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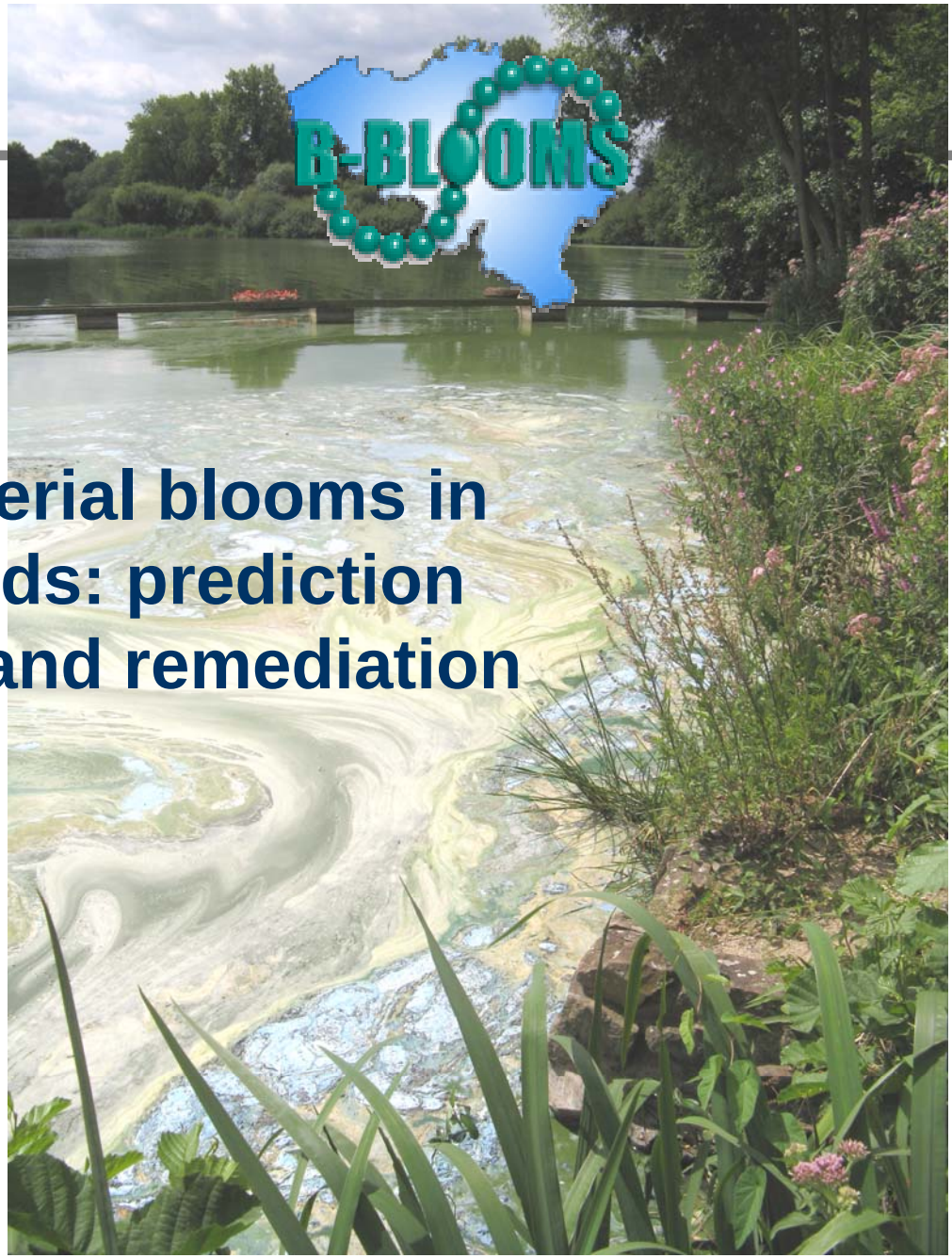

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Cyanobacterial blooms in urban ponds: prediction prevention and remediation

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CONTRACT NUMBER SD/TE/01A

Ponds and services to local communities

- Ponds are small often neglected water-bodies
  - Provide numerous amenities
    - Recreation (boating, fishing, swimming …)
    - Biodiversity repositories
    - Fresh water reservoirs
    - Storm water surge buffers

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Eutrophication - a threat to ponds

- Eutrophication (human induced nutrient enrichment) – a threat to lakes and ponds
  - Sewage overflow/discharge
  - Atmospheric deposition
  - Feeding of aquatic birds
  - Increased productivity
  - Degradation of ecological quality
  - Increased frequency of toxic blooms
    - samples 2007 positive for microcystins
  - Public health concerns

