

LakeAdmin
LPAB seminar
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Biomanipulation in water quality management of Finnish lakes

**Ilkka Sammalkorpi
Senior Researcher
Freshwater Centre**

Finnish Environment Institute SYKE



European Union
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Outline

- Definitions
 - good practice
 - biomanipulation
 - Biomanipulation in Finland & N-Europe
 - typical target lakes & how to define the need
 - methods used
 - how much to remove,
 - impacts on water quality
- Implementation in a local Finnish case study
- video on the methodology of pelagic seining and stakeholder activity (release of piscivores, handling & logistics of the catch) with professional fishermen

Good practice

“In the context of the INTERREG IVC programme, a **good practice** is defined as an **initiative** (e.g. **methodologies**, projects, processes and **techniques**) undertaken in one of the programme’s thematic priorities **which has already proved successful and which has the potential to be transferred to a different geographic area.** **Proved successful** is where the good practice has already provided tangible and measurable results in **achieving a specific objective.**”

(Interreg IVC Manual version May 2012)



Biomanipulation is an old Good Practice

- developed in Czech fishponds & oxbow lakes in 1960's
- applied and further developed to lake management in Finland, Denmark, Netherlands, Hungary, Sweden ... and N-America in the 1980's-1990's
- today also considered as one tool for the Baltic Sea

Hrbacek, J., M. Dvorakova, V. Korinek & L. Prochazkova 1961. Demonstration of the effect of the fish stock on the species composition and the intensity of metabolism of the whole plankton association. Verh. int. Ver. Limnol. 14: 192-195.

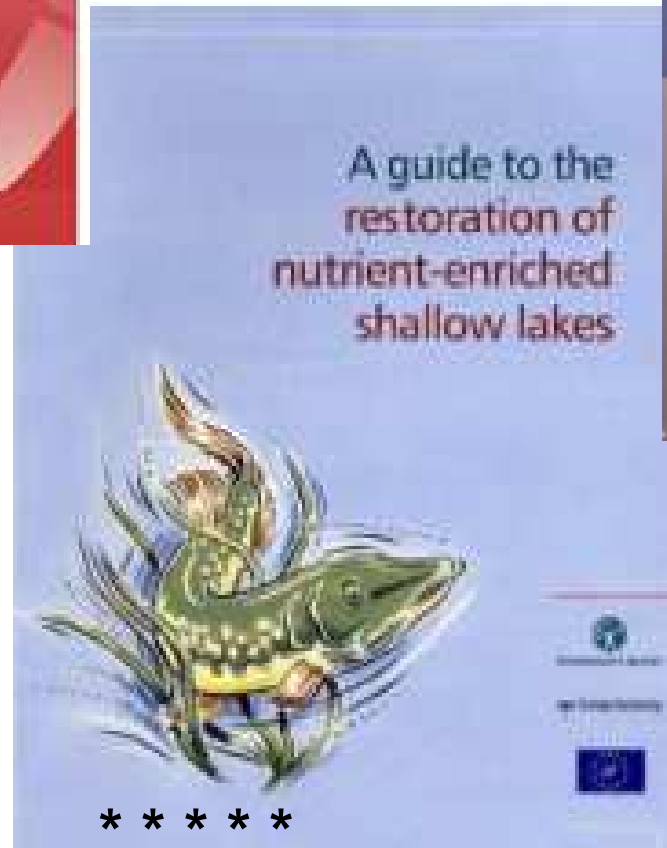
From the Czech fishponds in the 1960's to lakes in > 12 European countries by 2000



