Restoration of Eutrophic Lakes in Europe

Where are we and where are we heading?

Per Nyström

EUROPEISKA UNIONEN
Europeiska regionala utvecklingsfonden
Interreg IV A
ÖRESUND - KATTEGAT - SKAGERRAK
Algae Be Gone!

The Key Issues (bottlenecks)…

- ✓ The ”Fishy” one
- ✓ The ”Internal P” one
- ✓ The ”External P” one
- ✓ The ”Long-lasting” one
- ✓ The ”All together” one
- ✓ The ”All on board and participation” one

The (major) Challenge…

Back to the macrophytes!

EUROPEISKA UNIONEN
Europeiska regionala utvecklingsfonden
Interreg IVA
ÖRESUND - KATTEGAT - SKAGERRAK
Algae Be Gone!

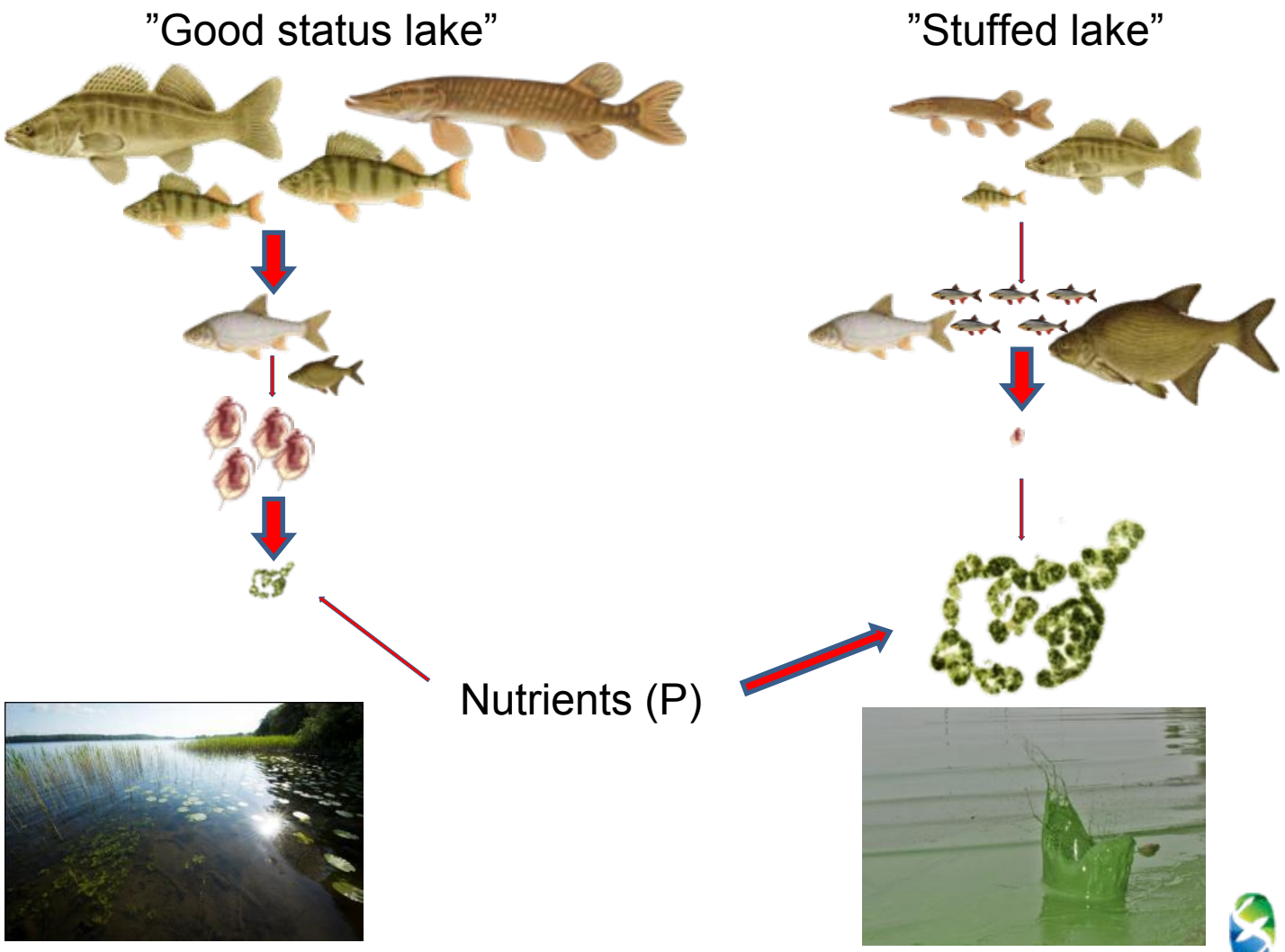
The (major) Challenge…

Cost efficient solutions – long lasting!

