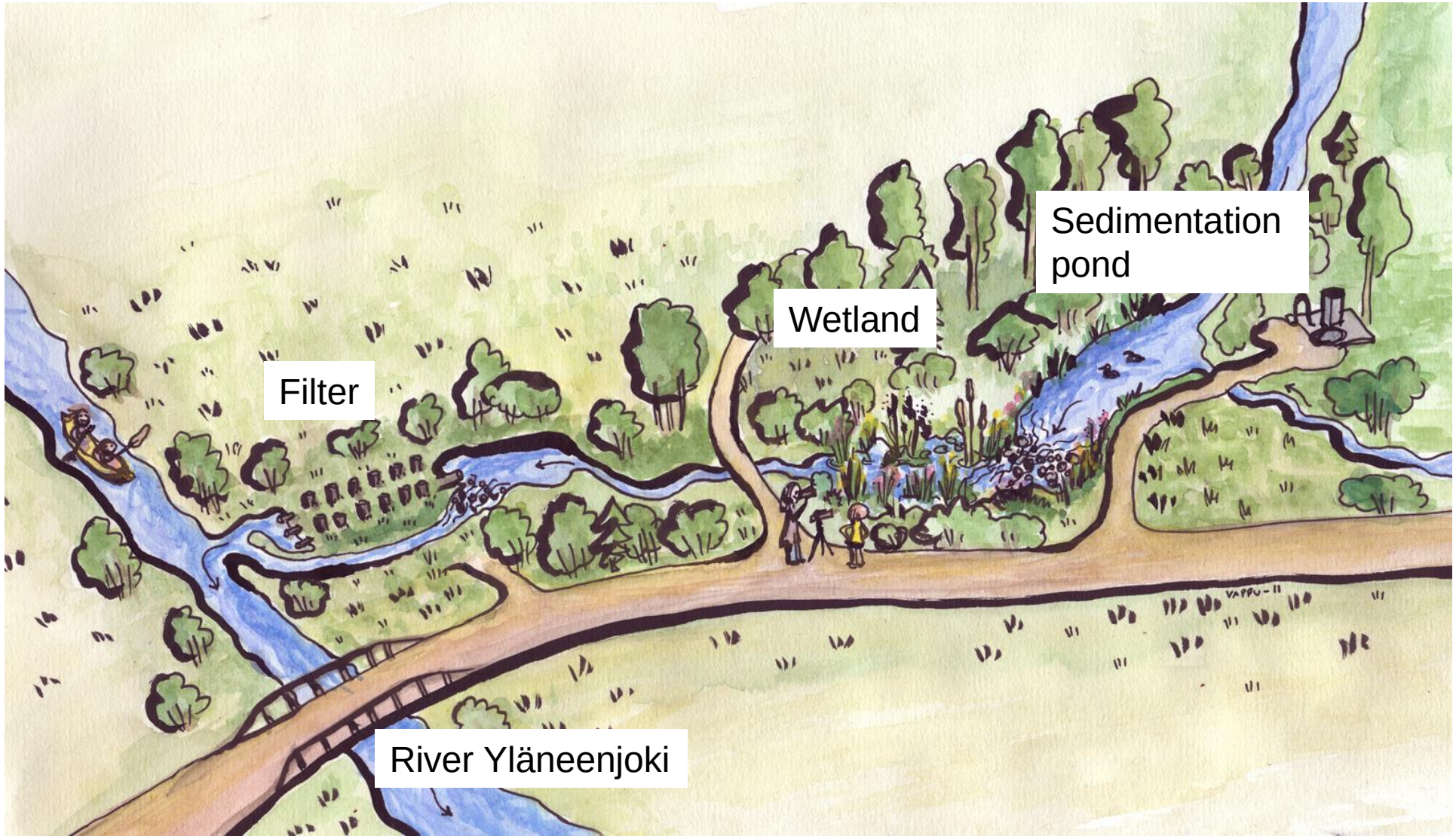
Filters with various structures of different scale since 1990's