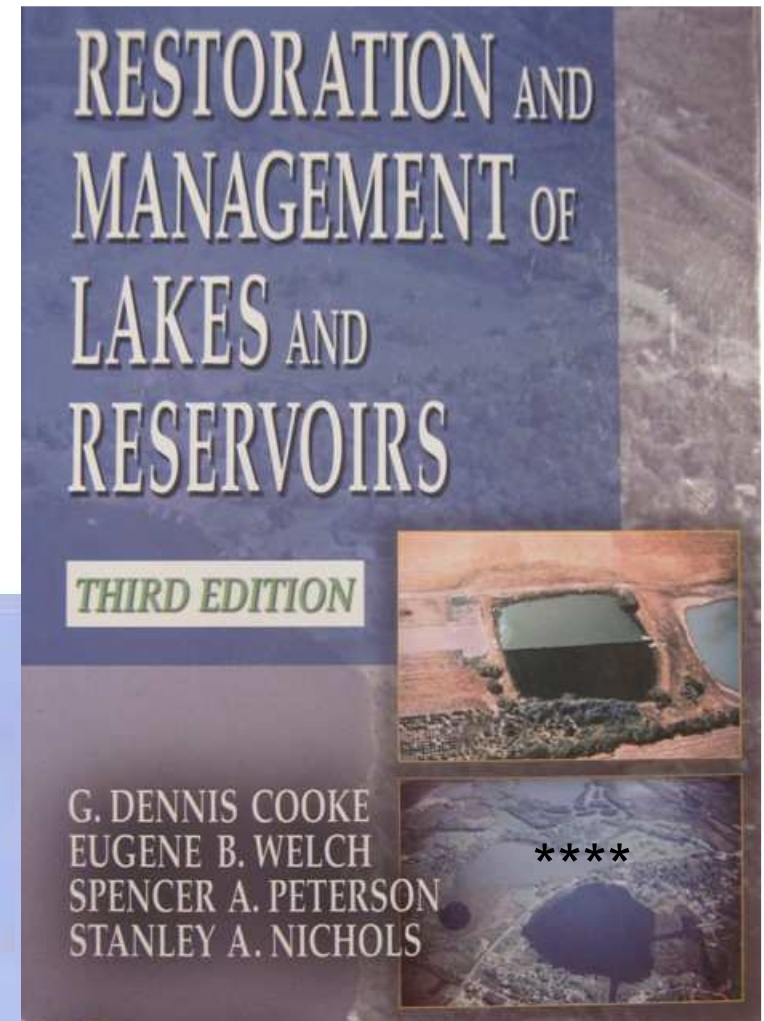


Gulati et al. 1990.
Hydrobiologia
200/201. 629 pp

Moss et al. 1996
EU LIFE project
publication



Scientifically valid
when properly
applied



Cooke et a. 1993/2005.
North American lake
restoration handbook

Three important good practices in lake management

Reduction of external phosphorus loading by sewage treatment (Vollenweider e.g. 1976, Vollenweider & Kerekes 1982/OECD) is an obligatory first step in saving lakes from blooms of toxic cyanobacteria

... **and** there is still usually need to reduce **the non-point external loading** (agriculture, urban storm water, ...) when it is too high (RBAP's of WFD)

Biomanipulation (Hrbacek et al. 1961, Hrbacek 1962 etc., Novotna & Korinek 1965, Brooks & Dodson 1965, Straskraba 1963 & 1967, Shapiro et al. 1975, 1982) **an additional** and often very important step in management

Before biomanipulation

- Turbid water, few macrophytes
- Blooms of toxic cyanobacteria
- Very high density and biomass of cyprinids
(roach *Rutilus rutilus*, bream *Abramis brama*)
(10 000 – 40 000 fish/ha, 300 – 500 kg/ha)
- Low density of waterfowl

Lake Tuusulanjärvi until 1997

After biomanipulation

- Clear water, rich in macrophytes
- Few cyanobacteria, diverse phytoplankton
- Low density and biomass of cyprinids and a higher percentage of predatory fish (pike, perch, pikeperch, ...)
- Higher density of waterfowl