Once upon a time…

Lakes were used as recipients of sewage water, but also as a source of drinking water and for recreation...

What happened?…



Algae Be Gone!

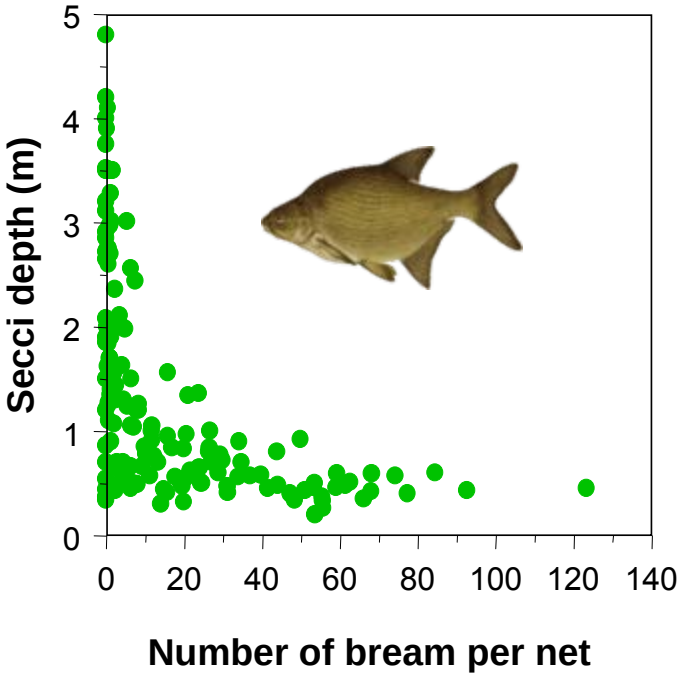
The Tasks…

- ✓ Increase zooplankton grazing on algae
- ✓ Reduce internal loading of P
- ✓ Reduce external loading of P

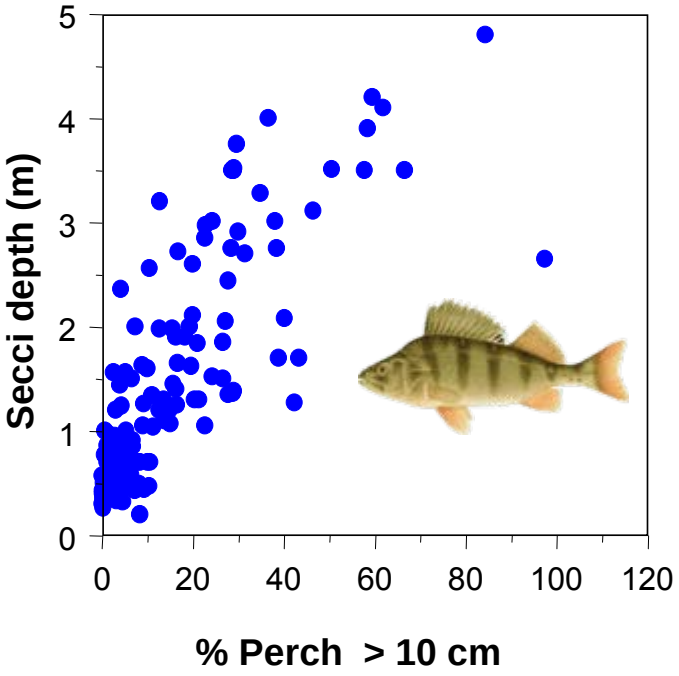
Shallow, who gives a…
What about the toxic blue green algal blooms?

The ”fishy” problem

”The bad guy”



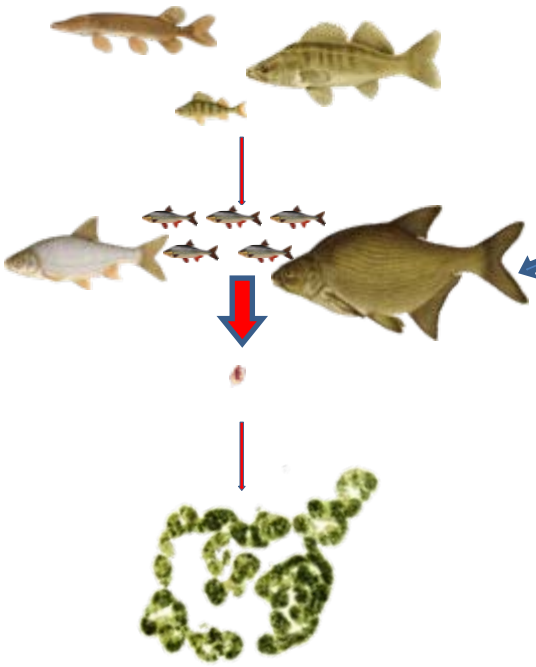
”The good guy”



