Macrophytes in boreal streams: Characterizing and predicting occurrence and abundance to assess human impact

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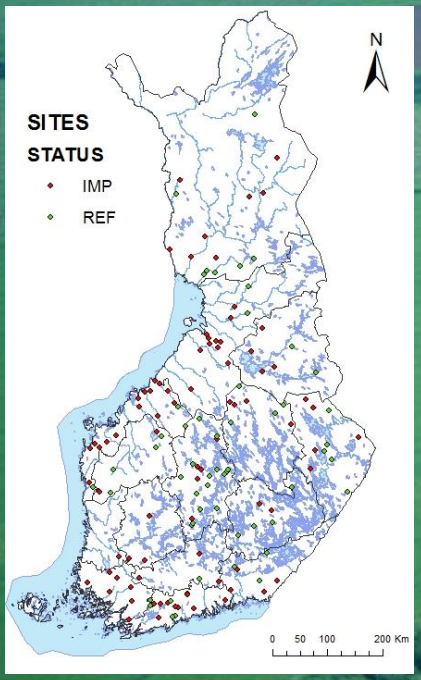
Why use macrophytes to study the ecolocical status & human impact?

Essential component of the stream ecosystems and their functioning

- Absorb nutrients & produce biomass
- Trap sediment and stabilize soil
- Sustain ecosystem processes
  - -retention of leaves
- Change the local current velocities
- Serve as a feeding area for aquatic insects & provide sheltering habitats

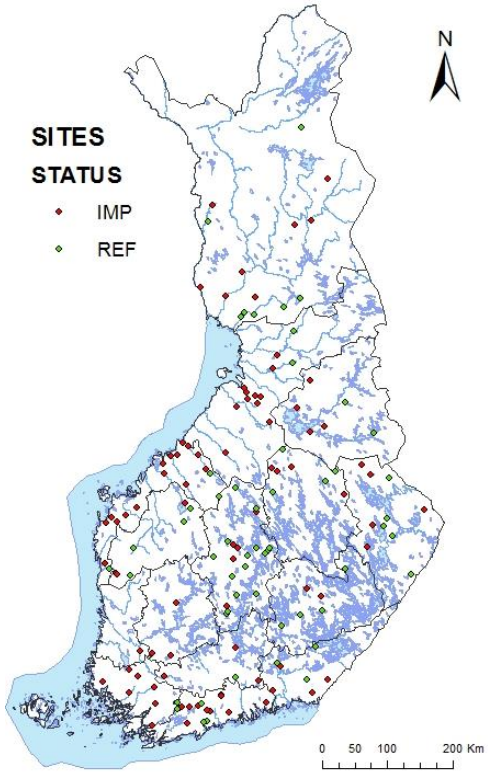


Questions

- **How to assess the extent of the impact of agriculture on stream ecosystems?**
- **How to define (in a reliable way) the ecological status of macrophytes?**
  - **Habitat**
  - **Presence/absence or abundance**
  - **Index**

Materials & methods

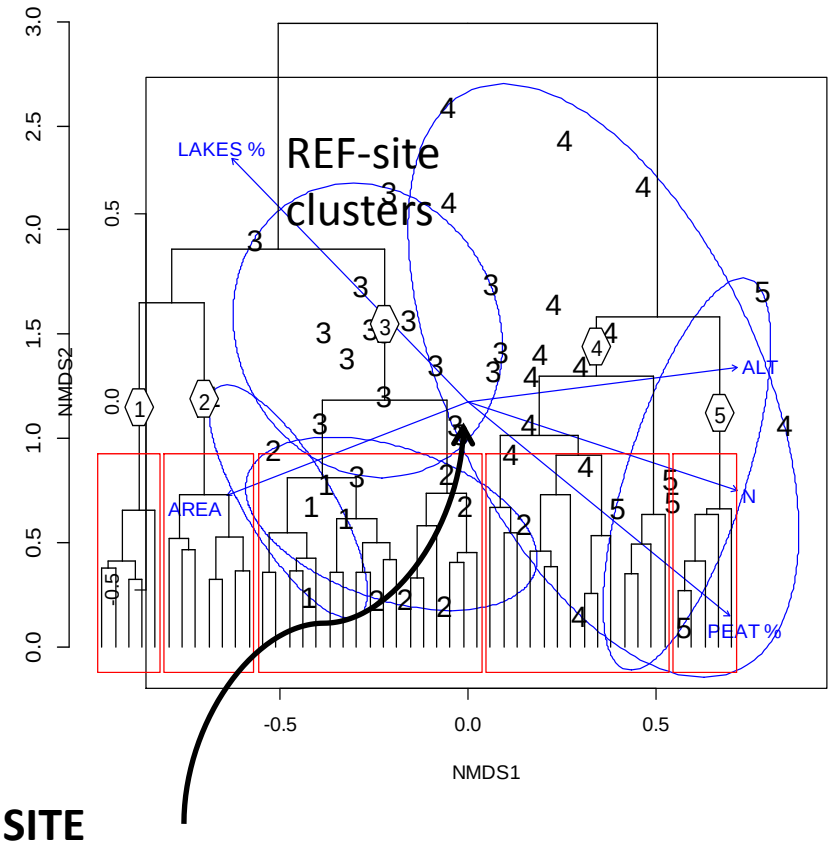
- Data from 51 near natural reference (REF) and 67 impacted (IMP) streams
  - national agricultural monitoring network
  - Data on water quality, hydro-morphological changes and land use
- Represent a range of streams from headwaters to larger rivers
- At each site macrophytes were surveyed at **riffle** and **pool** section (2*100 m)
- We developed RIVPACS-type (Moss et al. 1987) models to assess the ecological status