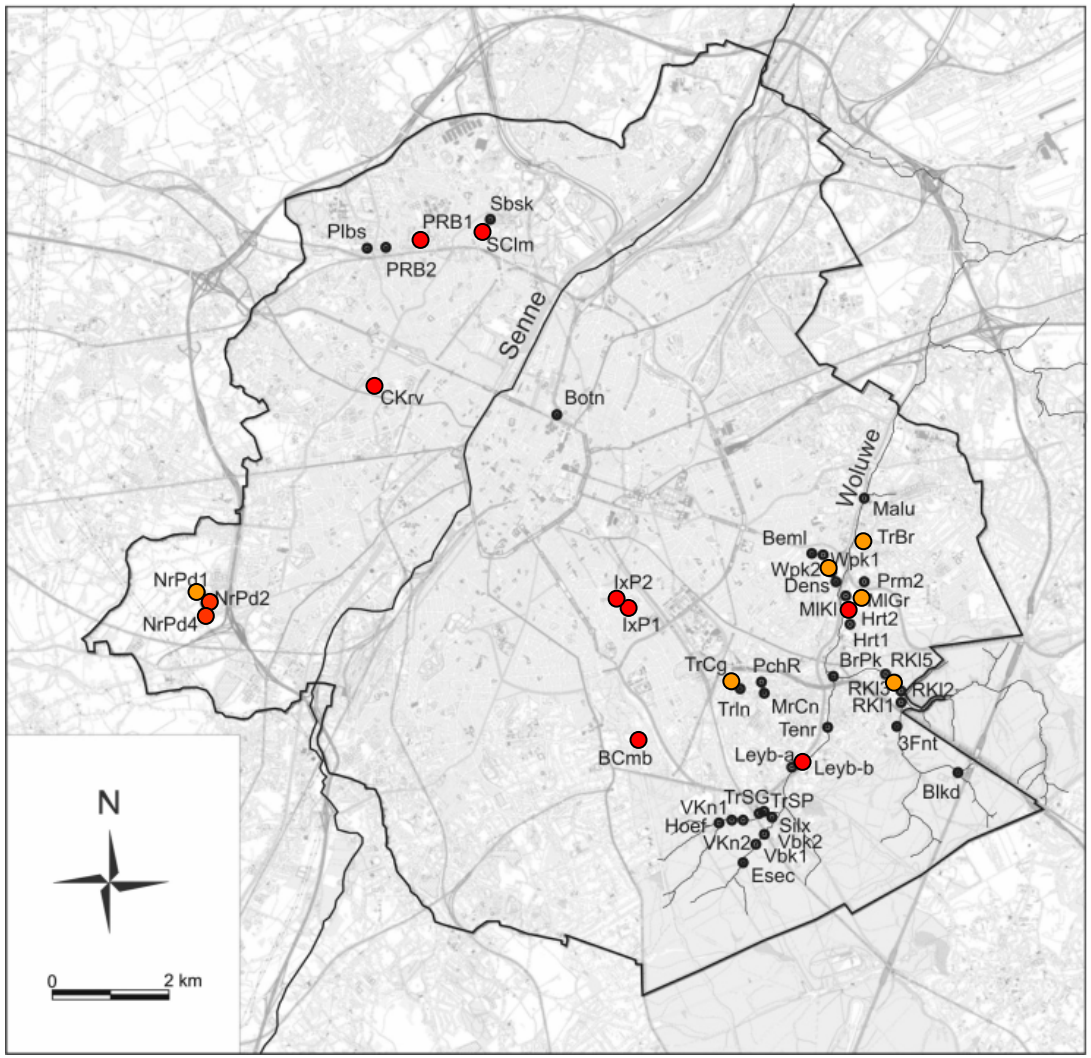
Blooms 2007, 2008

- More than 40 Brussels ponds monitored for blooms
- 22 ponds sampled monthly in 2007
- 33 ponds sampled 3 times in 2008
- 5 ponds sampled on the requests of administrations of different Brussels districts

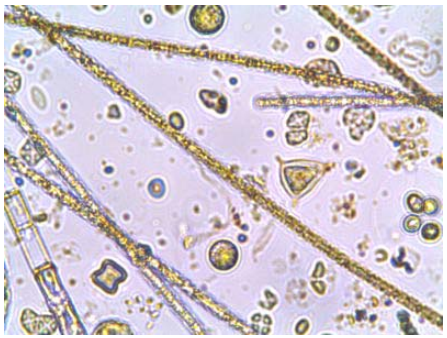
Cyanobacterial blooms – 16 ponds

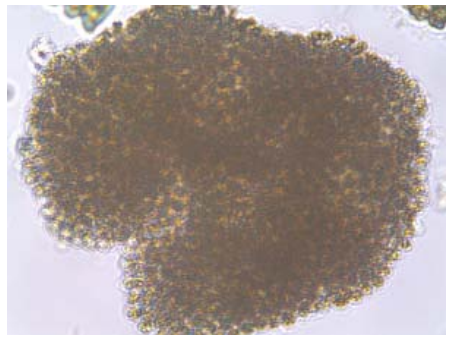
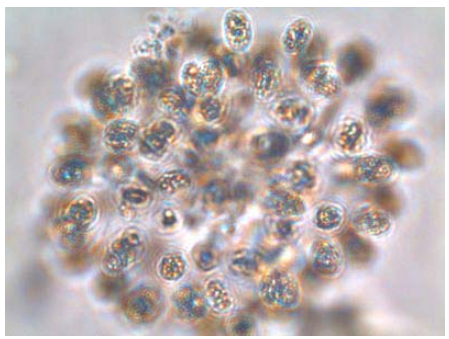
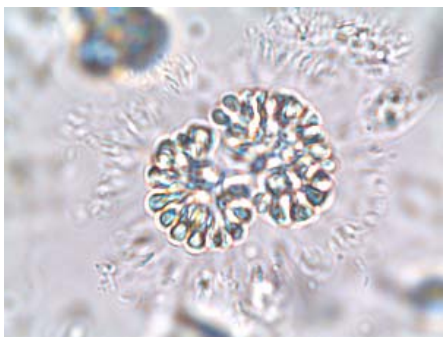
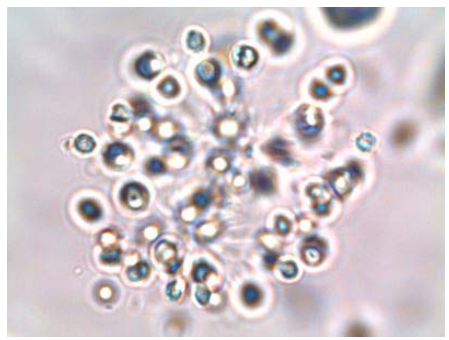
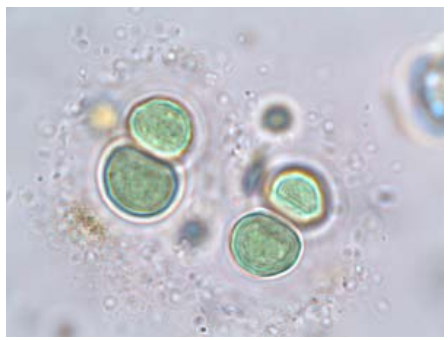
6 ponds - moderate blooms