•techniques were used for wastewater treatment but not for runoff waters before





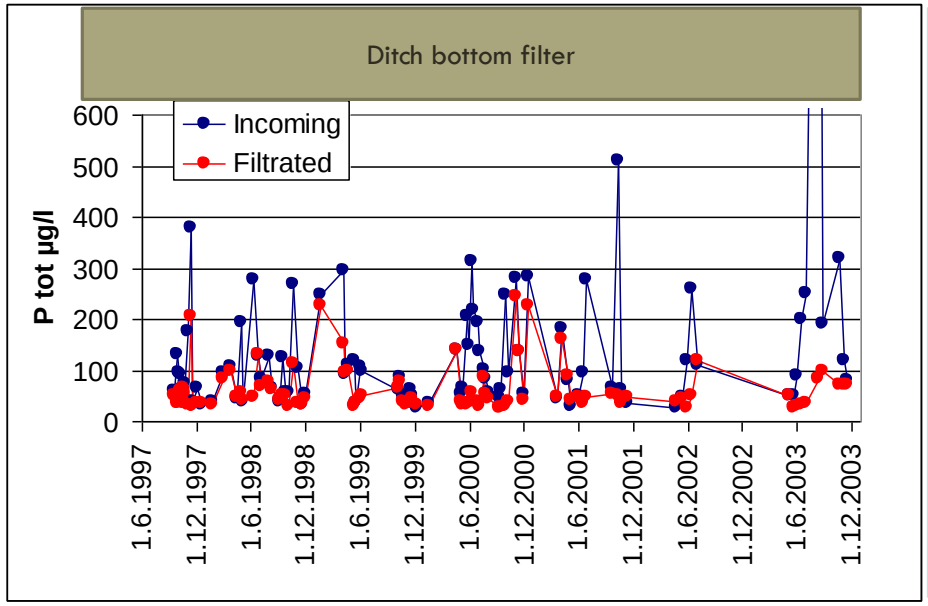
COMBINATION OF SEDIMENTATION POND-WETLAND-FILTER IN IMPONOJA

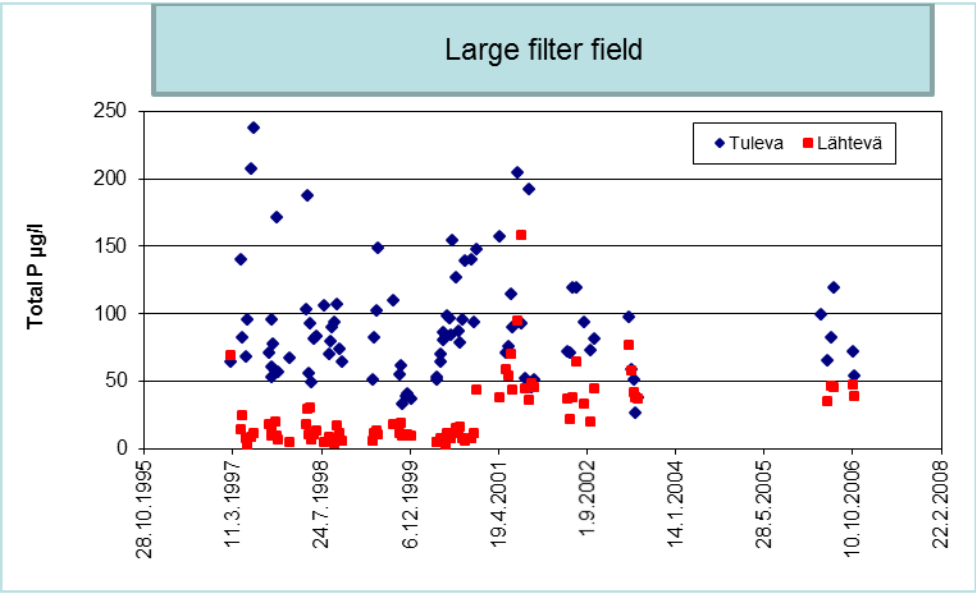


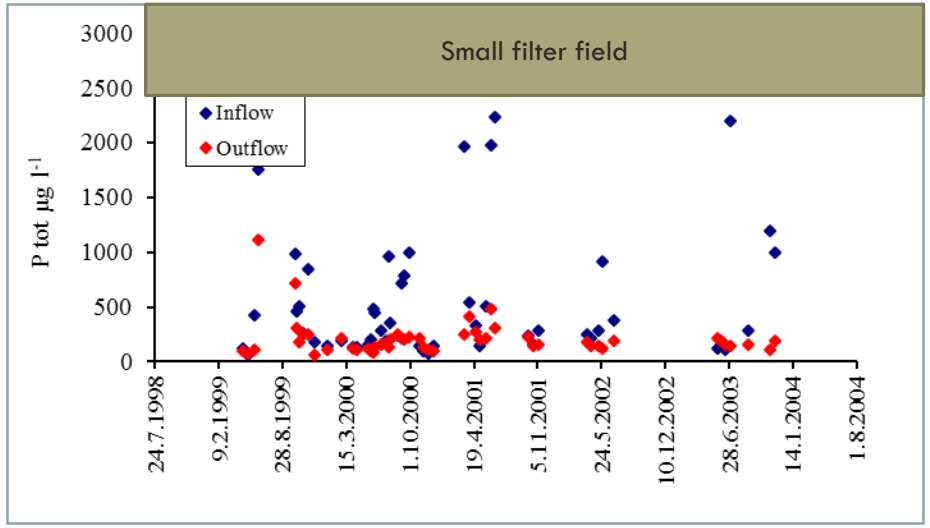
Filter bed

In 2000’s new filters with new commercial nutrient adsorbing materials

Ditch bottom filters



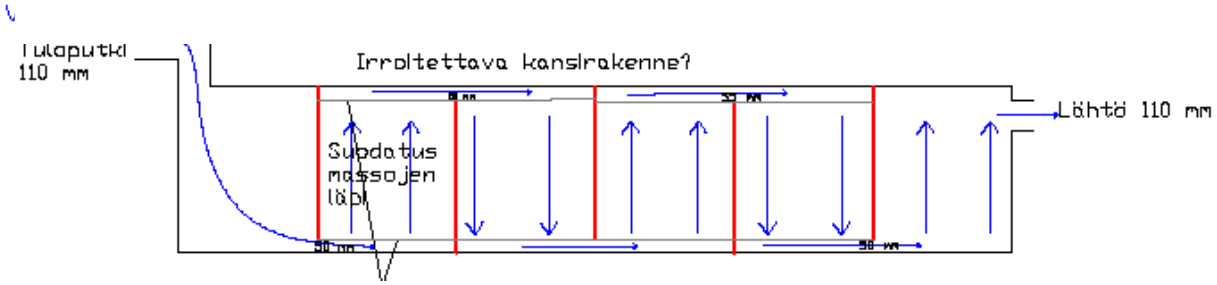




Reduction of

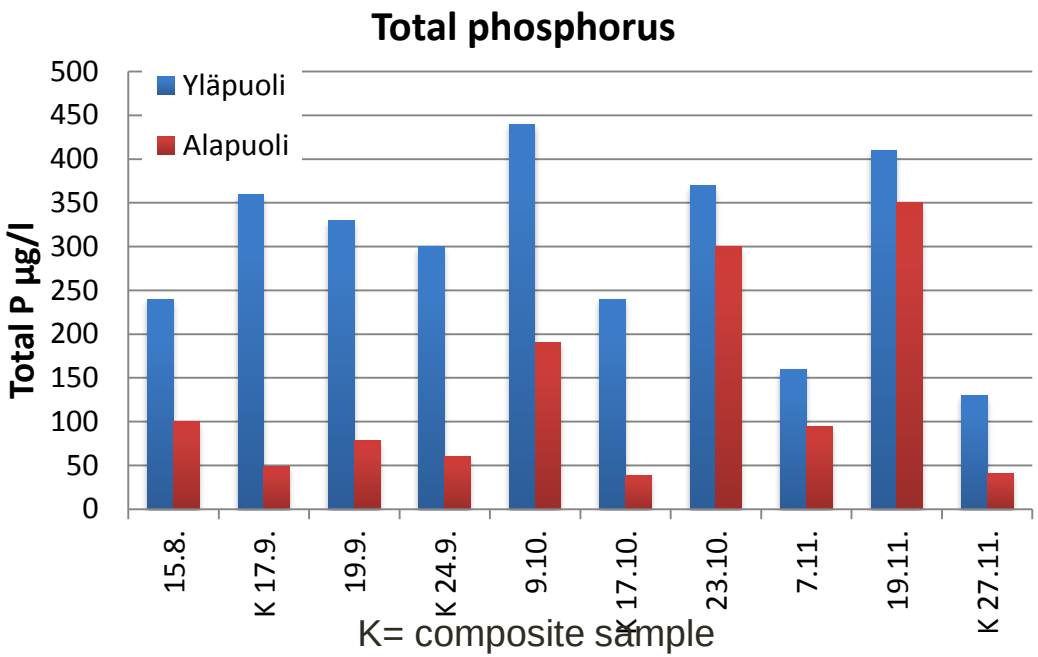
- suspended solids 37 – 94 %
- total phosphorus 37 – 82 %
- nitrogen 4 -28 %