Data from Danish Lakes, Jens Peter Müller consultant Fiskeøkologisk Laboratorium

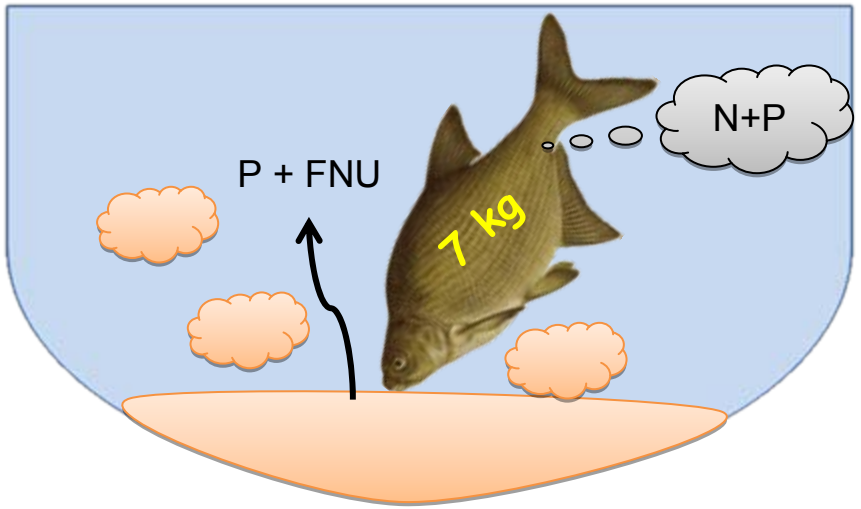
The ”fishy” problem

”Stuffed lake”



”The bad guy”

- ✓ Resuspension of sediments
- ✓ Size-refuge from piscivorous fish
- ✓ Feeding on zooplankton



The Actions today…

- ✓ Biomanipulation ”The fishy problem”

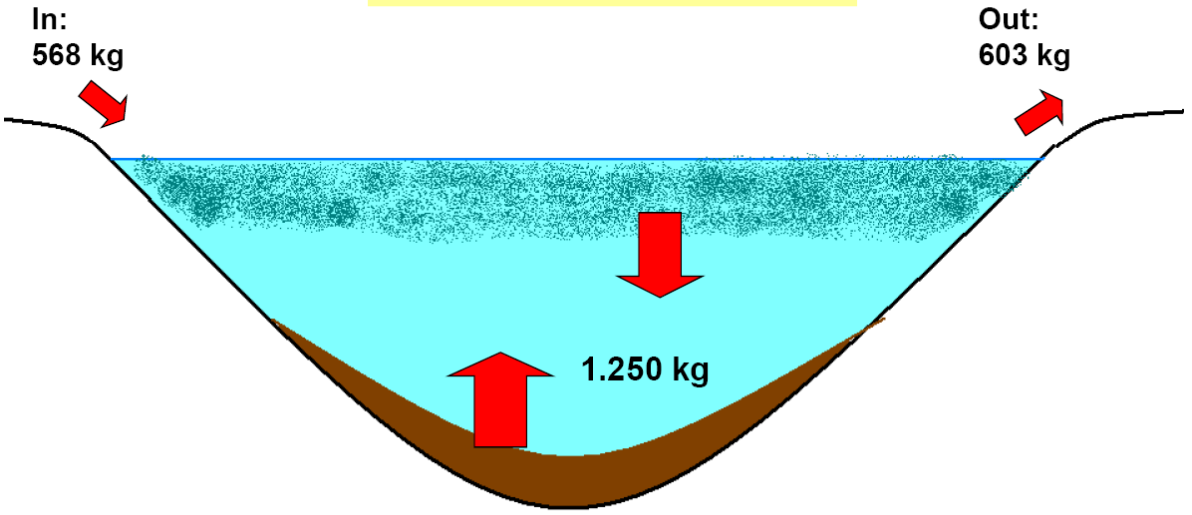
The internal ”P” problem

”Stuffed lake”

Phosphorus budget for Lake Nordborg 2002

Internal P-loading dominates in summer.

