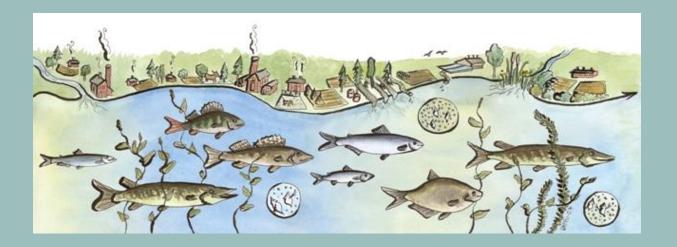
### COMMERCIAL FISHERY IS REMOVING EFFICIENTLY PHOSPHORUS FROM LAKE SÄKYLÄN PYHÄJÄRVI



Anne-Mari Ventelä, Tero Forsman, Henri Vaarala, Teija Kirkkala Pyhäjärvi Institute

**Jouko Sarvala** University of Turku



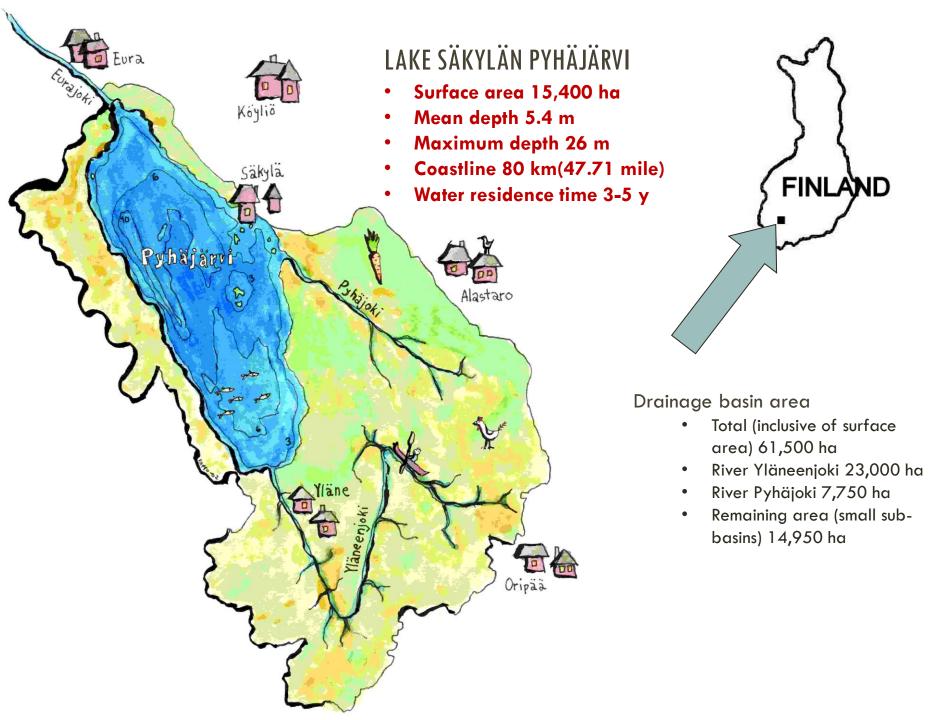


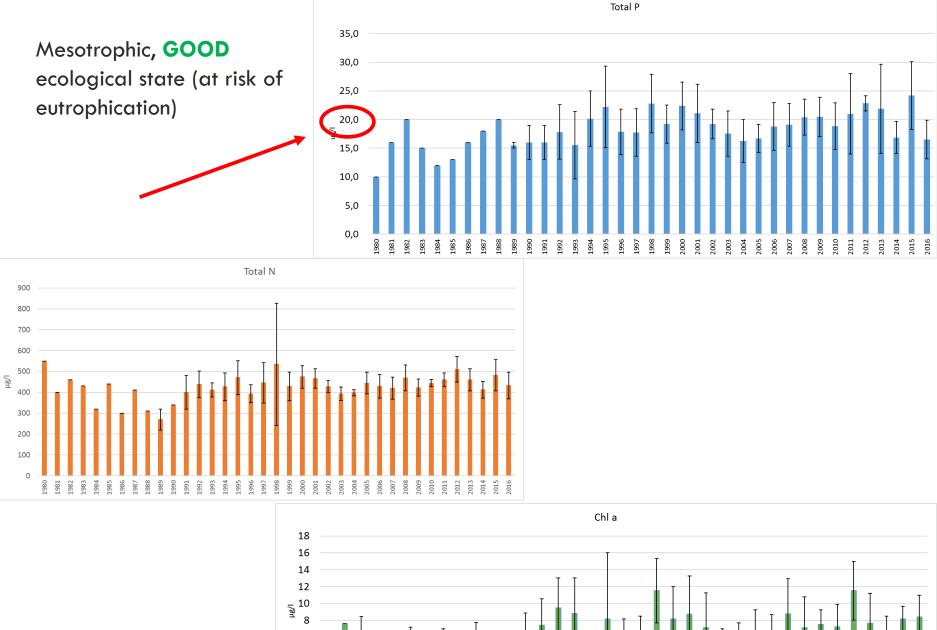


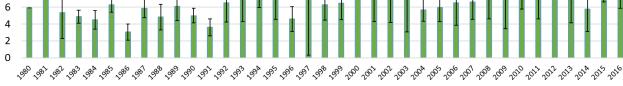
**Leverage from** 

2014-2020

European Union European Regional Development Fund









## 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

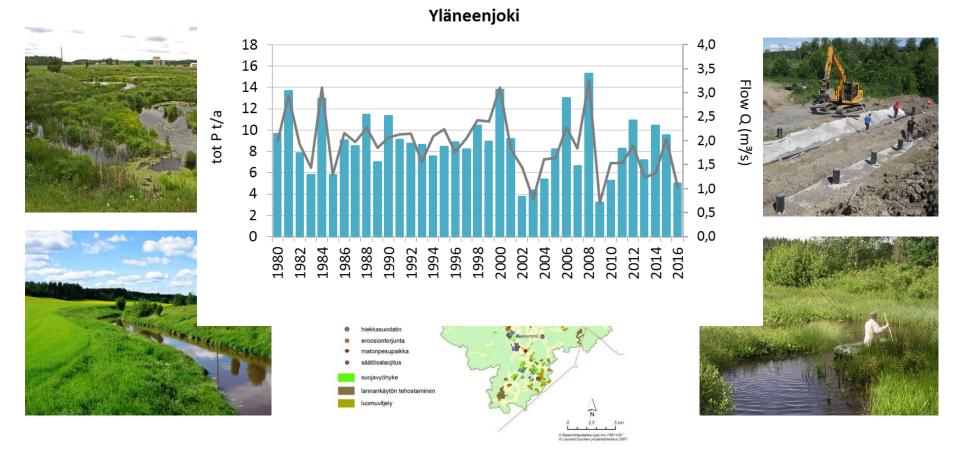
### 2. Management of the lake

- commercial fishery
- biomanipulation
- 3. Education and communication
- 4. Research and monitoring



Voluntarily funded by local municipalities and industry since 1995

# VARIETY OF LONG TERM LOAD REDUCTION MEASURES IMPLEMENTED IN THE CATCHMENT SINCE 1980'S



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

Pyhäjärvi has >60 professional fishermen

#### Total catch 600 000 – 800 000 kg/year



Total fish catch 1995-2016 roach trout smelt ruffe Ŗ burbot bream pike perch whitefish vendace