Experimental small-scale filter cartridge



For the treatment of subsurface drainage waters

- CaOH –granules and sand



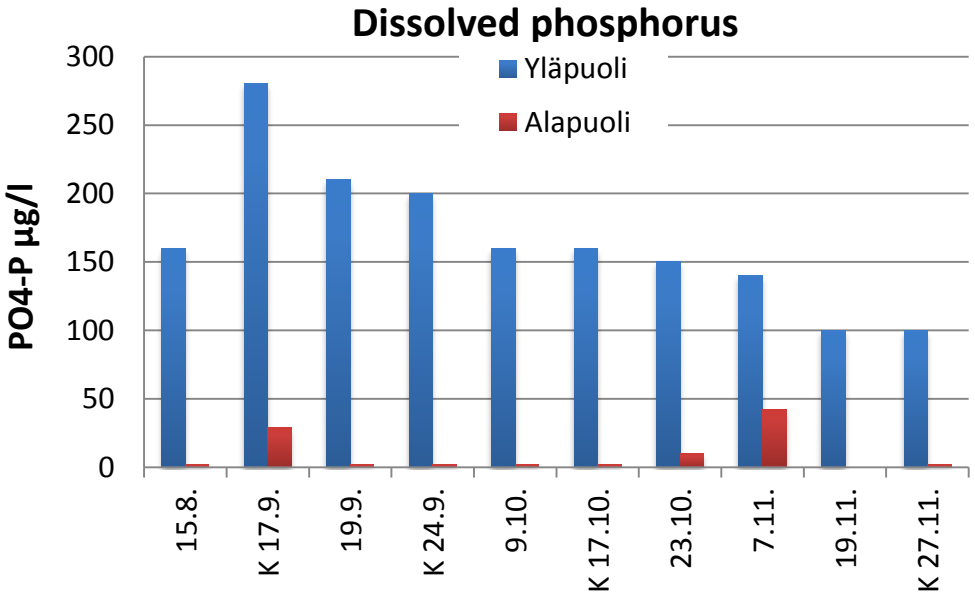
Results in 2013

CaOH/sand 50/50

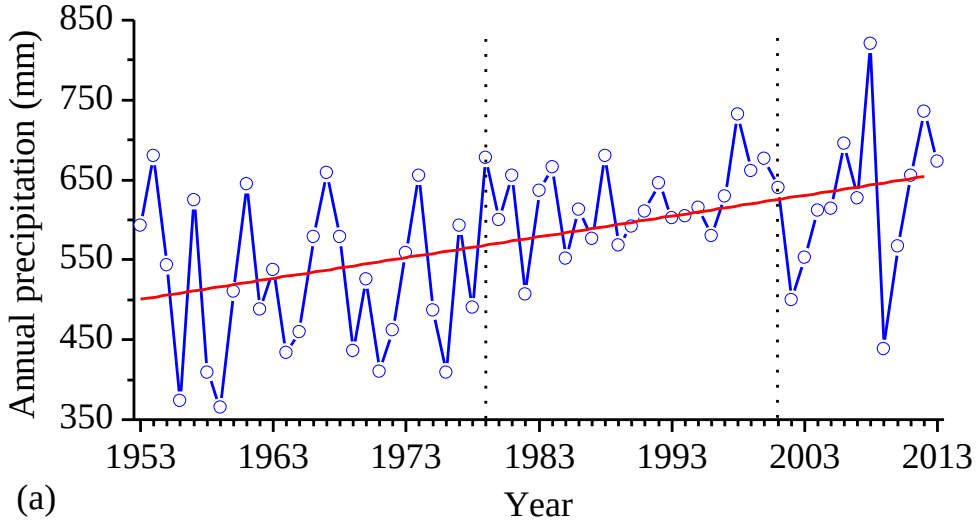
Changes in concentration:

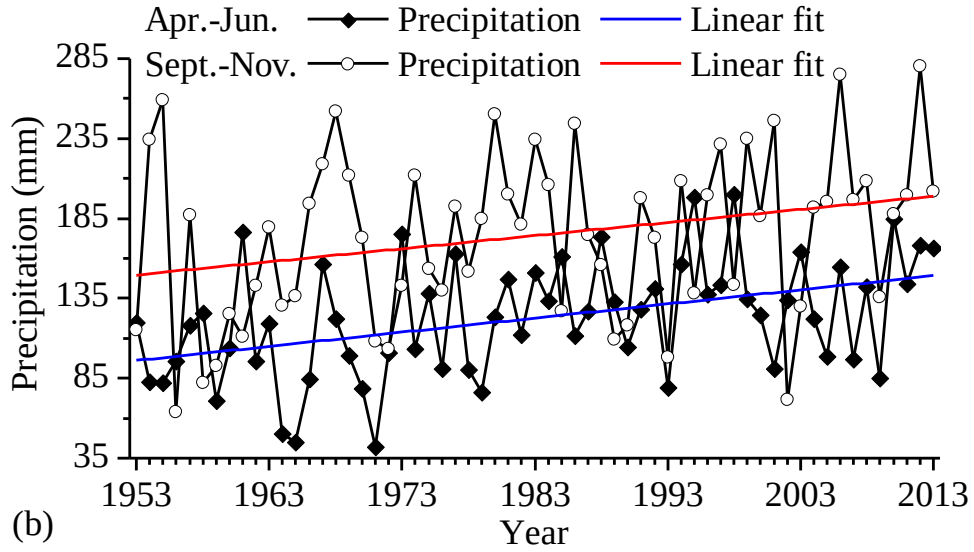
Total P: DS – 56%

PO4-P: DS – 94%



CLIMATE CHANGE - PRECIPITATION





Pyhäjärvi

Annual precipitation

- Variation has change in the course of time
- More precipitation with reduced yearly rainy days (decline 10.6d/10 yr 1953-2013) has lead to heavier rains
- Soil erosion increase

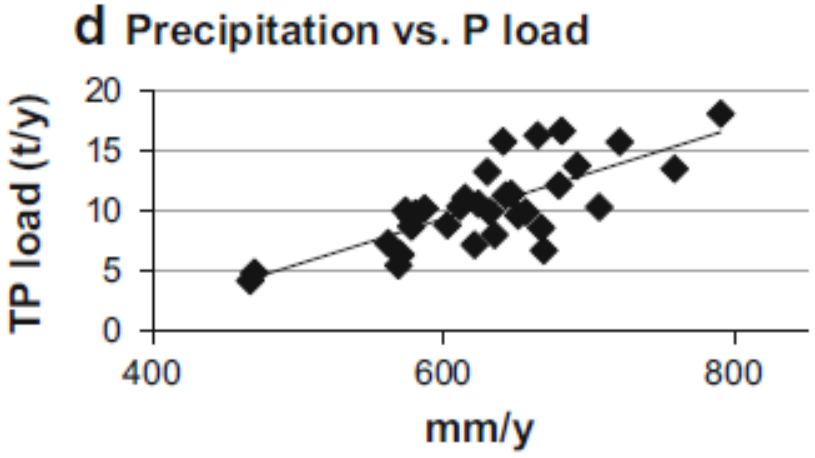
Seasonal precipitation

- Increasing trend

Variation increased

CHALLENGES IN P LOAD REDUCTION

- annual load is too much linked to precipitation, Ventelä et al. 2015
- extreme events



MAIN FOCUS IN THE FUTURE – ”GAZING AT THE FIELDS”

- **Farming technics and solutions**
- Soil structure
- Challenges related to changing climate

MANAGEMENT OF THE LAKE: FISHERY

PYHÄJÄRVI INSTITUUTTI

Professional fishermen working in the lake = top predators of the system!