10 ponds - severe blooms



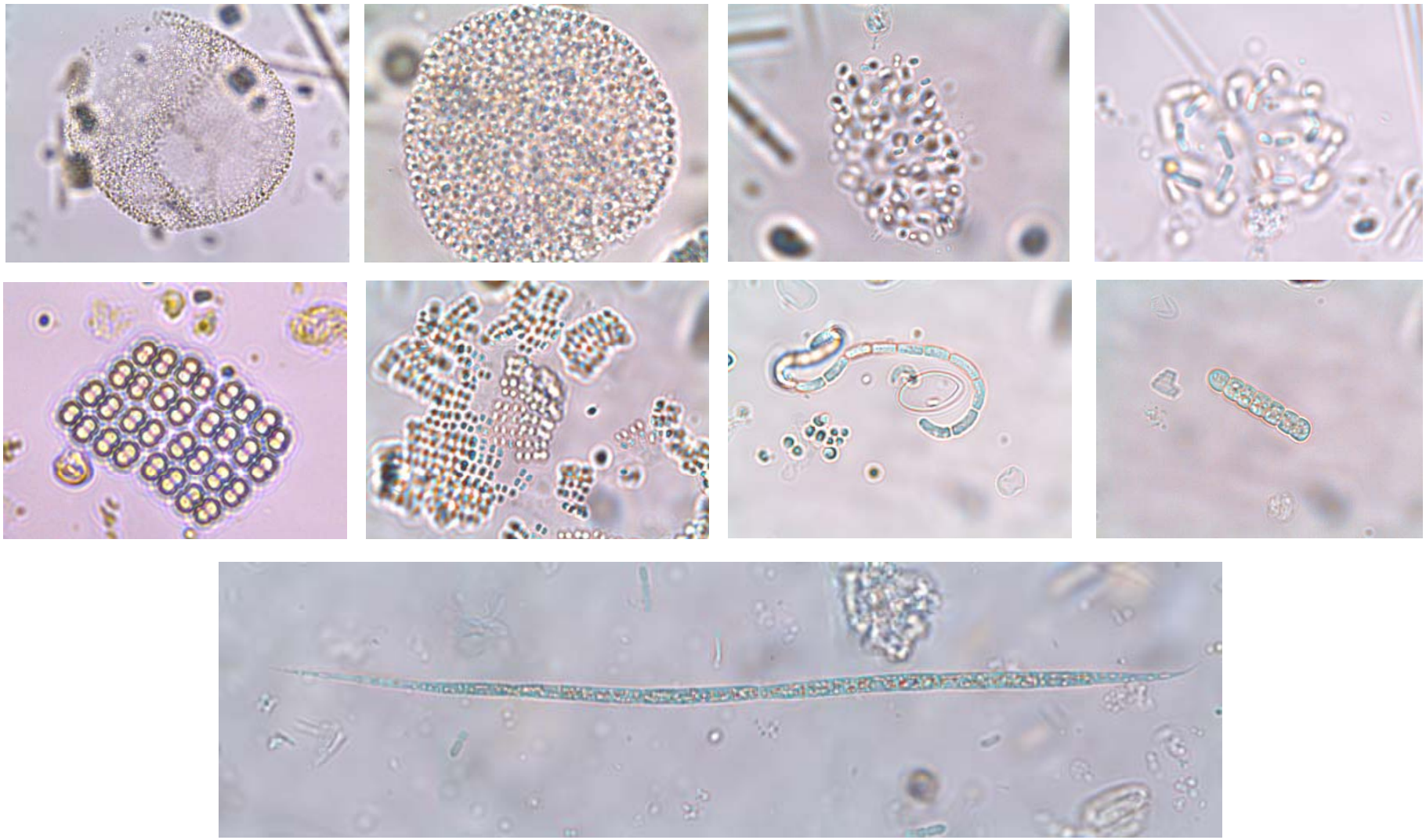
Cyanobacterial diversity



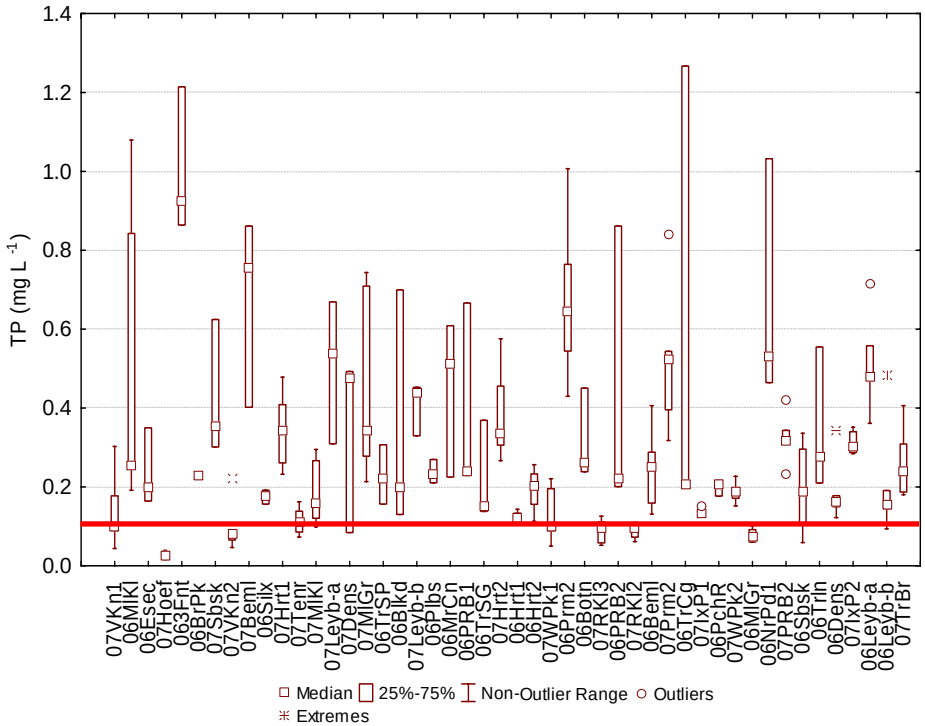









Cyanobacterial diversity



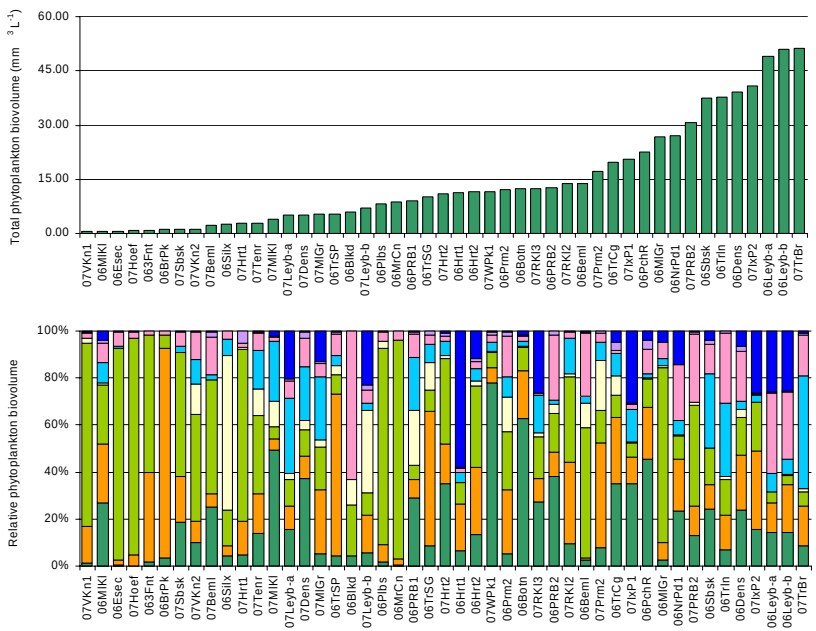
Trophic status – productivity



Many ponds do not develop high phytoplankton biomass / cyanobacterial blooms