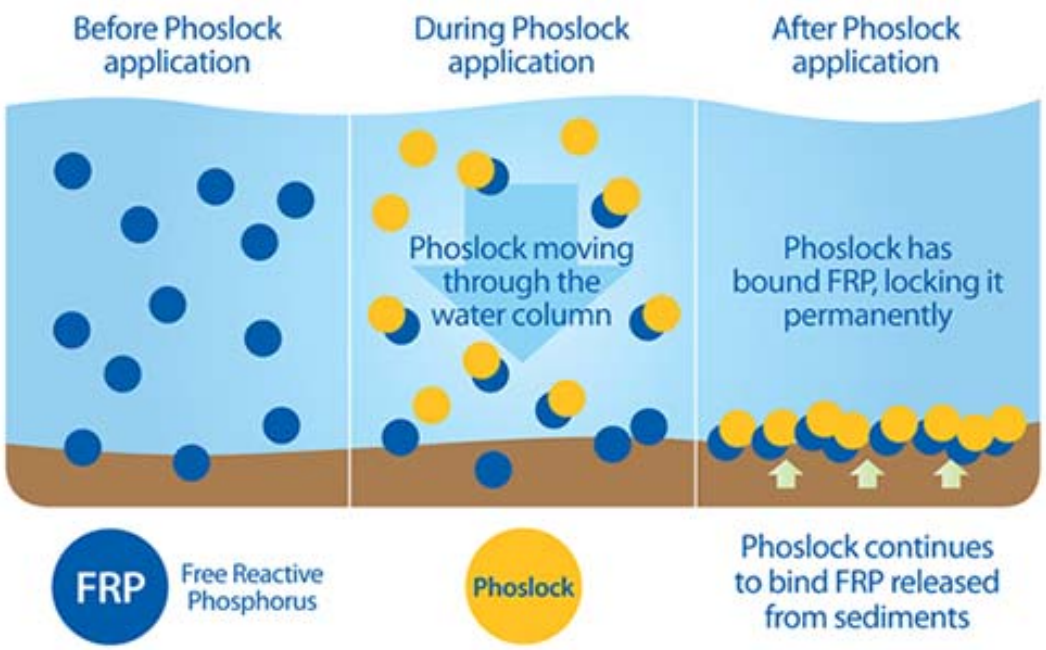
P transport in and out occurs during winter.



Upper 10 cm of the sediment: 11.000 kg – of which 3.500 kg are mobile

The Actions today…

- ✓ Reduce internal loading of P

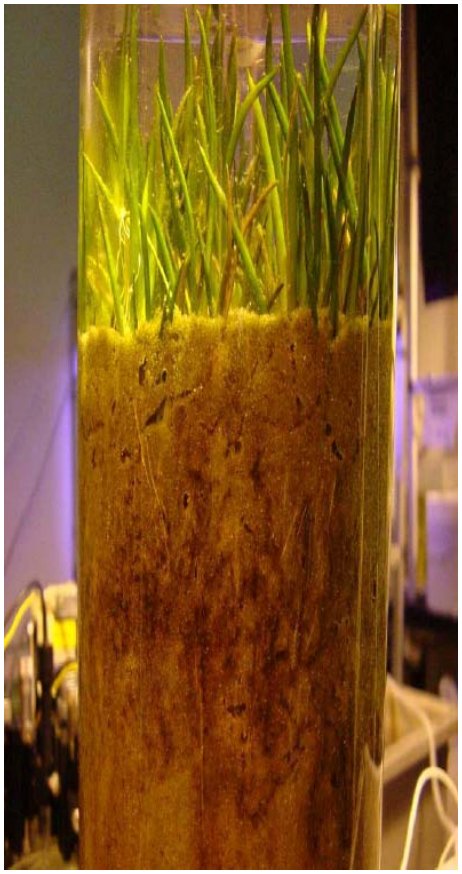


Aim:
To bind phosphorus in the water column and prevent the release of sediment phosphorus