Pyhäjärvi has 20 professional fishermen

Total catch 600 000 – 800 000 kg/year

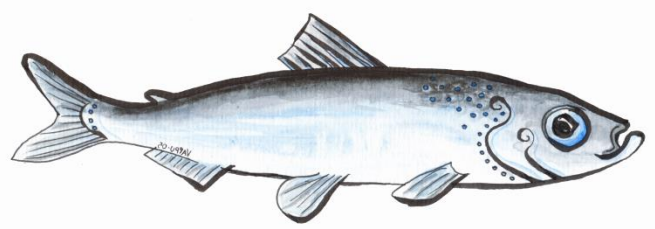
FISHING METHODS

Tradionally most of the catch has been fished during the **winter with seine net**

- The catch is transported to harbour in a ice-water in transboxes
- Very cost efficient and effective method
- Catches 20 000 kg/day/group of fishermen

During the **open water season** the main (professional) fishing methods are the fyke net and open water seine

LONG-TERM BIOMANIPULATION IN PYHÄJÄRVI =



Planktivores:
Vendace
Whitefish
Smelt
juveniles (many species)

Commercial catch, especially planktivores vendace (*Coregonus albula*) and whitefish (*Coregonus lavaretus*)

+

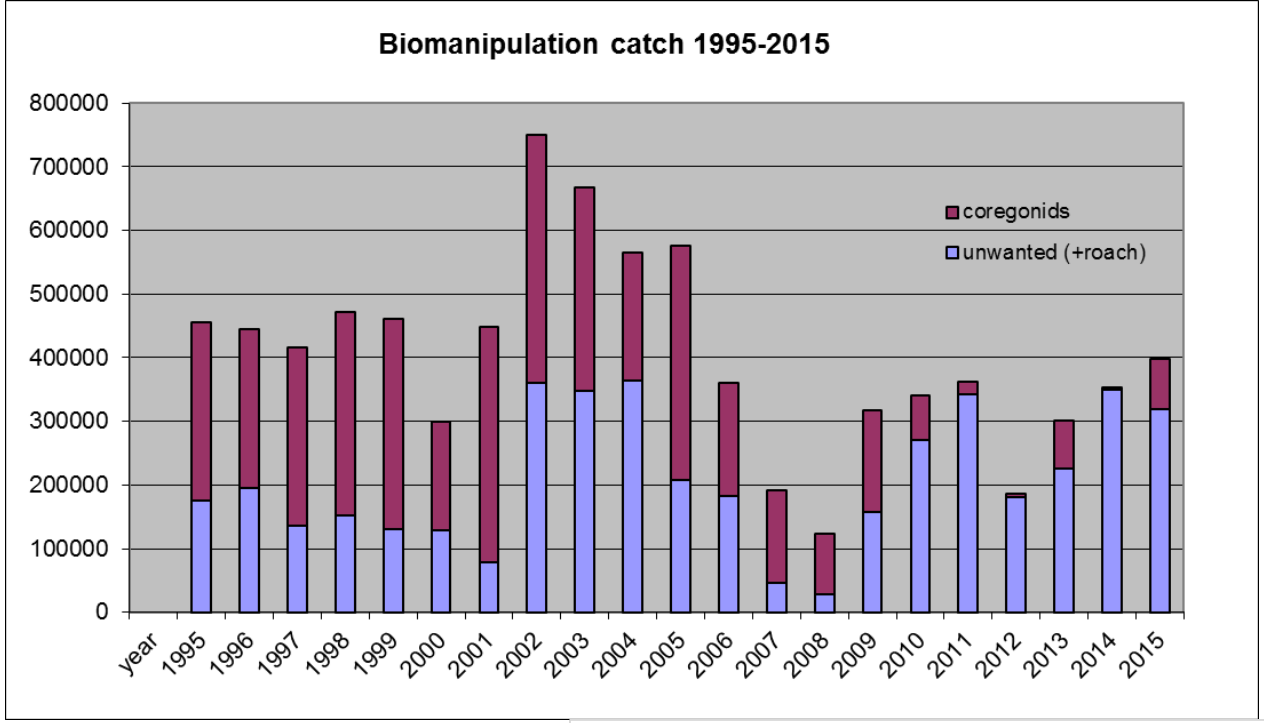
Fishing of commercially unwanted fish species:

Smelt (in France 2017)

Bream

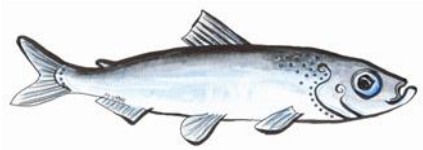
Ruffe

Roach (increasingly commercial since 2013)