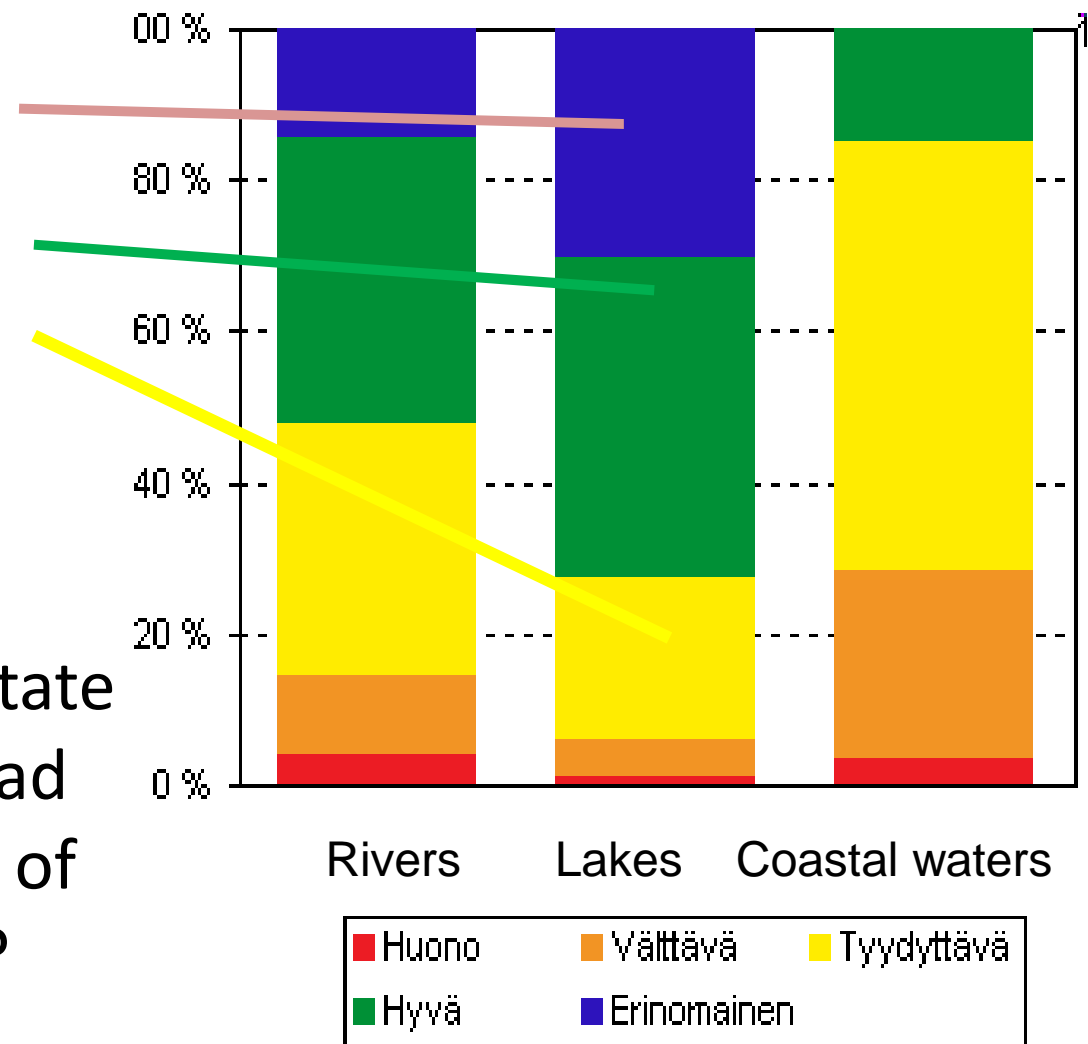
Lake Tuusulanjärvi since 1999

Status of Finnish waterbodies

By the area of lakes:

- High status 30 %
- Good 42 %
- Moderate 22 %
- Poor 5 %
- Bad 1 %

28 % of classified area
below good ecological state
-high diffuse external load
- also a too high density of
cyprinids in many lakes?