Other factors than nutrients might be more important in controlling phytoplankton / cyanobacteria

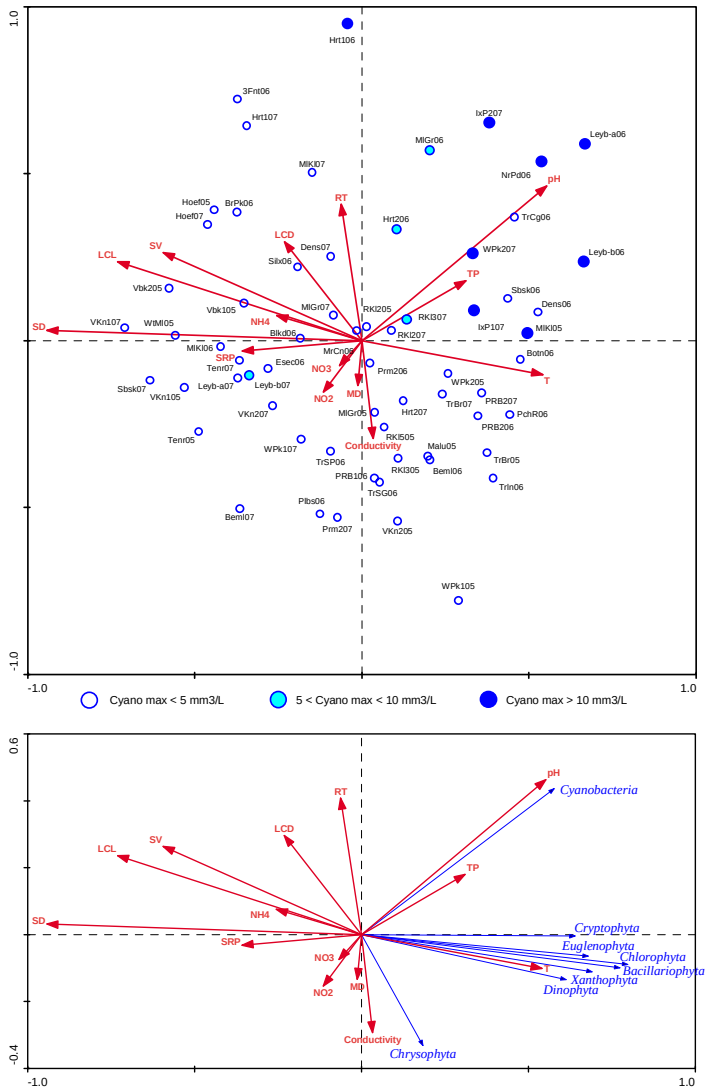
Most of the ponds are hypereutrophic – very productive, have the potential to develop high phytoplankton biomass / cyanobacterial blooms