http://www.sepro.com/phoslock/

The Actions today…

- ✓ Reduce internal loading of P



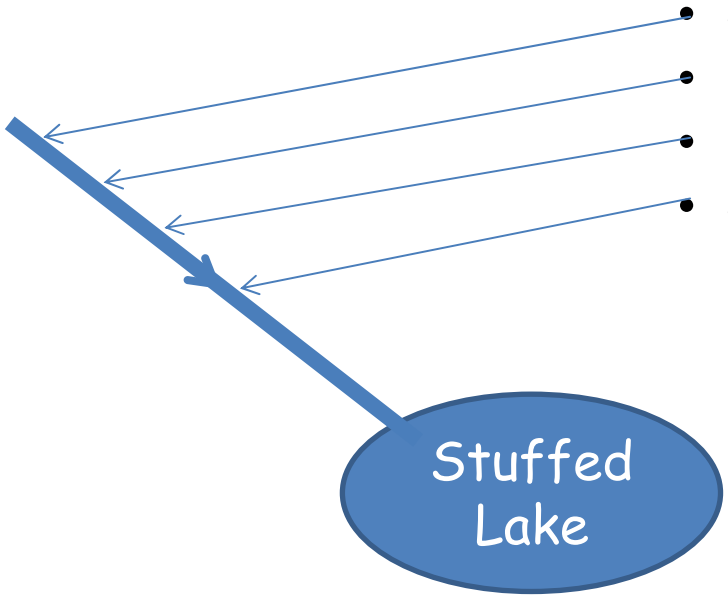
Litorella uniflora, Fø, Andersen, CLEAR

Increase macrophyte depth distribution!

Macrophytes more efficient than algae in P-retention

Algae Be Gone!

The external ”P” problem



- Small sewage treatment plants
- Point sources (sewage treatment plants)
- Drainage pipes from agriculture
- Surface run-off (nutrient rich soils)

The external ”P” problem

- Surface runoff, main pathway for P-loss !

  - Storm events or snowmelt
  - Frozen soil thaws
  - Flat topography
  - Soil type (clay/silt) and management practices

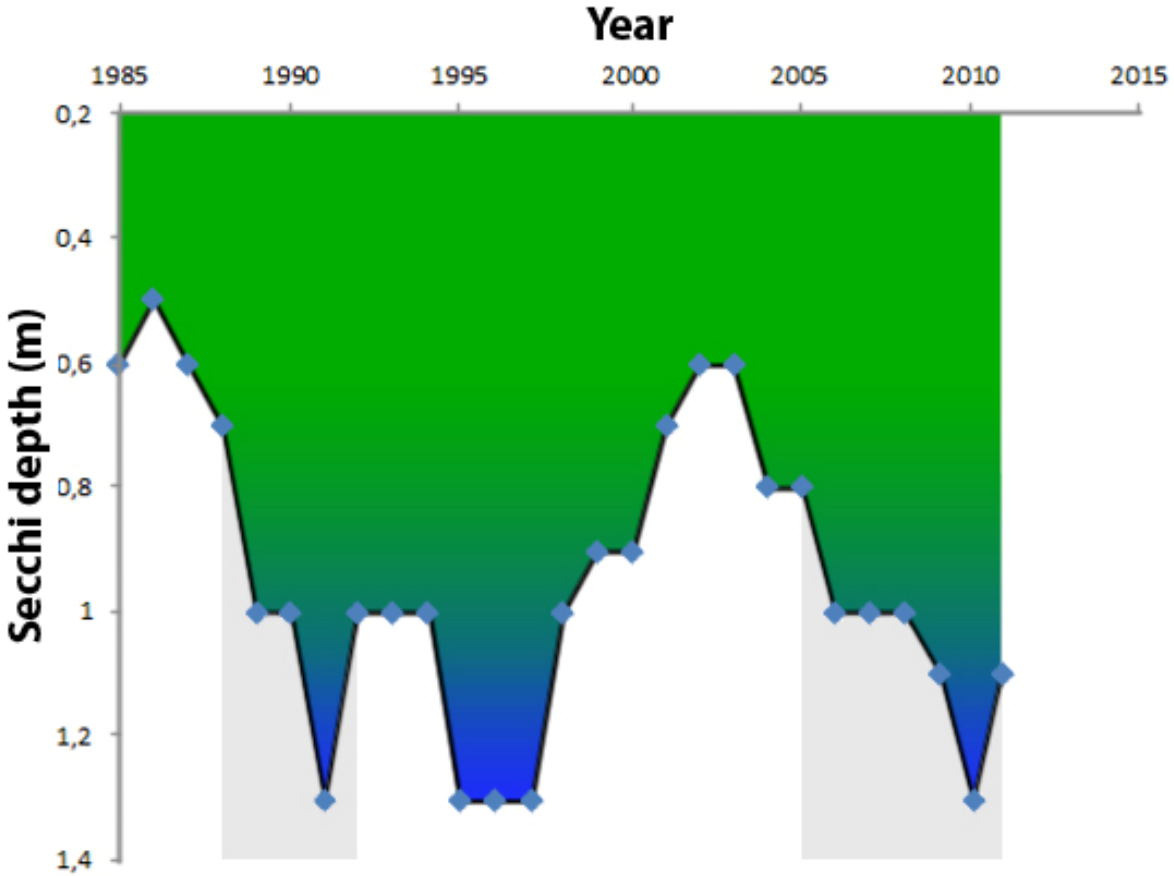
- Drainage pipes
  - Clay soils – (PP + SRP)
  - Sandy soils – (SRP)
  - Soil P-content

