

An integrated assessment framework for assessment of key ecosystem services and effect on aquatic ecology

Katri Rankinen¹, Kirsi Usva², Harri Lilja²,
Merja Saarinen², Elena Valkama², Jukka-Pekka Vähä³

1 Finnish Environment Institute
2 Natural Resources Institute Finland
3 The Association for Water and Environment of Western Uusimaa



Background of FRESHABIT LIFE IP



- Natural and cultural values form the basis of our water heritage
- We implement a range of water protection measures to reduce the loading that catchment areas impose on water bodies
- We improve the habitats of freshwater pearl mussel (*Margaritifera margaritifera*) by restoring streams, rivers and lakes

Freshwater Pearl Mussels

- The known populations in southern Finland consist of elderly individuals incapable of reproduction
- We collect glochidia larvae from the populations in the rivers Mustionjoki and Ähtävänjoki
- The larvae are first grown in the gills of salmon fish and then, in artificial channels within gravel
- The tiny young mussels are then transferred back to their home waters



Photos: Tuija Mattsson



Habitat criteria



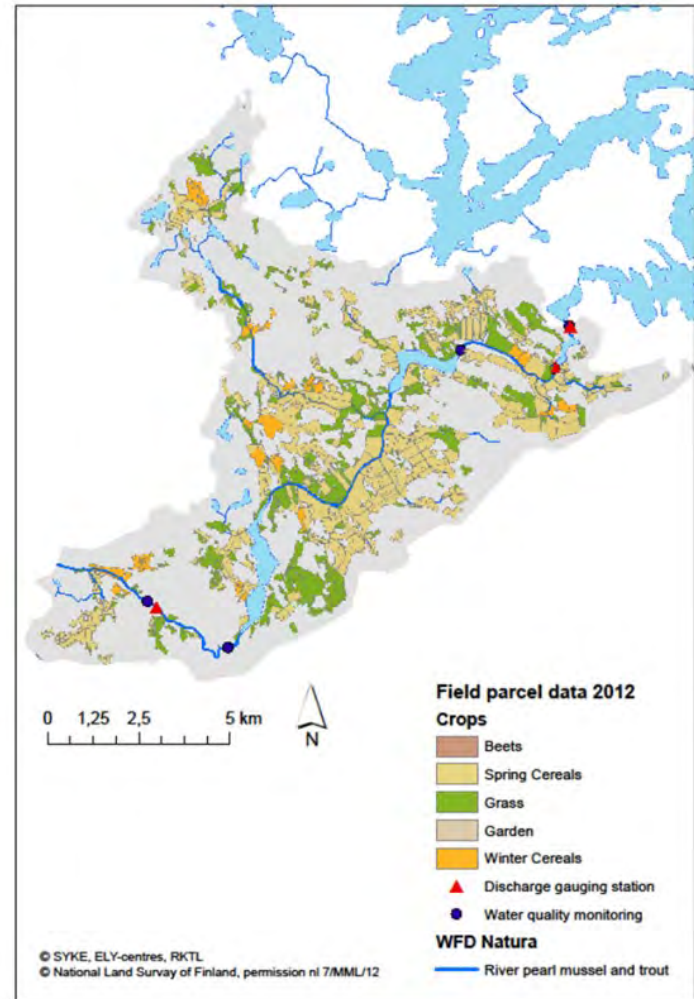
Photo: Katri Rankinen

Parameter	Limit	Criteria
pH	≥ 6.2	
TP	< 35 ; 5-15 $\mu\text{g/l}$	Mean
TN	< 1000 $\mu\text{g/l}$	
$\text{NO}_3\text{-N}$	< 125 $\mu\text{g/l}$	Mean
Turbidity	$< 1\text{-}1.5$ FNU	Mean, spring flood
Colour	$< 80\text{-}85$ mg Pt/l	Spring flood
Water temp.	$< 23\text{-}25$ °C	Max.
Redox	> 300 mV	Min.
Fine particles ($< 1\text{mm}$)	$< 25\%$	

Degerman et al. 2009; Törrönen 2016

Mustionjoki river basin

- Lower reach of the Karjaanjoki river basin
- Soil types mainly clay and moraine
- Crop production area
- Monthly water quality and daily discharge monitoring in the main river
- Monitoring campaigns during the project in branches