Fish removal in Finnish lakes

- First initiatives in 1984 for L Vesijärvi and L Tuusulanjärvi
- Reduction of sewage loading was implemented in the 1980' s
- Municipalities are most important actors
- Until today, fish removal for water quality and/or fisheries management has in c. > Finnish 150 lakes
- Potential role for the implementation of WFD and management for biodiversity in waterfowl lakes/wetlands
- Many local cases insufficiently planned, funded & documented
- Very good know how on cost effective fish removal (c. 1 €/kg or < 100 €/kgP)



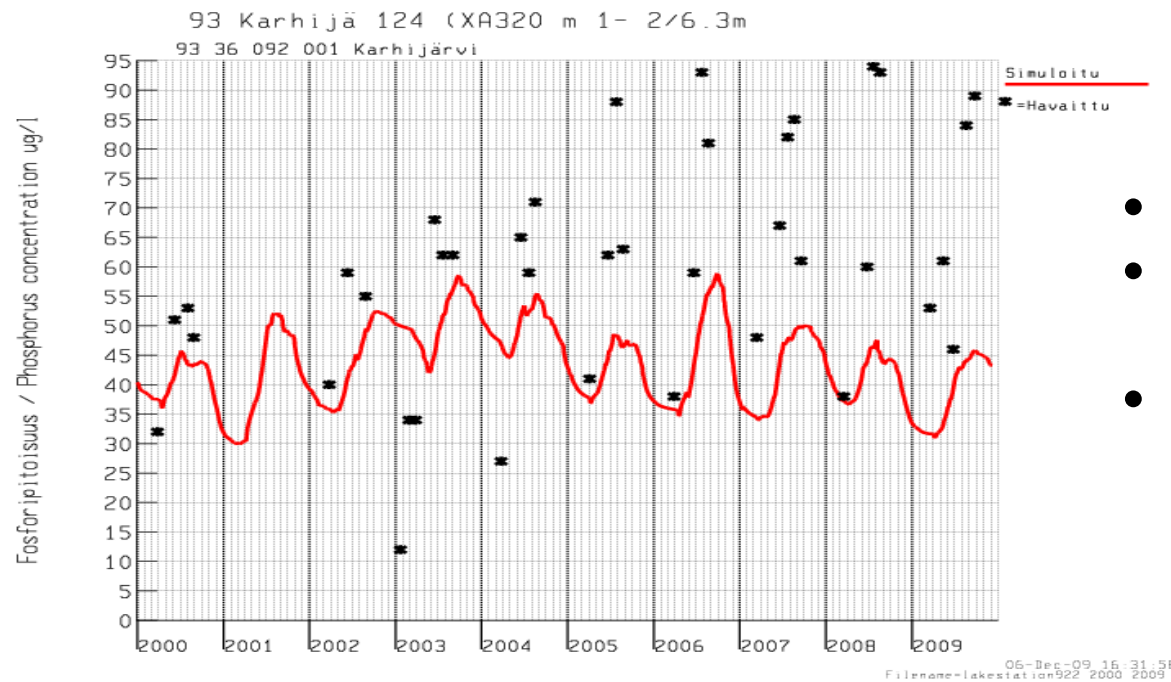
Typical target lakes & defining the need

- Catch per Unit Effort
CPUE in multimesh gillnet monitoring (WFD standard):
 - poor class in WFD classification,
 - cyprinid dominated and high in relation to TP
- Other information are, e.g. reductions in depth of macrophytes, big perch or waterfowl (diving ducks)



Chlorophyll-a and total phosphorus

- High Chl-a/TP ratio from water monitoring
 - when 0.3-0.4 or more a high fish density may be one reason for blooms/high phytoplankton biomass
- Internal phosphorus loading: the mean total phosphorus > calculated from external load



- Lake Karhijärvi (3350 ha)
- Very high CPUE of cyprinids in fish monitoring
- Observed level of total phosphorus in summer is higher than it "should be" calculated from the external loading

Positive impacts when ...

(extended from Olin et al. 2006. Hydrobiologia 553: 67-88)

- > 200 kg/ha/3 years, high catch/TP
- Not too high external loading of phosphorus
- Blooms of cyanobacteria at low phosphorus level
- Diverse bathymetry (distinct spawning and shoaling areas, more cost effective fishing)
- Moderate piscivore density (indirect effect)
- Weather conditions:
 - warm and not windy periods in May-June (fykenets)
 - "cool autumn weather", low water level and only moderate winds in Sept-Nov (seining)

Lack of impacts when ...