Cyanobacteria - environmental factors

Redundancy analysis

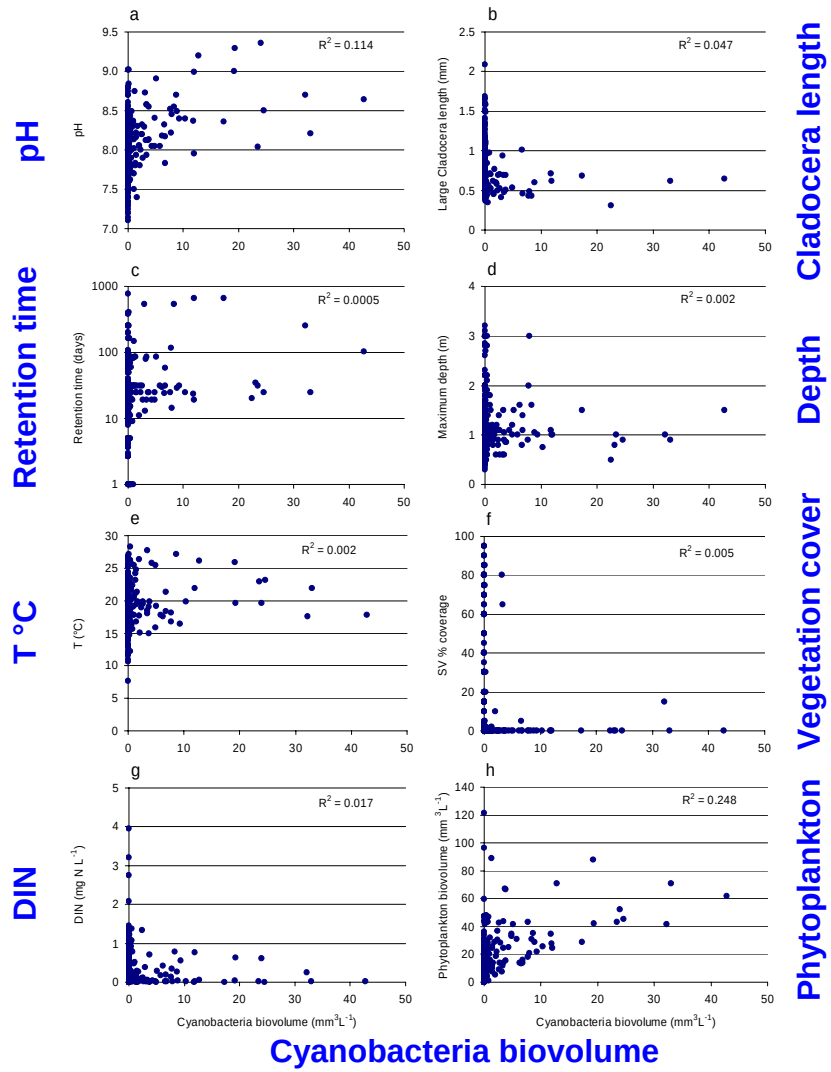
Marginal Effects		Conditional Effects		
Variable	Lambda1	Variable	LambdaA	*p*
LCL	0.26	LCL	0.26	0.002
SV	0.17	pH	0.06	0.002
pH	0.16	SV	0.06	0.004
T	0.14	T	0.03	0.014
SRP	0.07	SRP	0.03	0.016
LCD	0.04	NH4	0.01	0.310
NH4	0.04	Cond	0.01	0.302
NO2	0.02	LCD	0.02	0.154
Cond	0.01	MD	0.01	0.424
MD	0.01	RT	0.00	0.572
RT	0.01	NO3	0.01	0.532
NO3	0.01	NO2	0.01	0.710