Mustajoki river basin

Current water quality

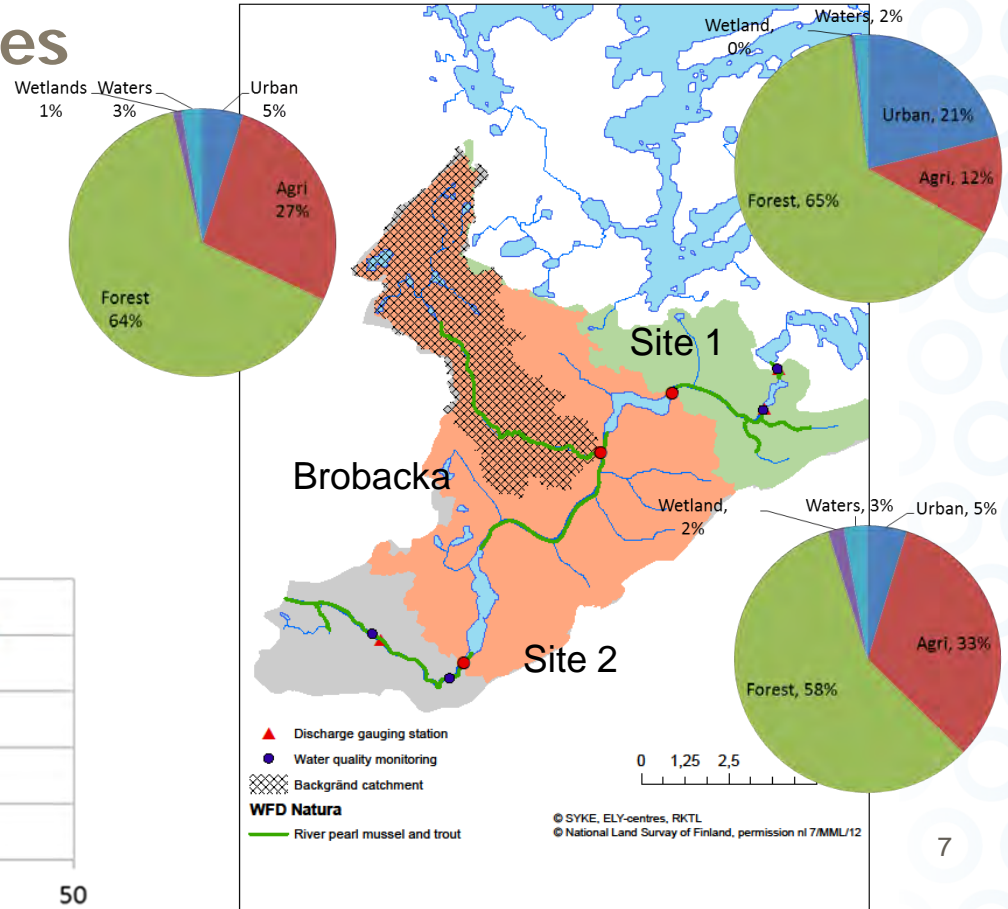
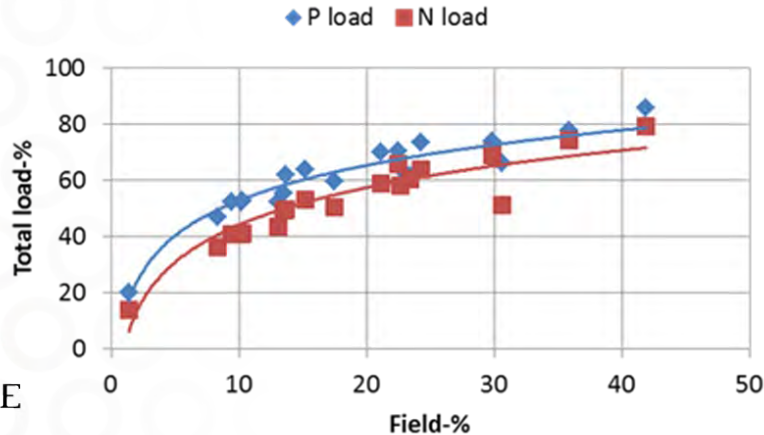
Parameter	Lake outlet	Basin outlet
Turbidity	4 FNU	12 FNU
TP	24.7 µg/l	31.9 µg/l
TN	799 µg/l	914.6 µg/l
NO ₃ -N	150 µg/l	430.5 µg/l