(extended from Olin et al. 2006. Hydrobiologia 553: 67-88)

- <200 kg/ha/3 years and low catch/TP
- High external loading, clay turbid water
- Homogenous bathymetry
- Weather:
 - cold and windy in May-June (fykenets)
 - heavy rains and winds, high water level in Sept-Nov (seining)

Selective mass removal in large lakes

- Knowing the target fish and their behaviour
- Using the right gear in the right place and time

Selective mass removal in large lakes

Pelagic seining of shoaling fish

Passive fish – active gear



Removal of the youngest cyprinids → cost effective removal



- Young fish aggregate in deepers areas to shoals in autumn to avoid predatory fish
- Fine mesh is needed in the codend of seines (< 8 mm)
- Catches of all age classes often exceed 5000 kg/day

Selective mass removal in large lakes

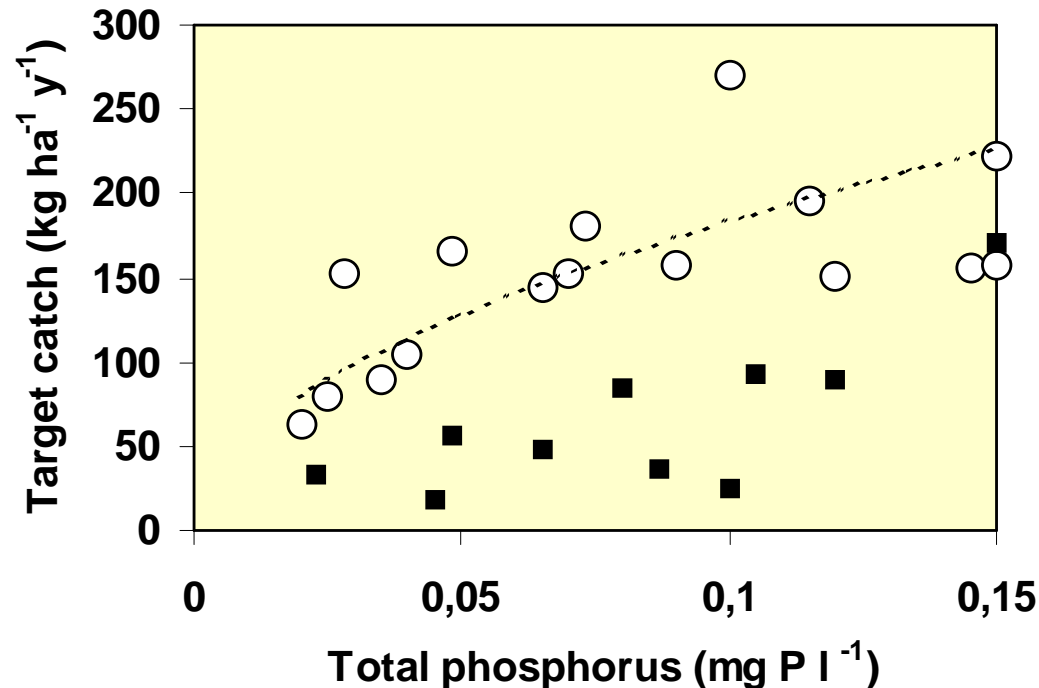
Active fish – passive gear

- **Large fykenets for adult fish migrating to spawning areas and pelagic feeding juvenile fish in summer**
- **Catch up to > 10 000 kg per fykenet in one year**
- **Fine meshes in fykenets (< 10 mm)**



How much to remove?

- The amount, how much to remove for a successful biomanipulation can roughly be estimated by the total phosphorus concentration: $\text{kg/ha} = 16.9 * \text{TP}^{0.61}$
- Phosphorus 50-100 $\mu\text{g/l}$ → 100-200 kg/ha is needed
(Jeppesen & Sammalkorpi 2002; Handbook of Ecological restoration)