The Actions today…

- ✓ Reduce External loading of P

Spade och spett?
Kratta går också bra…

The Long lasting…

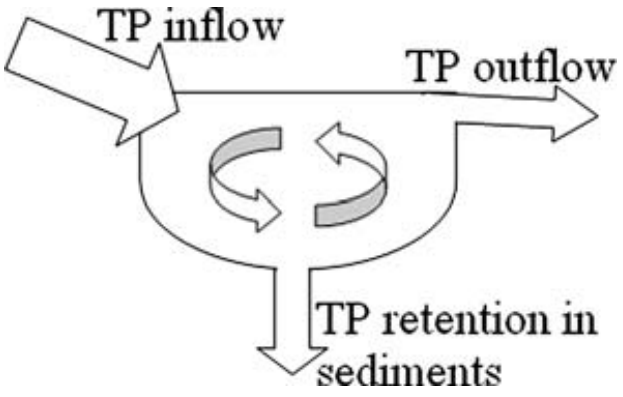


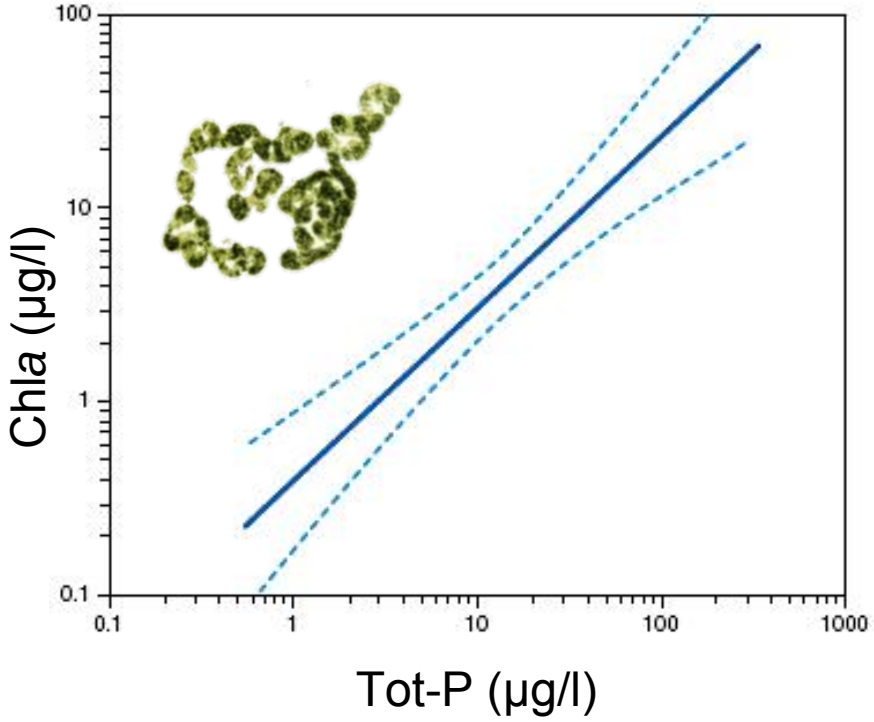
Ringsjön

Biomanipulation “only”
Lasts 10 years...

The All together ones…

✓ Modelling of P (Static lake models)