Habitat requirements

Parameter	Limit 1	Limit 2
Turbidity	1 FNU	1.5 FNU
TP	5-15 µg/l	< 35 µg/l
TN		< 1000 µg/l
NO ₃ -N	< 125 µg/l	(< 500 µg/l)

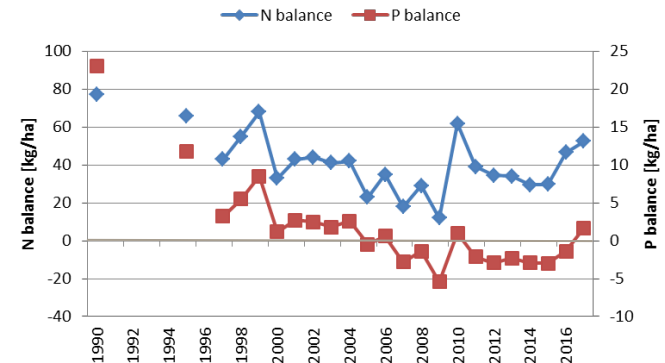
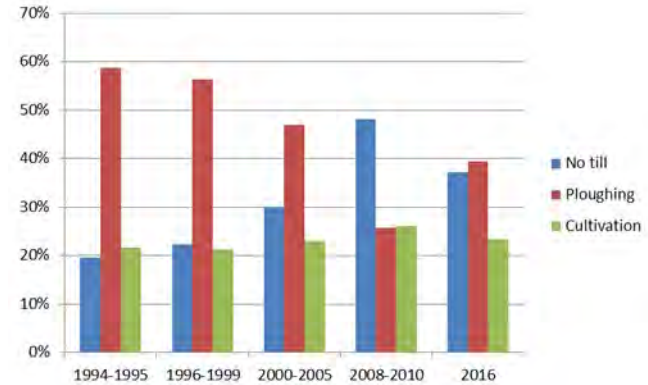
Possible habitat sites

- 3 possible sites to where return mussels
- Main pressure for water quality comes from agriculture