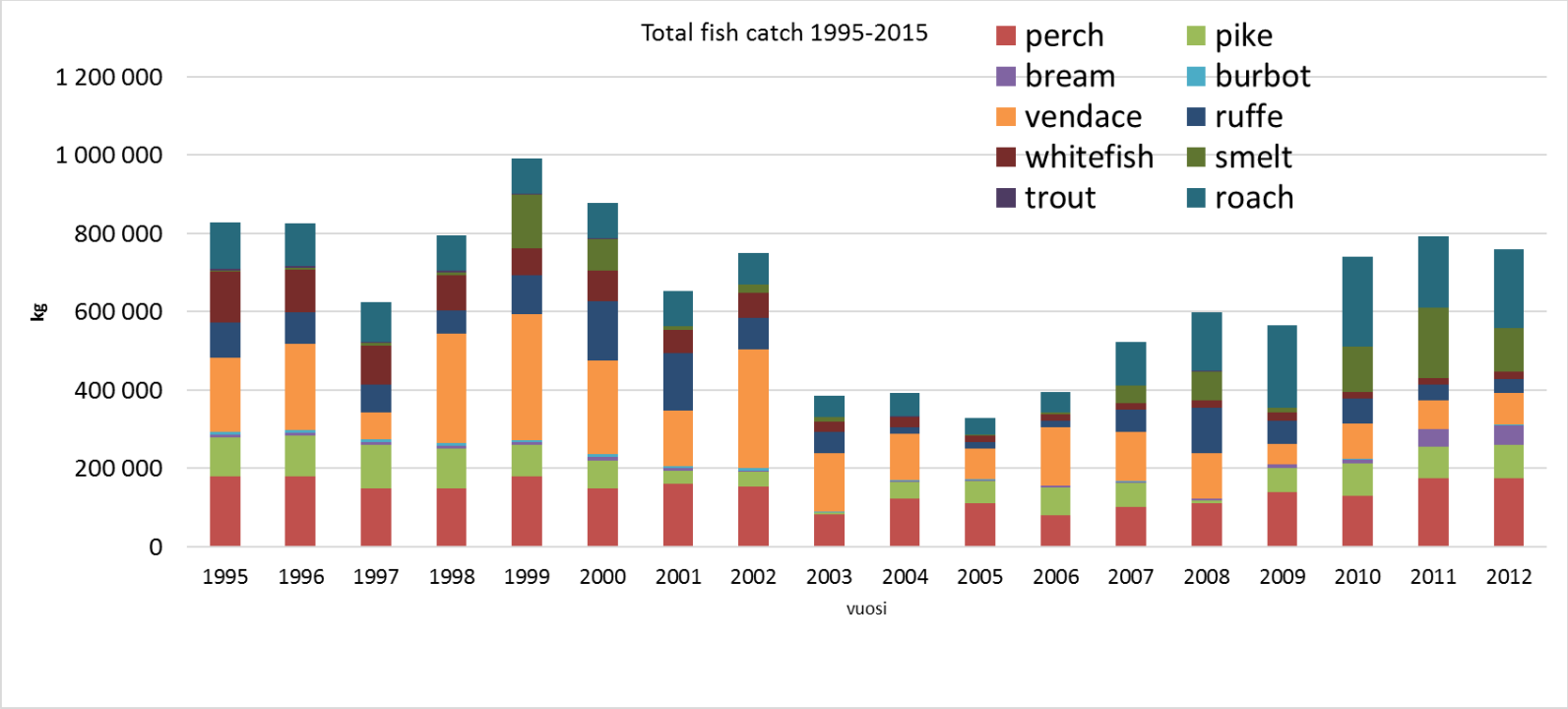
Total biomanipulation catch 1995-2015

8 490 608 kg



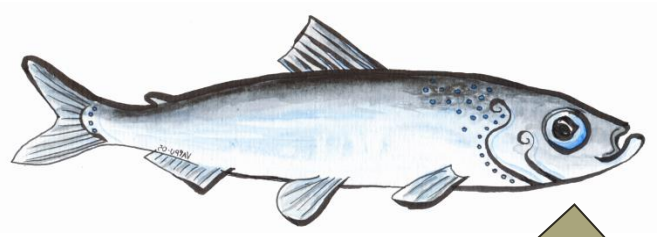
Total catch 1995-2015

14 368 732 kg

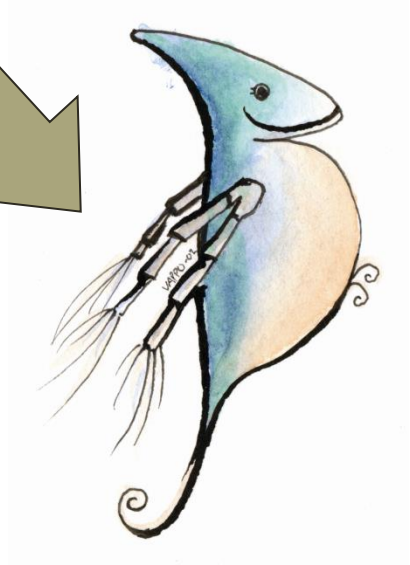


HOW BIOMANIPULATION IS WORKING IN PYHÄJÄRVI?

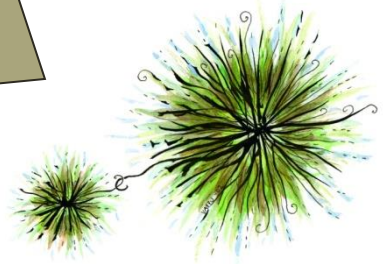
1. VIA FOOD CHAIN



Strong **planktivorous fish stocks**, strong predation pressure on zooplankton



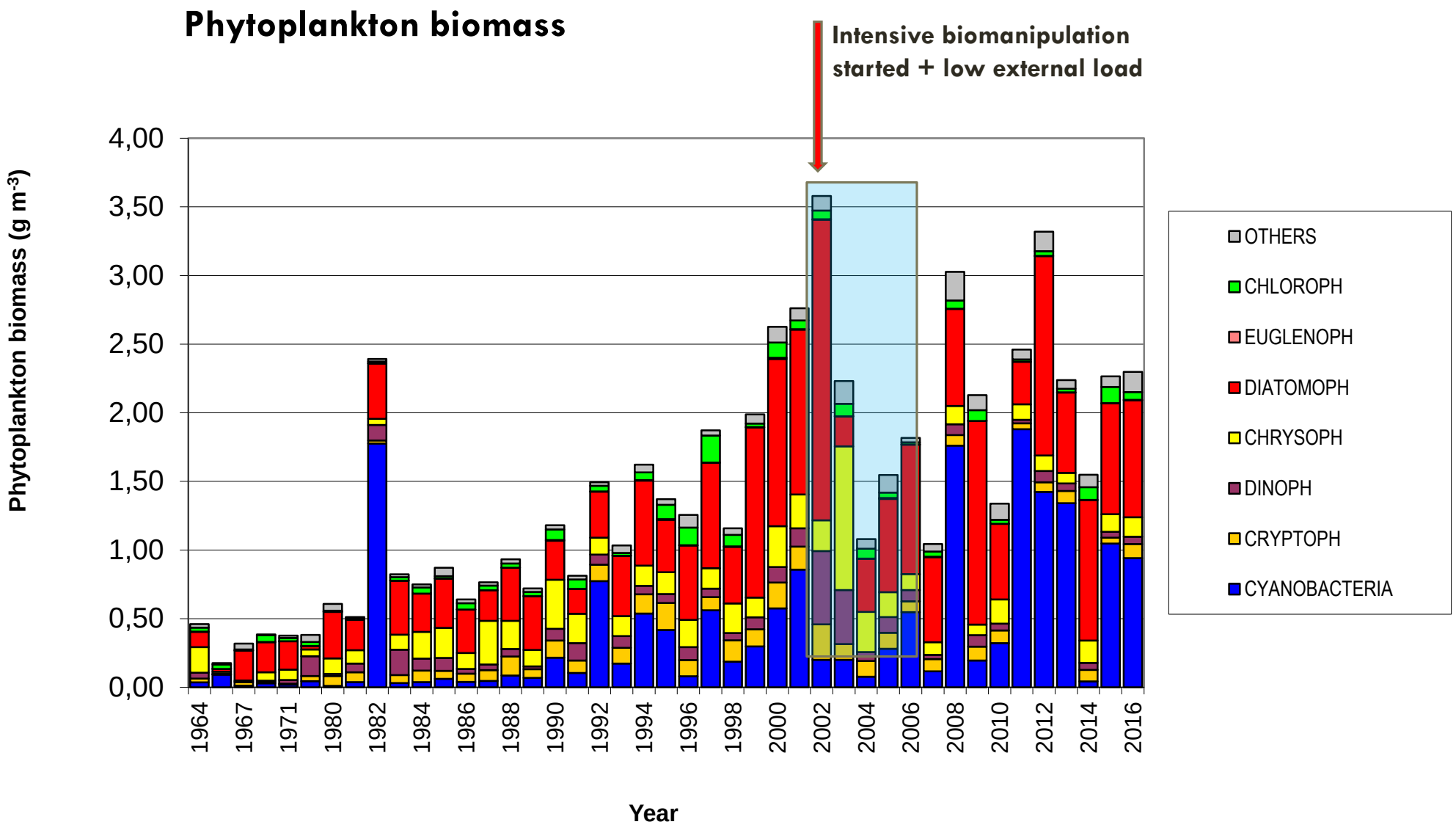
number and body size of *Daphnia* decreaces