> Total <u>commercial</u> <u>catch</u> 1995-2016 <u>15 milj. kg</u>

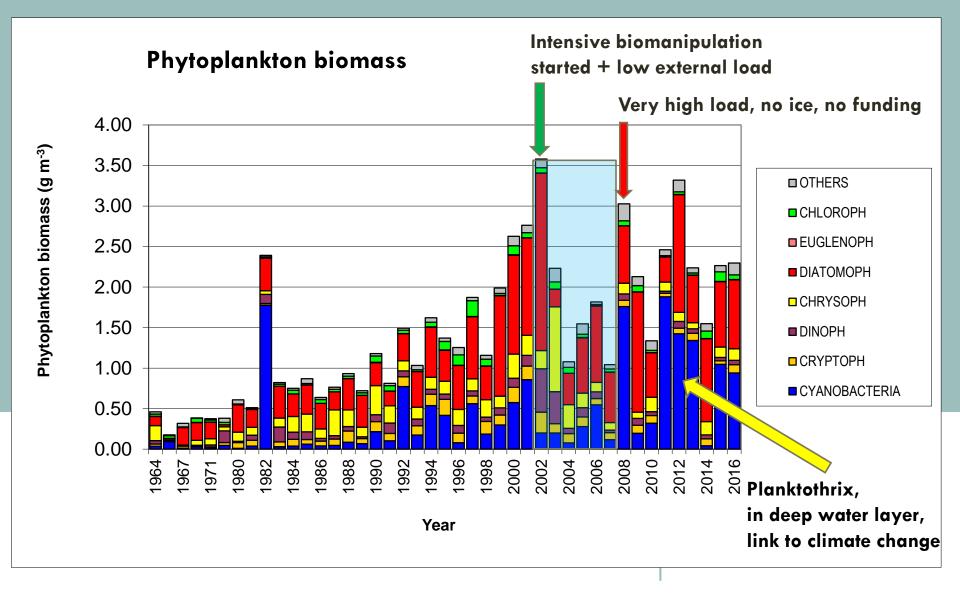


# HOW FISHERY IS LINKED TO WATER QUALITY?

### **1. VIA FOOD CHAIN** Strong **planktivorous fish stocks**, strong predation pressure on zooplankton Number and body size of Planktivores: Daphnia decreaces Vendace Whitefish Smelt All fries

#### Phytoplankton not controlled by zooplankton, becomes more abundant

Sarvala et al. 1999, Ventelä et al. 2016



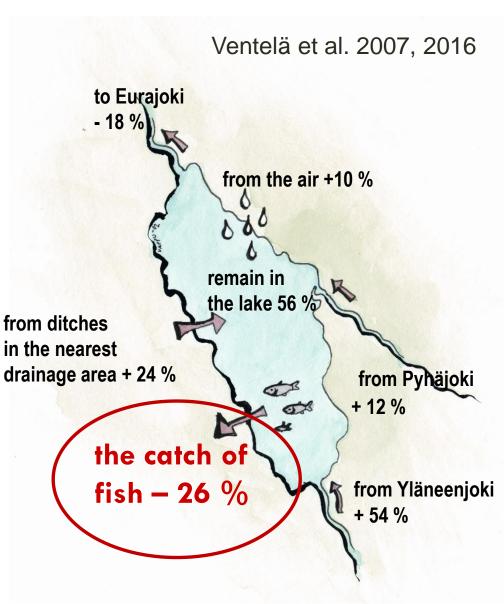
# 2. VIA NUTRIENT REMOVAL

Total <u>commercial catch</u> 1995-2016 **15 milj. kg** → <u>100 000 kg removed</u> <u>phosphorus</u>

1/4 - 1/3 of the annual phosphorus load is removed from the lake with the fish catch!

### OR

Biomanipulation eliminates the effect of internal load (Nürnberg et al. 2012)





# **3. VIA SEDIMENT RESUSPENSION**



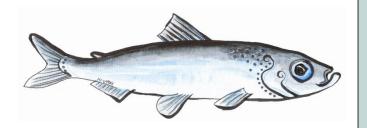
### **Ruffe, roach, bream** Tarvainen et al. 2005, Freshwater Biology



# PROFITABLE BIOMANIPULATION?

### **BIOMANIPULATION IN PYHÄJÄRVI 1995 - 2017**

#### The harvest of commercially less valuable fish was subsidized in 1<u>995-</u> 2015



<u>Commercial catch</u>, especially planktivores vendace (Coregonus albula) and white fish (Coregonus lavaretus)