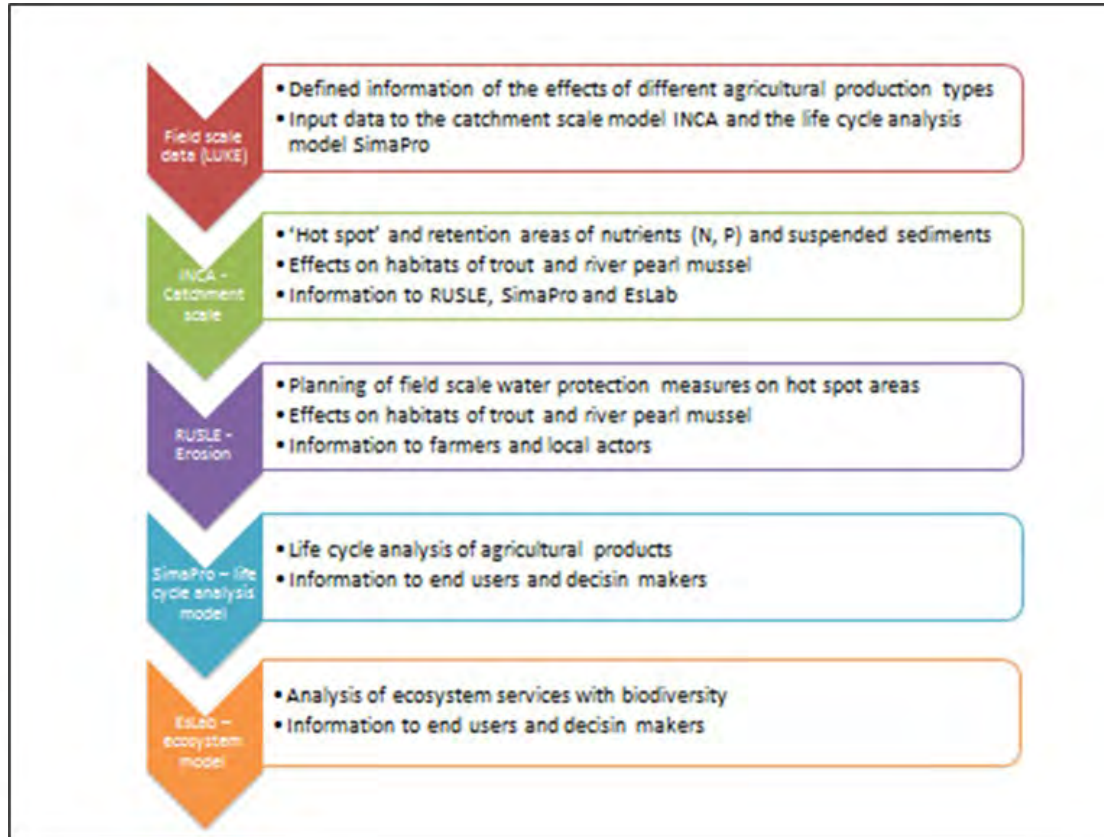


Agri-Environmental Programme

- Basic measures
 - Farm scale environmental planning and monitoring
 - Lay out and care of fallows and filter strips
 - Balanced fertilization of crops
- Additional measures
 - Targeted fertilization
 - Vegetation cover in winter or reduced tillage
 - Calculation of nutrient balances
 - Cultivation of catch crops

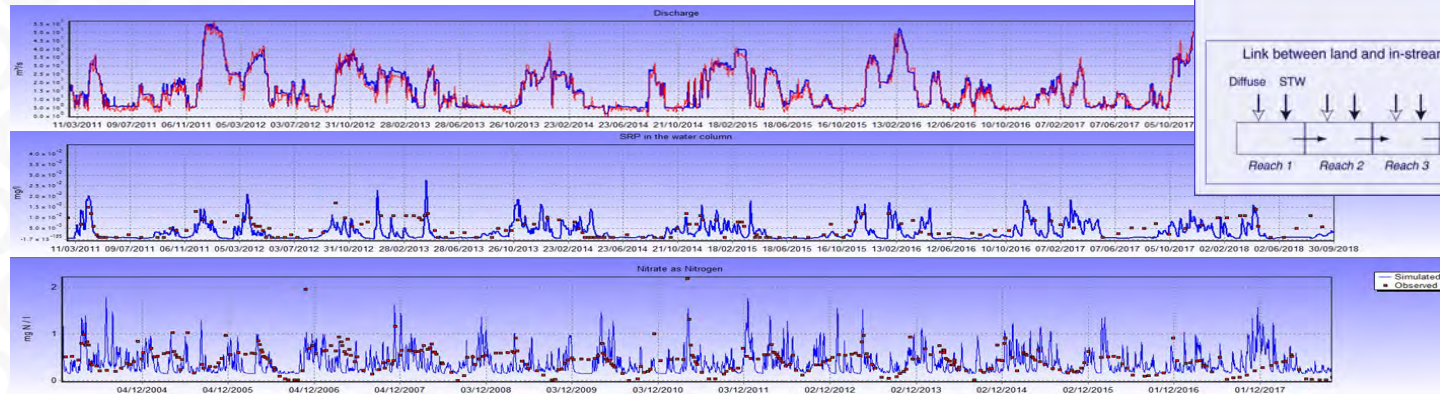
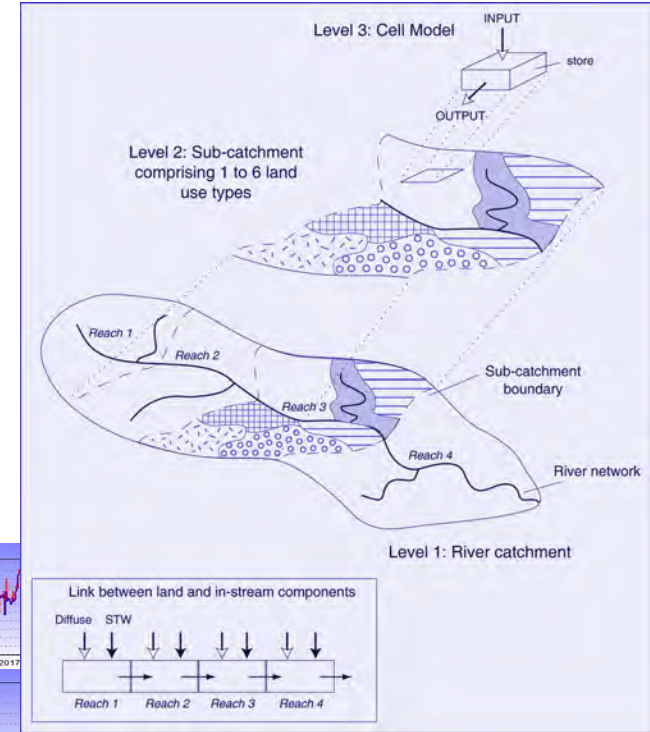