Phytoplankton not controlled by zooplankton, becomes more abundant

Sarvala et al. 1999, Ventelä et al. 2016

PREDATORY FISH CRUCIAL ROLE


Phytoplankton biomass
Intensive biomanipulation started + low external load
Phytoplankton biomass (g m-3)
4,00
3,50
3,00
2,50
2,00
1,50
1,00
0,50
0,00
1964
1967
1971
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Year
OTHERS
CHLOROPH
EUGLENOPH
DIATOMOPH
CHRYSOPH
DINOPH
CRYPTOPH
CYANOBACTERIA

2. VIA NUTRIENT REMOVAL

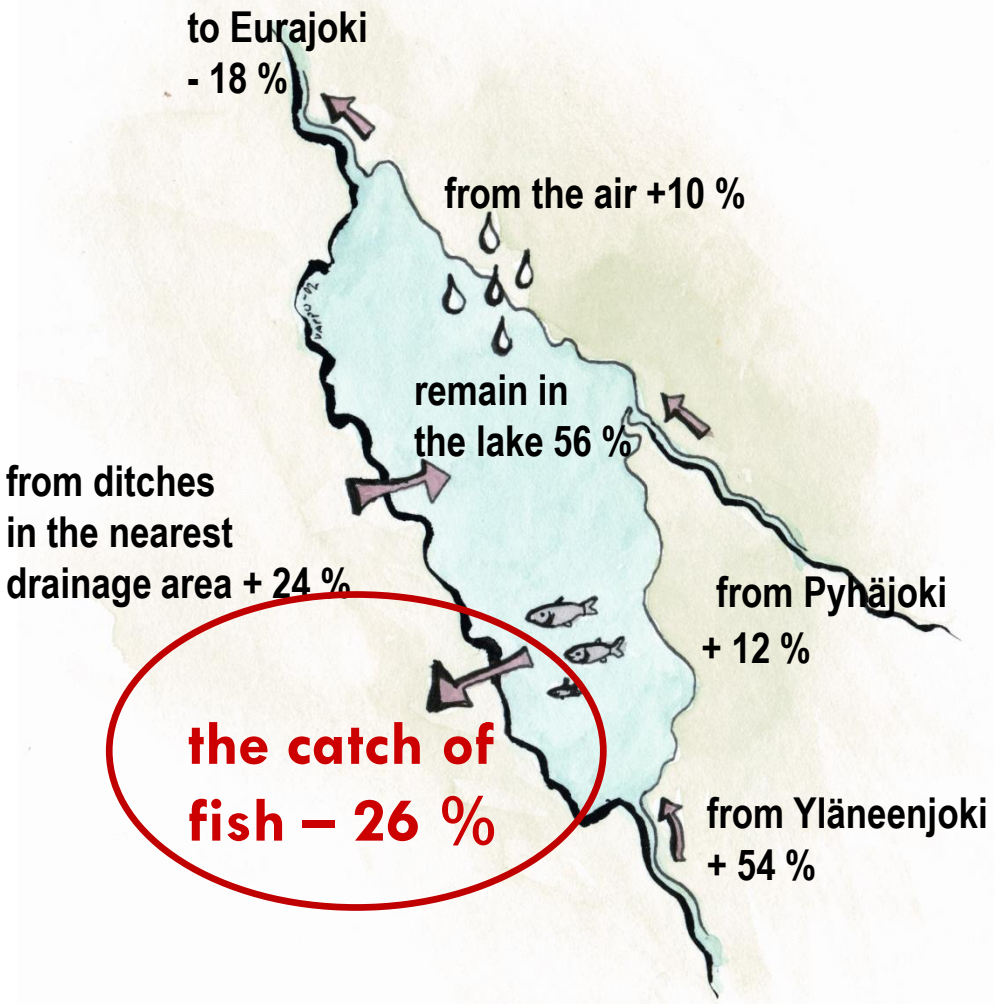
26 % of the annual phosphorus load is removed from the lake with the fish catch!

Total commercial catch 1995-2015

14 368 732 kg

→ ~ 93 000 kg removed phosphorus

Ventelä et al. 2007, 2011



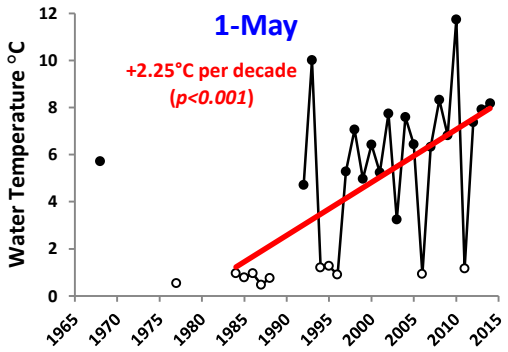
3. VIA SEDIMENT RESUSPENSION

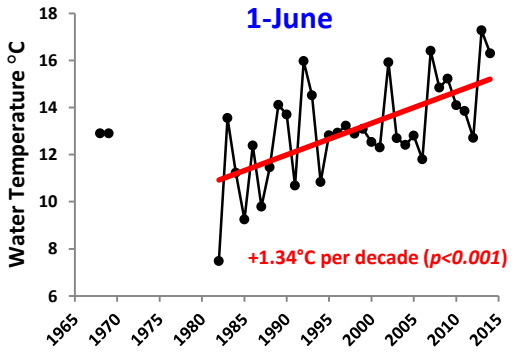
Ruffe, roach, bream

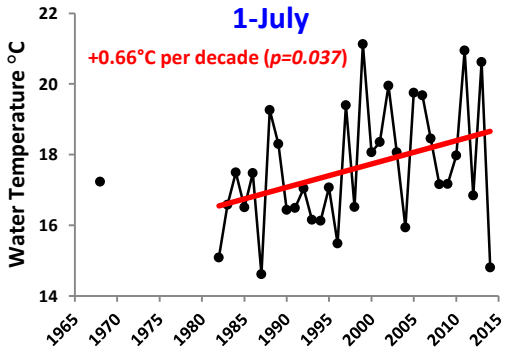
Tarvainen et al. 2005, Freshwater Biology