Cyanobacteria - environmental factors

Regression analysis

Poor predictive capacity of linear relationships

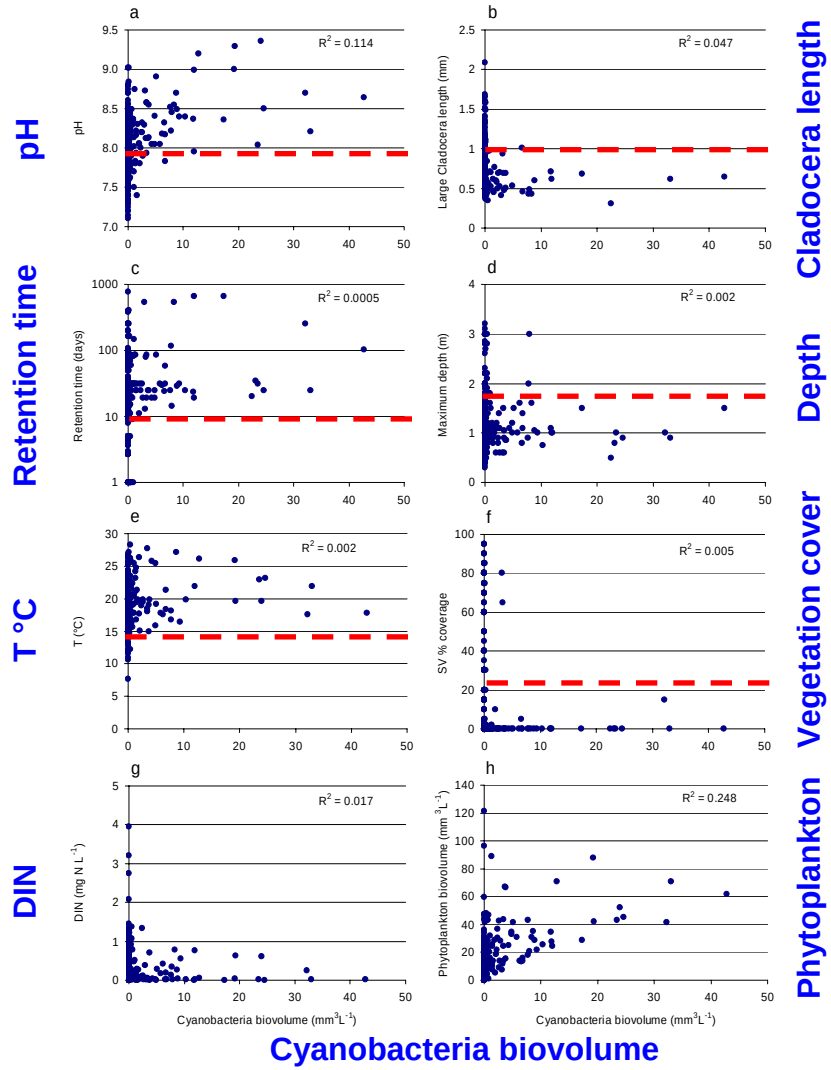


Cyanobacteria - environmental factors

Regression analysis

Threshold rather than linear relationships between cyanobacteria and environmental variables

Conditional probability calculation with these threshold used as conditions allows the risk of bloom occurrence to be quantified



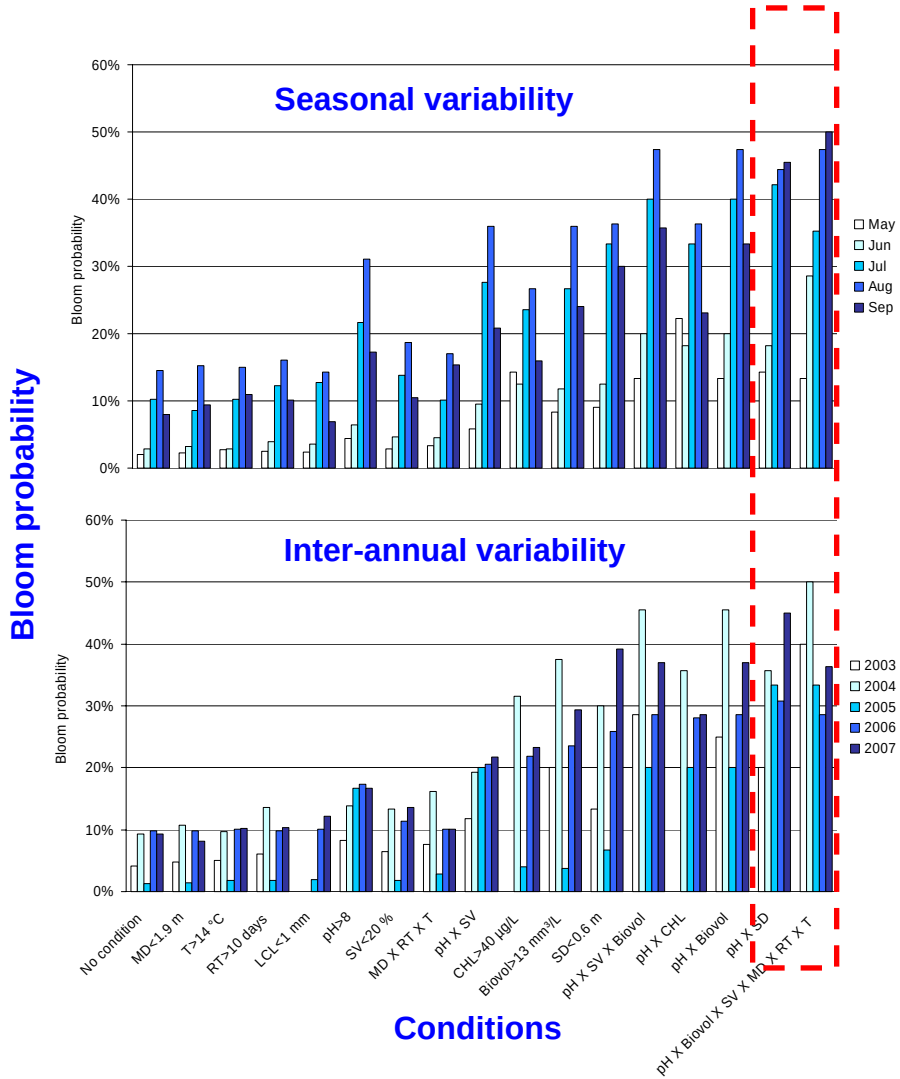
Probabilistic approach to bloom prediction

Probability = predictive capacity

pH X SD gives probabilities statistically equal to the combination of all factors together - similar predictive capacity for blooms

Management implication

- rapid assessment of the risk of bloom occurrence
- simplified application of this approach for monitoring, and restoration planning