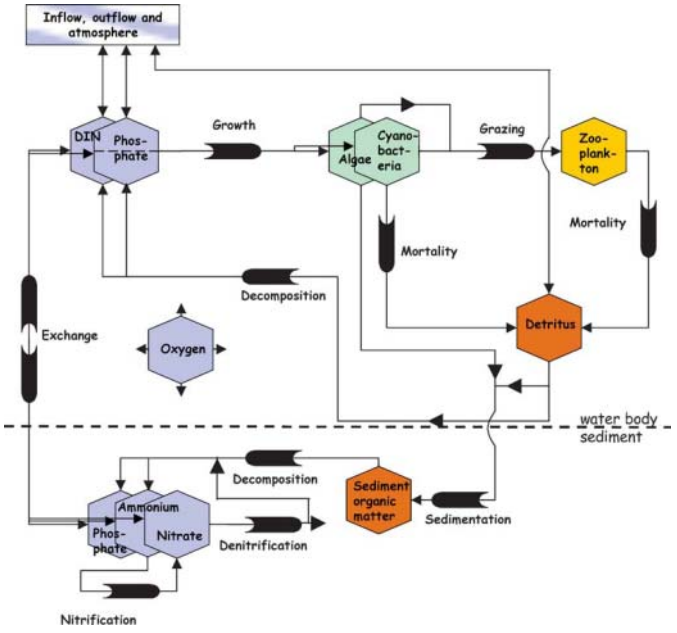




+ Accessible to non-specialists
+ Can be used to predict algal biomass
- Assume constant nutrient input

All On Board…

- ✓ Public participation in Water Management



Dear Peasant. Read my paper and you will see that this model and calibration data explain it all. You and your environmentally hazardous activities are responsible...

EUROPEISKA UNIONEN
Europeiska regionala utvecklingsfonden

Interreg IV A
ÖRESUND - KATTEGAT - SKAGERRAK

Algae Be Gone!

Cost efficient and long-lasting?

EUROPEISKA UNIONEN
Europeiska regionala utvecklingsfonden
Interreg IV A
ÖRESUND - KATTEGAT - SKAGERRAK
Algae Be Gone!

Algae Be Gone!

2011-2013

EUROPEISKA UNIONEN
Europeiska regionala utvecklingsfonden

Interreg IV A
ÖRESUND - KATTEGAT - SKAGERRAK

Algae Be Gone!

ABG, who is that?

Partners (50% contribution of: )

Höörs municipality (Lead partner)
- Hörby municipality
- Eslöv municipality
- Sydvatten AB
- Lund University
- Ringsjön water council (not financing)

Alleröd municipality (coordinating partner, DK)
- Rudersdal municipality
- Hørsholm municipality

ABG, who is that?

Booooooooooooring!

Adults only. Lot´s of sloppy feeding

Film Time!

(Revenge of the Daphnia - part One, Epilimneon
- part Two, Armageddon)

EUROPEISKA UNIONEN
Europeiska regionala utvecklingsfonden
Interreg IVA
ÖRESUND - KATTEGAT - SKAGERRAK
Algae Be Gone!

The End

EUROPEISKA UNIONEN
Europeiska regionala utvecklingsfonden
Interreg IV A
ÖRESUND - KATTEGAT - SKAGERRAK
Algae Be Gone!

Final goal?

ABG!

The cost efficient
Cookery book

With the best from the Baltic region
(and the worst)

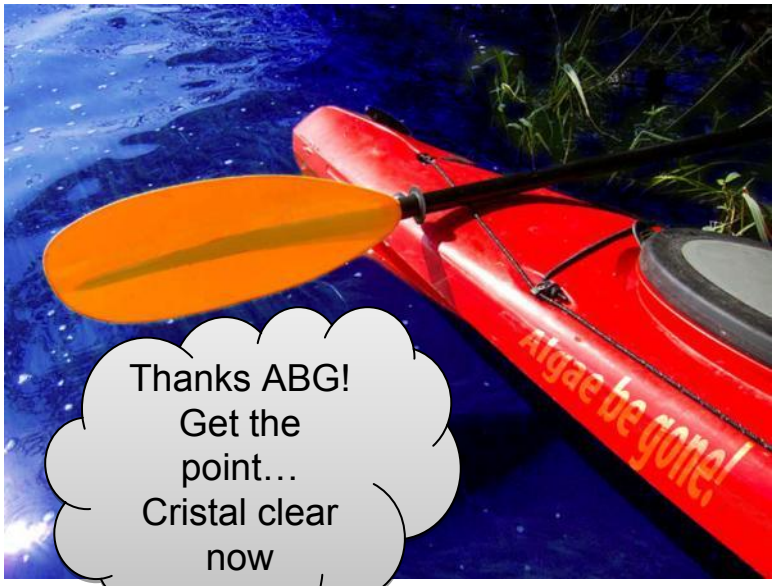
Interreg IVA

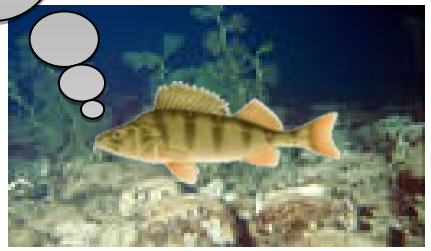
Algae Be Gone!