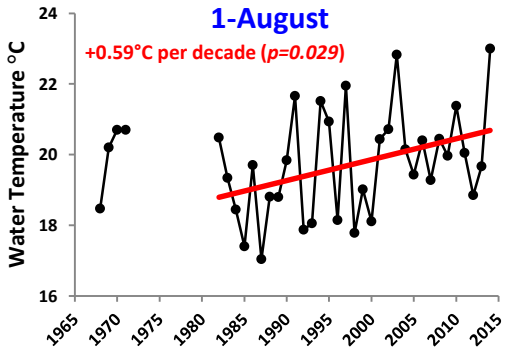
NEW CHALLENGES

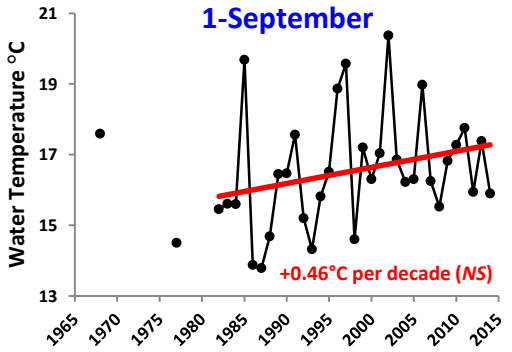
Pyhäjärvi seasonal trends for water temperature
(1982-2014)