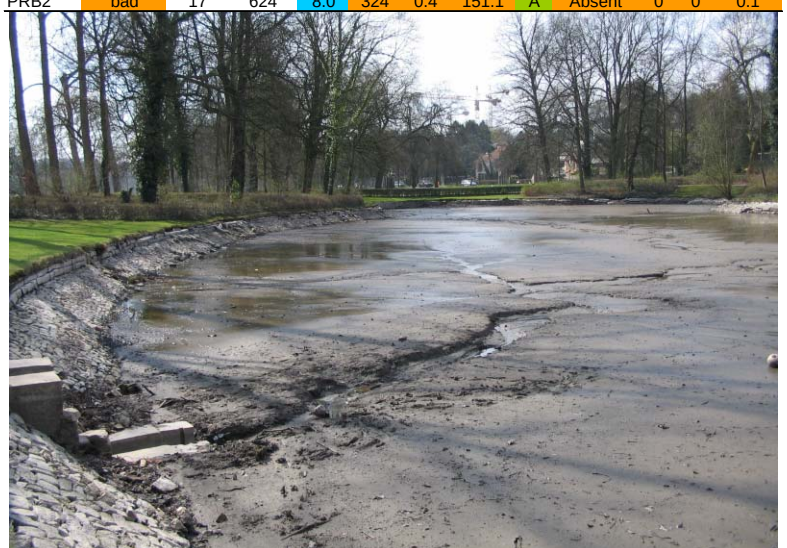
Biomanipulation

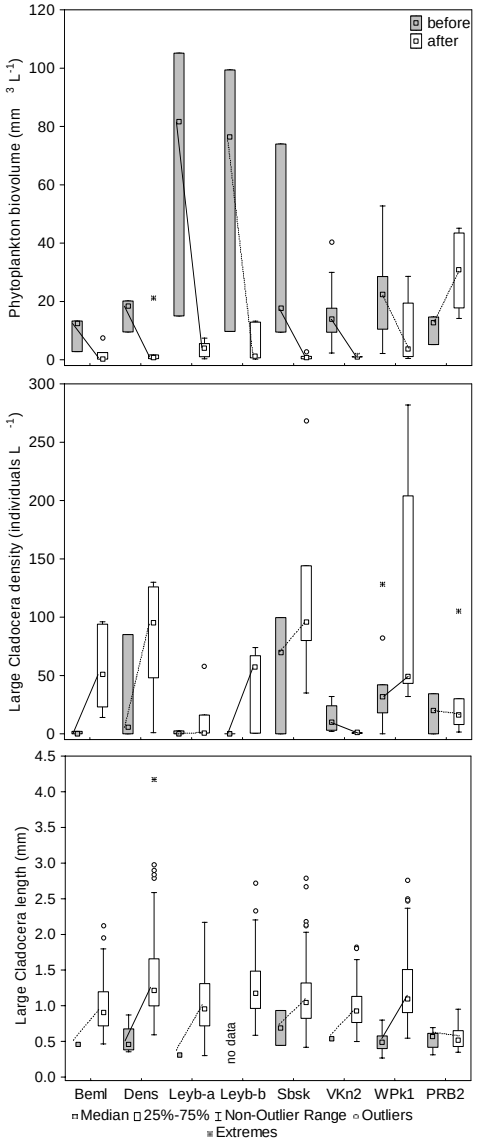
An efficient and cost-effective tool for pond restoration and cyanobacterial bloom prevention

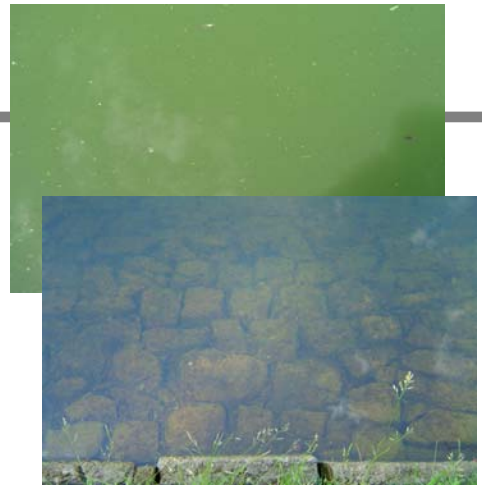
Biomanipulation

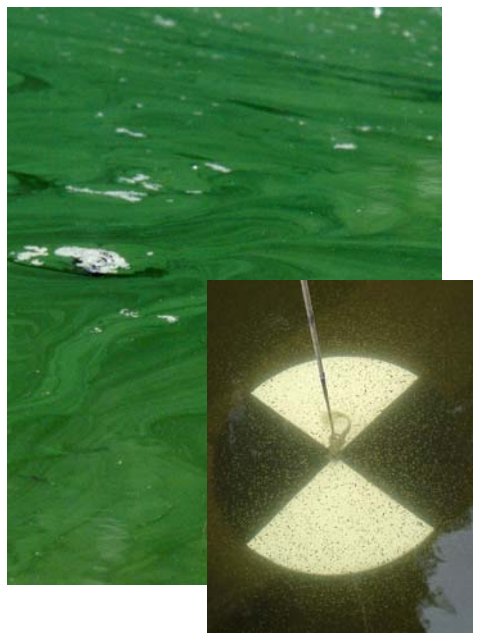
ECOFRAME scheme, version 8 (EWD)