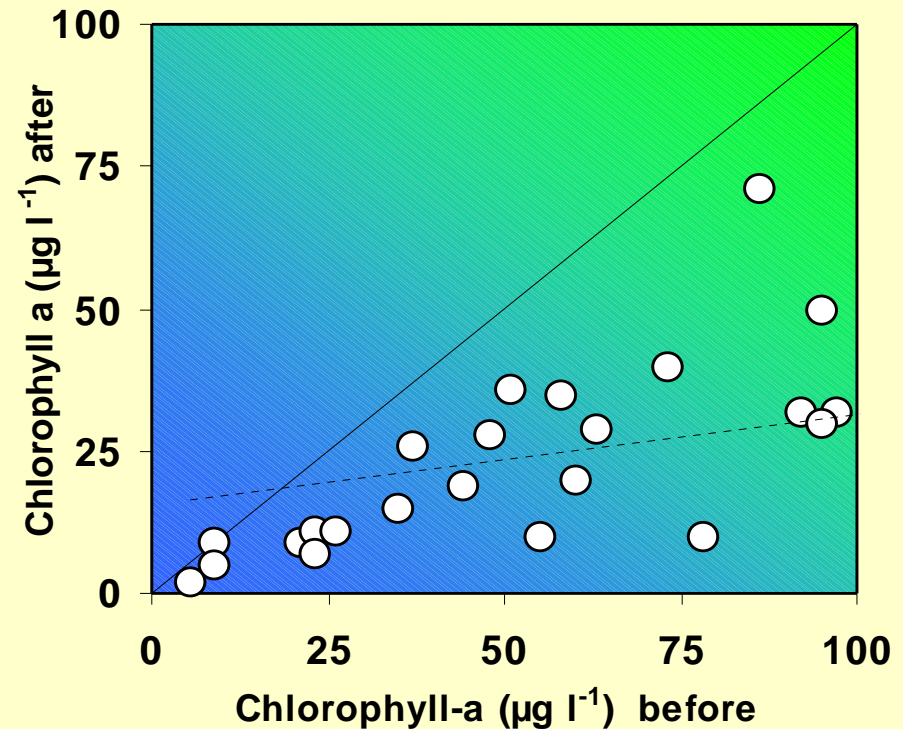
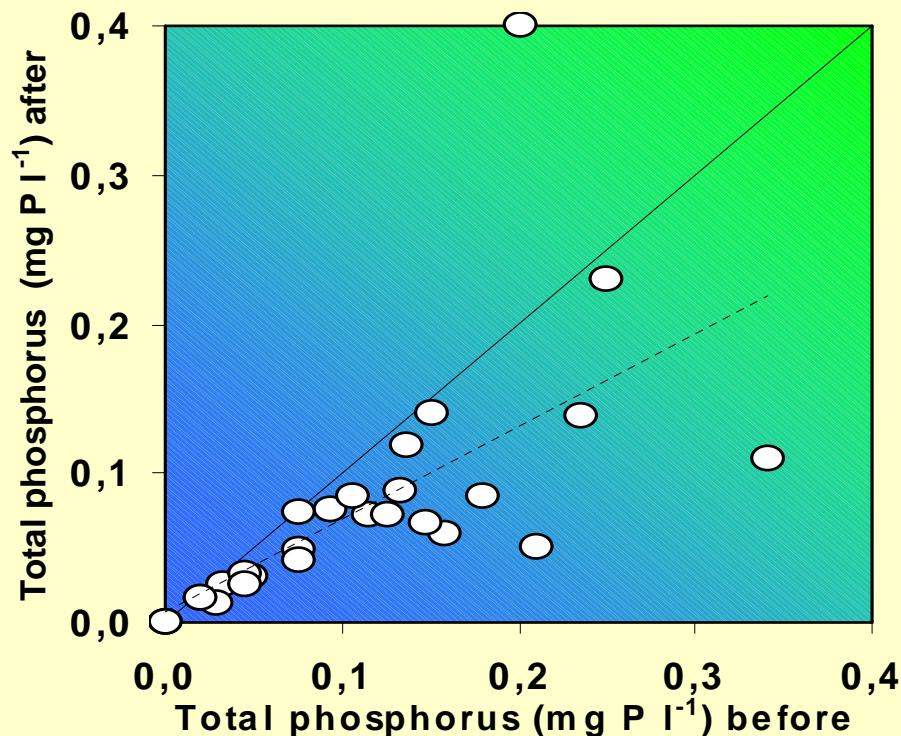