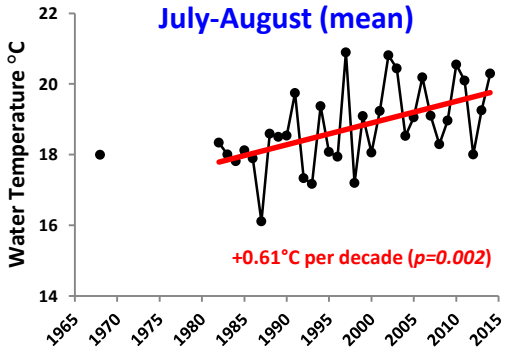


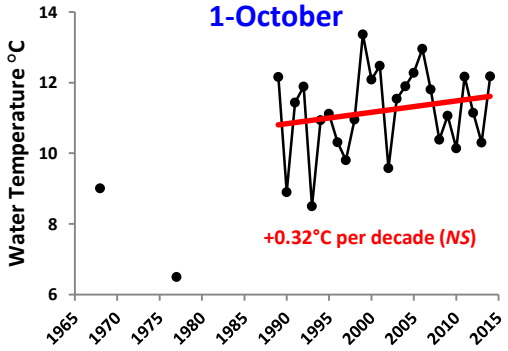


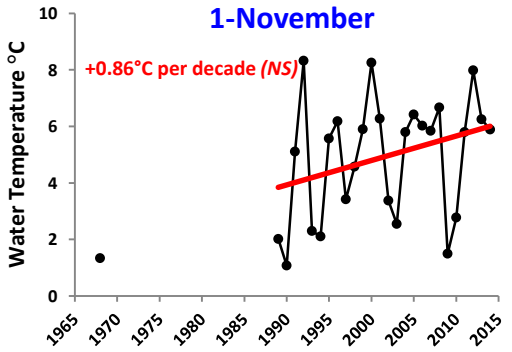




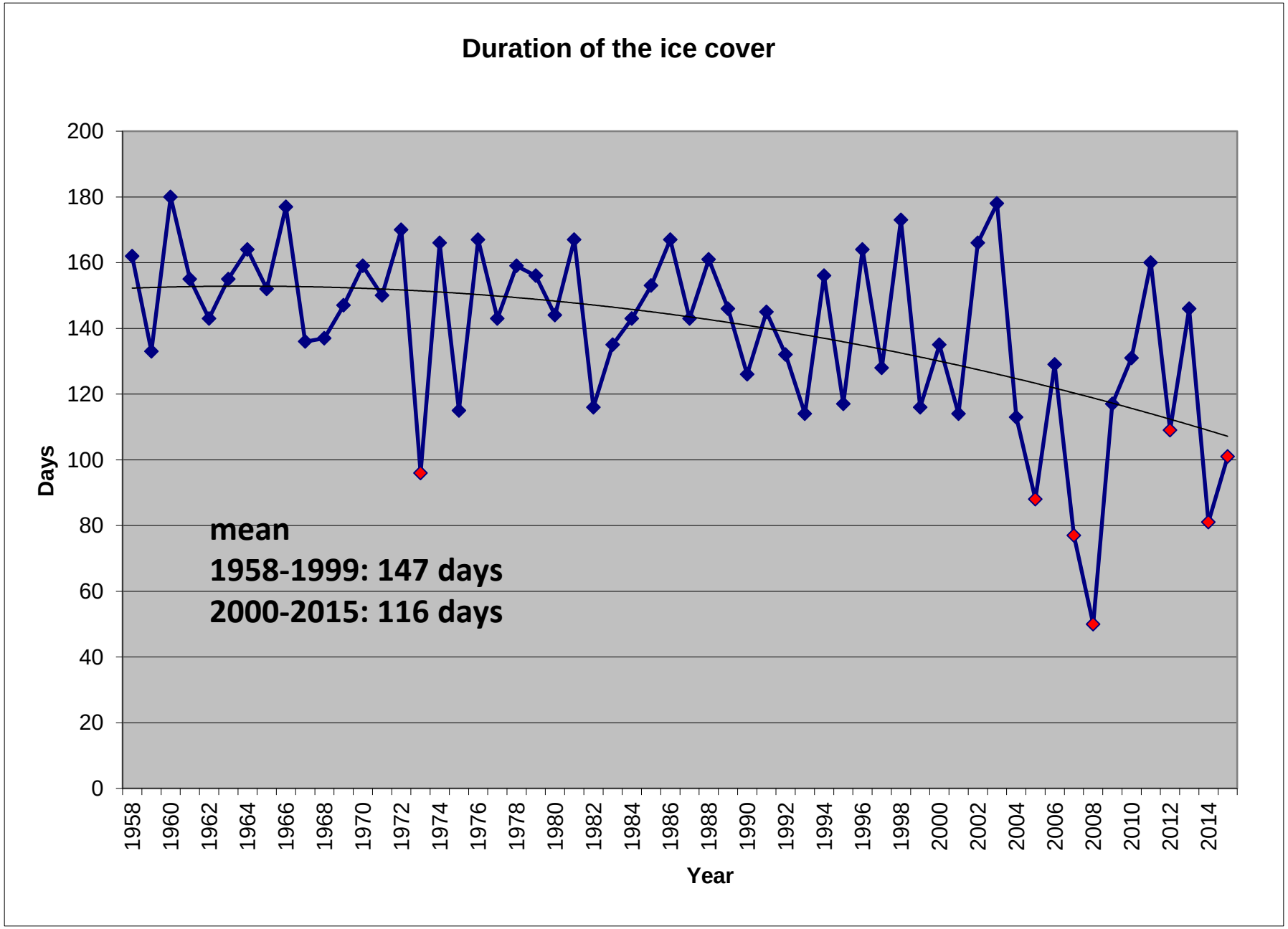






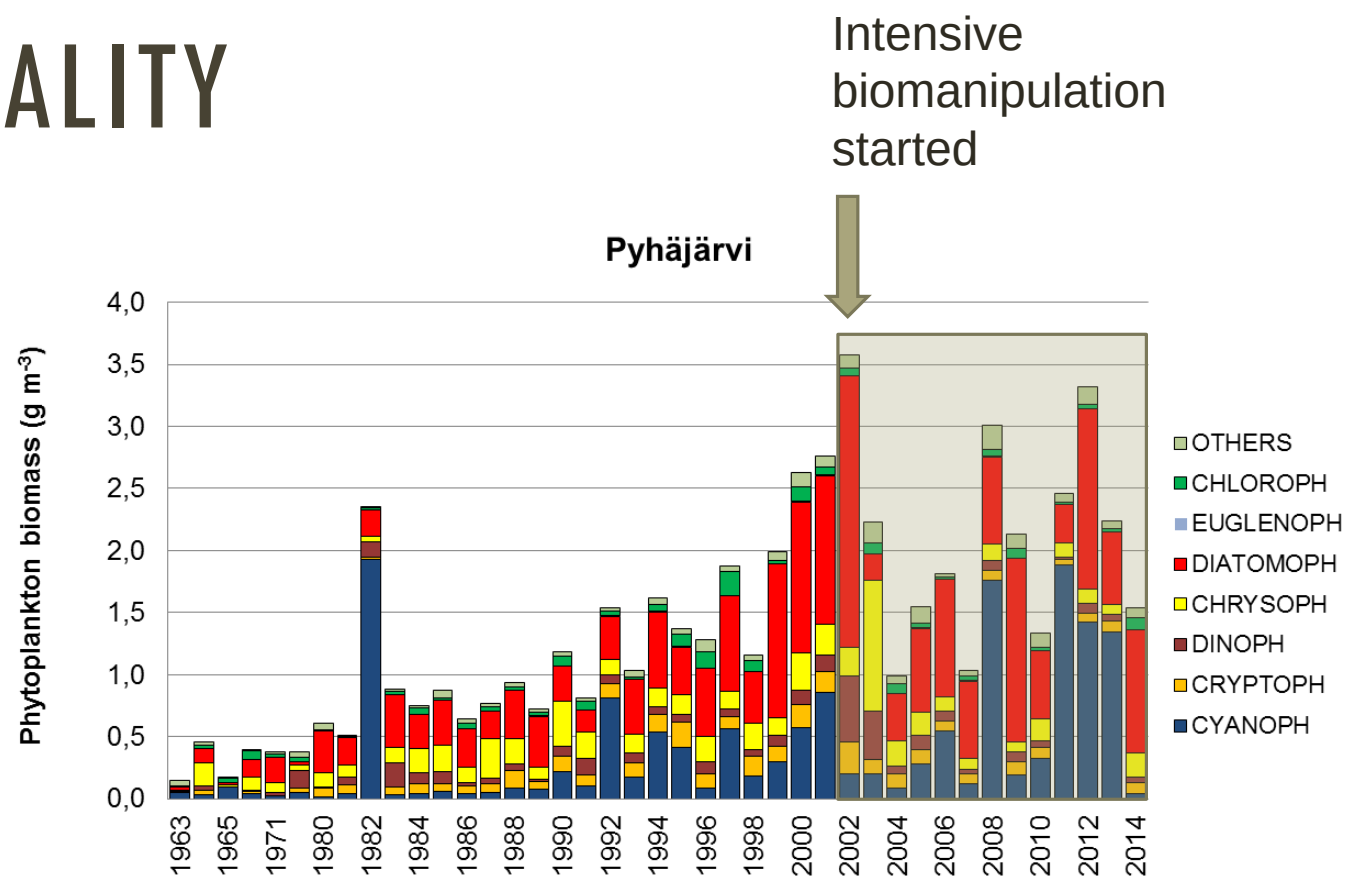


Source: Lathrop, Kasprzak, Ventelä, Tarvainen, et al., unpubl. data



Ventelä et al. 2011, updated

WATER QUALITY



Deng et al. (2016):

- increasing wind speed decreased Secchi depth, promoting shade-tolerant taxa such as *Planktothrix*.
- increased mixing reduced the loss rate of the heavy taxa such as *Tabellaria*.
- Increased nutrient concentrations and water temperature would also promote both *Planktothrix* and *Tabellaria*.

RESEARCH

PYHÄJÄRVI INSTITUUTTI

MONITORING

We are monitoring the lake for:

- Nutrients
- Secchi depth
- Chlorophyll a
- Fish catch
- Phytoplankton
- Zooplankton

Also:

- Efficiency of the water protection measures
- Flow rates in the catchment ditches

Co-operation with authorities and several universities in Finland (Turku, Helsinki, Jyväskylä…)

INTERNATIONAL RESEARCH CO-OPERATION

- Japan
  - Tohoku University
  - Okayama University
- China
  - NIGLAS
  - Taihu Basin Authority
  - Ministry of Water Resources
  - Shanghai Ocean University
  - Changjiang Water Resources Protection Institute
- Sweden
  - Swedish Agricultural University
  - Royal Technical University

Estonia, Latvia

- Estonian Agricultural University
- Tallinn Technical University
- Riga Technical University
- Institute for Environmental Solutions

- Denmark
  - Aarhus University
  - Eurofish
- USA
  - Wisconsin University
- Vietnam
  - Institute of Environmental Science and Engineering (Hanoi University of Civil Engineering)
  - Department of Agriculture and Rural Development (Ho Chi Minh City)
  - Ho Chi Minh University of Technology and Education.


THANK YOU!
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