An integrated assessment framework



INCA models

- Calculates **N**, **P** and **C** transport from terrestrial environment to waters
- Dynamic, semidistributed, process based
 - N first order kinetics
 - P equilibrium equations



Scenarios for water protection



Year 1995

- High nutrient balance
- Some no-till area



Current situation

- Low nutrient balance
- High no-till area



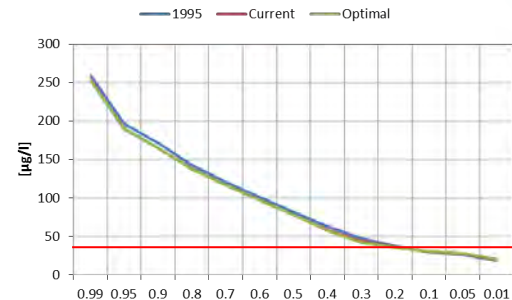
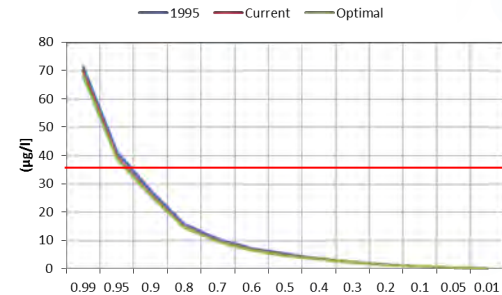
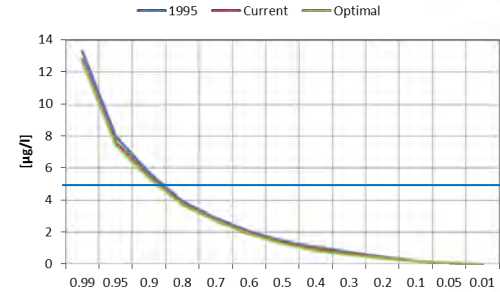
Optimum

- Optimal nutrient balance
- Optimal no-till area



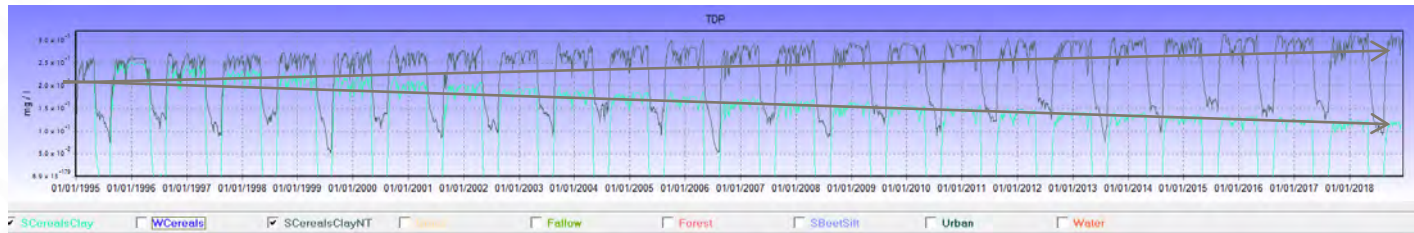
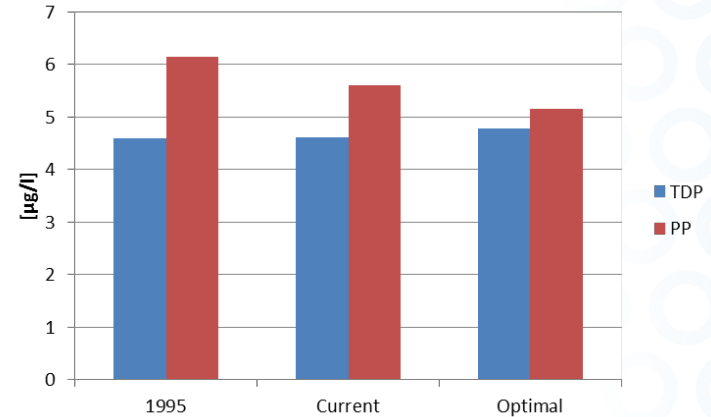
Results of total phosphorus