White circles:
successful cases

Black squares:
unsuccessful cases

Effects of foodweb management

- When the effort is sufficient, fish removal may reduce nutrients (phosphorus) by 20-50 % and phytoplankton (chlorophyll-a) from 30 up to >50 % from lake water
- The effect is transient especially at high external loading



Conclusions

- Good monitoring of the environmental parameters, fish population and the removal catch benefits the planning and evaluation of impacts
- Large lakes are potentially more “vulnerable” to fish removal than small lakes: fish can aggregate from larger areas – but large lakes are also more vulnerable to extreme weather conditions
- The typical intensive reproduction in 3-4 years after the onset of fishing shall and can be mitigated by age selective fishing and good management of piscivores (e.g. mesh/catch limits especially for pikeperch)
- After restoration: maintaining long-term management is needed

Pelagic seining in biomanipulation of Lake Karvianjärvi, Finland, October 2009

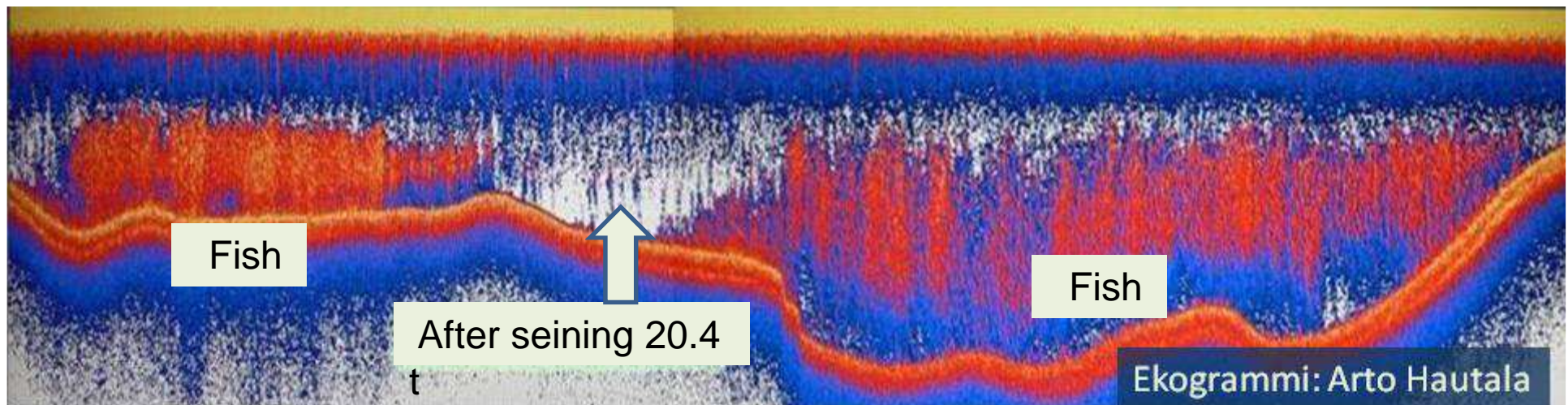
Video

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association

contacts: arto^{ÄT}artohautala.fi (Arto Hautala, seining) and
vesavihtori^{ÄT}gmail.com (Vesa Raiskio, local volunteers)

Pelagic seining in biomanipulation of Lake Karvianjärvi, Finland, October 2009

Three hauls, three days, 40.5 t of roach and bream



Echogram © Arto Hautala

artoÄTartohautala.fi

Thank you
Köszönöm



Compiled from publications, reports and data by Jukka Horppila, Mikko Olin, Martti Rask & Jukka Ruuhijärvi, Tommi Malinen, Jaana Hietala, Mauri Pekkarinen & Arto Hautala, Ismo Malin & Juha Keto and Jouko Sarvala & Anne-Mari Ventelä (L. Pyhäjärvi), Kaisa Vahanen et al. (Saunajärvi), Vesi-Eko Ltd (Kirmanjärvi),