Materials & methods

- We predicted the **presence and abundance of macrophytes** in the absence of human influence
  - Clustering →
  - Structuring environmental variables? → RF
  - Predict the probability to belong to cluster →
  - Predict the probability of each taxa & calculate expected abundances **in the absence of human impact**
  - Cross-validation of REF-sites

- We compared the predicted and observed communities using three indices:
  - O/E-taxa
  - BC
  - AB, abundance index
  - 1 excellent – 0 poor condition



TEST SITE

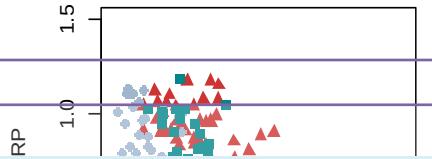
Lakes: 3.3 %
Altitude: 35 m
Latitude: 60° 21.338'
C. area: 199 m2
Peatland: 6 %

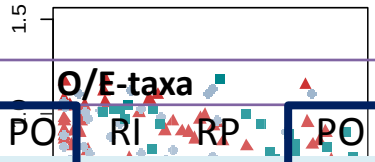
Results: model evaluation

	SD		Mean		% impacted	
Habitat & index	**null**	**model**	**null**	**model**	**null**	**model**
Pool						
O/E-taxa	0.34	0.27	0.98	0.94	35	36
BC	0.19	0.16	0.99	0.96	27	58
AB	0.25	0.22	0.99	0.99	23	32
Riffle						
O/E-taxa	0.27	0.19	0.94	0.97	52	64
BC	0.15	0.12	0.99	0.95	48	76
AB	0.20	0.16	0.97	0.97	51	70
Riffle and pool						
O/E-taxa	0.29	0.20	0.99	0.95	40	63
BC	0.13	0.16	0.99	0.96	55	66
AB	0.18	0.13	0.99	0.97	60	79

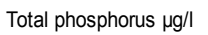
- The standard deviation of the REF index values show that BC and AB were most precise
- Mean values of the REF sites indicate that all models are relatively accurate
- The proportion of the IMP sites judged impaired was highest in the riffle and combined data

Results: response to human impact





	O/E-taxa			AB			BC		
	PO	RI	RP	PO	RI	RP	PO	RI	RP
Water quality									
Ammonium µg l^{-1}	-0.14	**-0.38**	**-0.39**	-0.09	**-0.43**	**-0.53**	**-0.43**	**-0.43**	**-0.49**
Suspended solids mg l^{-1}	-0.06	**-0.33**	**-0.29**	0.02	**-0.33**	**-0.42**	**-0.34**	**-0.32**	**-0.36**
Total P µg l^{-1}	-0.09	**-0.36**	**-0.31**	0.01	**-0.37**	**-0.44**	**-0.35**	**-0.35**	**-0.40**
Hydromorphology									
Habitat quality	0.09	0.15	0.13	0.11	0.17	**0.23**	**0.21**	0.14	**0.20**
Habitat Modification Score	-0.11	-0.12	-0.08	-0.07	-0.14	-0.12	**-0.22**	-0.13	-0.18
Channelization score	-0.09	-0.02	0.07	-0.05	0.02	0.06	-0.05	0.02	0.03
Land use									
Urban and agricultural land use %, whole catchment	-0.02	**-0.24**	**-0.24**	0.01	**-0.34**	**-0.38**	**-0.34**	**-0.33**	**-0.36**
Urban and agricultural land use %, riparian area	-0.02	**-0.32**	**-0.30**	-0.08	**-0.41**	**-0.44**	**-0.33**	**-0.39**	**-0.41**



Spearman's rank correlation between predictive modelling based OE-taxa, AB-, BC-indices (PO = pools, RI = riffles, RP = pool and riffle combined) and variables describing human pressure.

Conclusions

- The reference community variation explained by:
  - latitude, altitude, size of the catchment, proportion of lakes in the catchment
- The expected species composition can be predicted with reasonable accuracy and precision
- We developed a novel method to derive site-specific expectation for species abundance
  - The importance of abundances!
- The indicces based on community abundance and composition showed clear responses to several anthropogenic disturbance variables


Thank you!