- At the Habitat Site 1 TP concentration stayed close to lower TP limit (5-15 $\mu\text{g/l}$)
- At the Habitat site 2 in the main river TP concentration stayed most of the time under upper TP limit (35 $\mu\text{g/l}$)
- At the Brobacka site concentration stayed over the upper TP limit (35 $\mu\text{g/l}$)



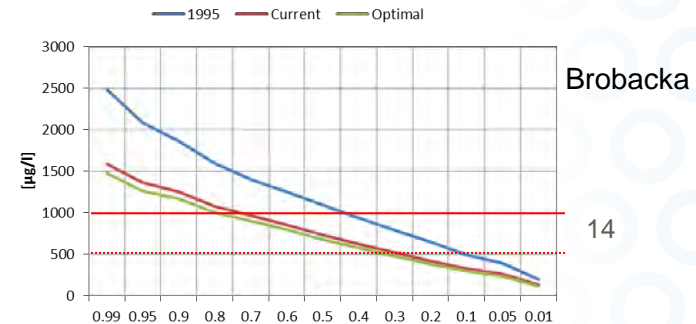
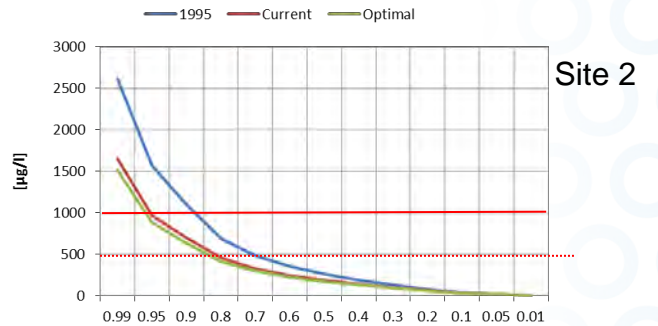
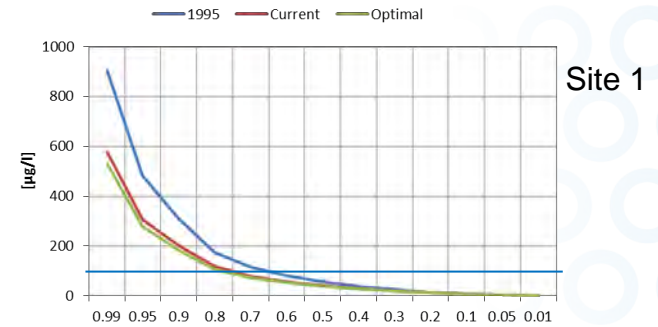
Results of total phosphorus

- Phosphorus fertilization has decreased since 1995
 - Soil test P values have decreased
 - Should be seen in TDP concentrations
- No-till area has increased
 - Changes ecosystem processes
 - Increases TDP in surface layer (equivalent to 3-4 kg P fertilization)



Results of total nitrogen

- At the Site 1 $\text{NO}_3\text{-N}$ remains under TN level 1000 (or 500) $\mu\text{g/l}$ and most of the time under nitrate level 125 $\mu\text{g/l}$
- At the Site 2 concentration remains most of the time under TN level 1000 $\mu\text{g/l}$
- At the Brobacka site concentration remains relatively often over 1000 $\mu\text{g/l}$



Conclusion

- Most promising habitat site is **Site 1** at the upper river
 - Benefit from clear lake water
 - Field-% is high enough that we can see effects of agri-environmental measures
- Phosphorus is a wicked problem; if we like to decrease PP we tend to increase TDP
 - It is hard to go under 1,5 FNU level, because turbidity in lake water is 4 FNU
 - Identify erosion sensitive areas (also upper reaches) and target effective measures there
- We can influence more to nitrate concentration; new measures are needed
 - Catch crops, buffer zones



**Toast fo the bright future of
pearl mussels**

Thank you!



Photo: Katri Rankinen