Site	Overall ecological status	Ecotype no.	Conductivity (µS cm^{-1})	pH (log units)	TP (µgL^{-1})	Secchi depth (m)	Chlorophyl a (µgL-1)	Phytoplankton diversity	Plant community	Plant diversity (species no.)	Plant abundance	Cladocera (no. large:no. total)
Before biomanipulation												
Beml	bad	17	748	7.9	673	0.7	52.1	A	CanNym	2	3	0.1
Dens	bad	17	422	8.4	351	0.4	87.8	B	Absent	0	0	0.1
Sbsk	bad	17	781	8.4	426	0.6	82.8	B	Absent	0	0	0.0
VKn2	bad	17	570	7.7	174	0.8	54.3	A	Absent	0	0	0.0
Leyb-b	bad	17	557	8.8	407	0.3	348.6	C	Absent	0	0	0.0
WPk1	bad	17	895	7.8	204	0.6	41.4	B	CanNym	2	1	0.1
Leyb-a	bad	17	536	9.0	506	0.3	469.7	C	Absent	0	0	0.0
PRB2	bad	17	735	8.0	428	0.6	40.2	B	Absent	0	0	0.0
After biomanipulation												
Beml	moderate	17	935	7.7	247	1.4	28.7	A	CanNym	4	3	0.8
Dens	bad	17	433	7.9	191	0.9	18.0	A	Absent	0	0	0.7
Sbsk	poor	17	711	7.8	196	1.8	7.0	A	ElPo	2	2	0.8
VKn2	poor	17	525	7.6	100	1.3	7.3	A	CanNym	1	3	0.2
Leyb-b	poor	17	661	8.0	213	1.5	25.7	B	ElPo	1	2	0.5
WPk1	poor	17	924	7.8	131	1.2	14.5	A	CanNym	2	1	0.4
Leyb-a	bad	17	634	8.3	517	1.2	19.8	B	ElPo	2	2	0.2
PRB2	bad	17	624	8.0	324	0.4	151.1	A	Absent	0	0	0.1

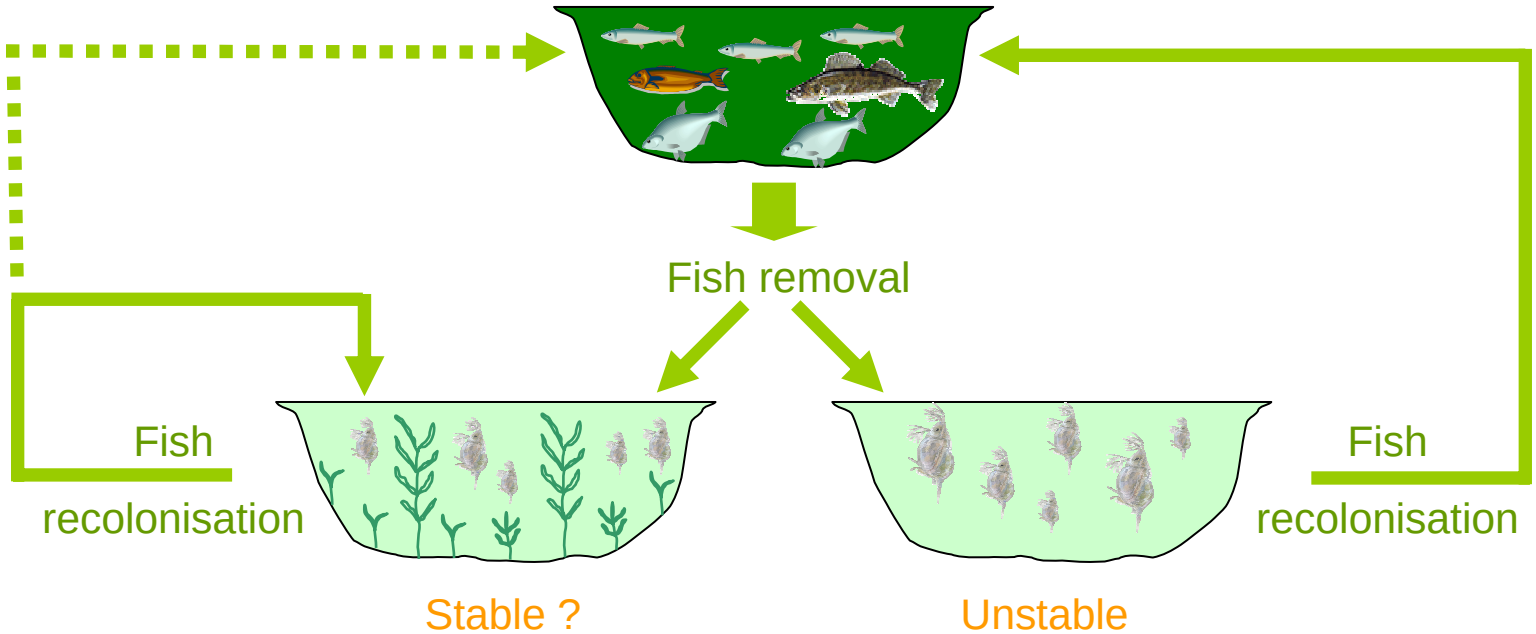








Biomanipulation



Conclusions

- Many Brussels ponds are severely affected by eutrophication
  - Toxic cyanobacterial blooms
- Probabilistic approach allows the risk of bloom occurrence in Brussels ponds to be assessed
- Biomanipulation has proven to be an efficient and cost-effective tool for pond restoration in the short term
  - Nutrient loading reduction/control might be needed for biomanipulation to be successful
- A way to stabilise the restored state is needed
  - Piscivore addition ?
- To improve efficiency of prediction, prevention and remediation, further research is needed
  - Better understanding of how cyanobacteria are controlled by environmental factors


Thank you!