# ╏

#### **Planktivores:**

Vendace

White fish

Smelt

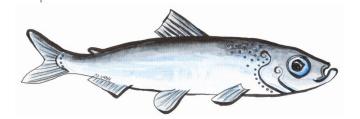
juveniles (many species)

Fishing of commercially unwanted fish species (subsidized biomanipulation):

Smelt, ruffe

Roach (increasingly commercial since 2013)

## FISHERY IN PYHÄJÄRVI NOW =



<u>Commercial catch</u>: vendace (Coregonus albula) white fish (Coregonus lavaretus) smelt (Osmerus eperlanus) roach (Rutilus rutilus) (+ all species for nutrient removal)

- The value of the **clean local food** is increasing in Europe.
- Development work with food industry → new products → demand on roach and smelt
  → increasing share of the catch has become commercial valuable
- In 2018 all biomanipulation is commercial, 2/3 of the catch goes to food industry, 1/3 to energy, compost or fur farms
- Challenge: fishery monitoring development needed!



# CONCLUSIONS

> Biomanipulation is very important restoration tool in Lake Pyhäjärvi

Lake Pyhäjärvi is situated in agricultural area with intensive farming
 External load reduction is a big challenge and may turn to
 mission impossible in near future due to climate change

BUT:

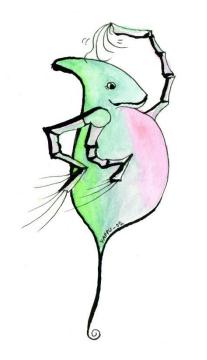
> The phytoplankton community is strongly affected by climate change (Deng et al. 2016, Pätynen et al. 2014) and may, as indicated by the development in recent years in Pyhäjärvi, become dominated by cyanobacterial species like *Planktothrix* and *Aphanizomenon*, which are less edible to zooplankton.

This may diminish the trophic cascade effect of the biomanipulation (Søndergaard et al., 2007; Ger et al. 2014).

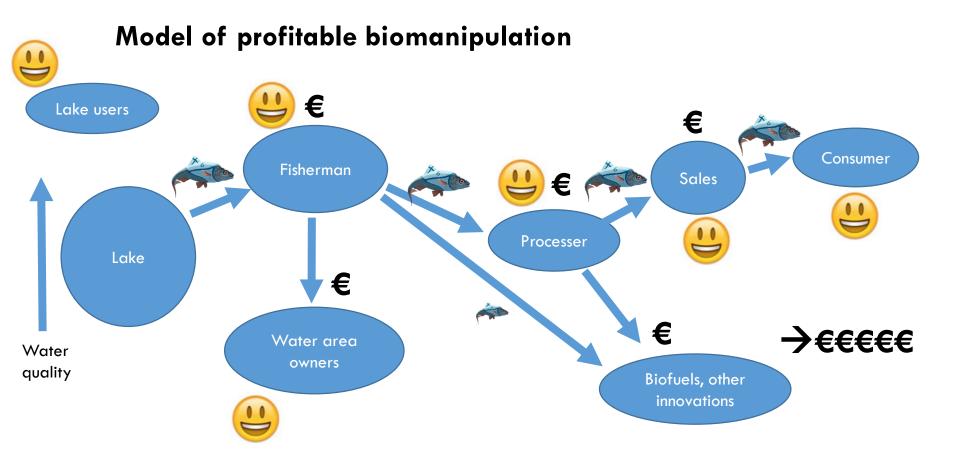
> BUT fishing is still removing phosphorus from the system



Modern biomanipulation should be the combination of fishery management + water quality management = <u>Commercially</u> <u>profitable, sustainable fishery with positive water quality effects</u>

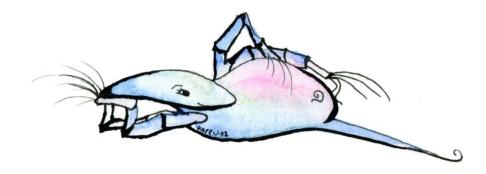








### THANK YOU!



anne-mari.ventela@pji.fi