Algae Be Gone!

Before and After

Algae Be Gone!





EUROPEISKA UNIONEN
Europeiska regionala utvecklingsfonden

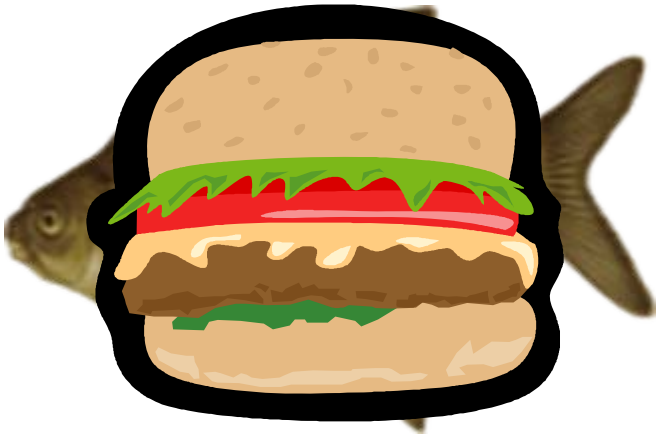
Interreg IVA
ÖRESUND - KATTEGAT - SKAGERRAK

How?

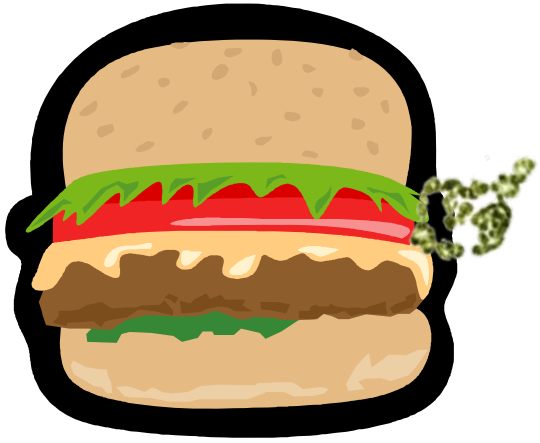
- ✓ Improve biomanipulation technology
- ✓ Evaluate zooplankton grazing on blue green algae and macrophyte responses
- ✓ Assess methods to reduce internal loading of P
- ✓ Identify external sources of P in catchments and make action plans, based on GIS and models
- ✓ Involve landowners, stake holders etc

How?

- ✓ Find new areas for using cyprinids



McBream



McRocystis

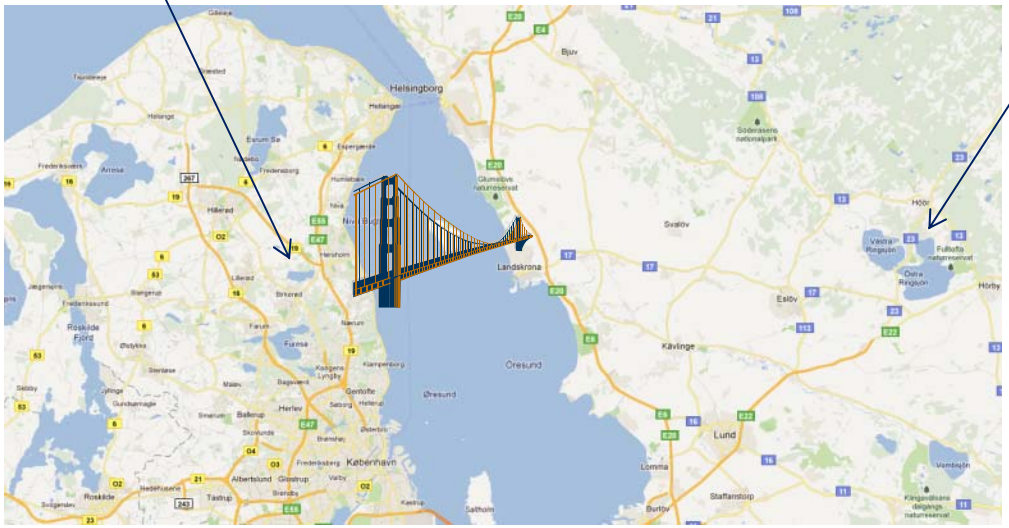
EUROPEISKA UNIONEN
Europeiska regionala utvecklingsfonden
Interreg IVA
ÖRESUND - KATTEGAT - SKAGERRAK

How?

- ✓ Find new areas for using cyprinids

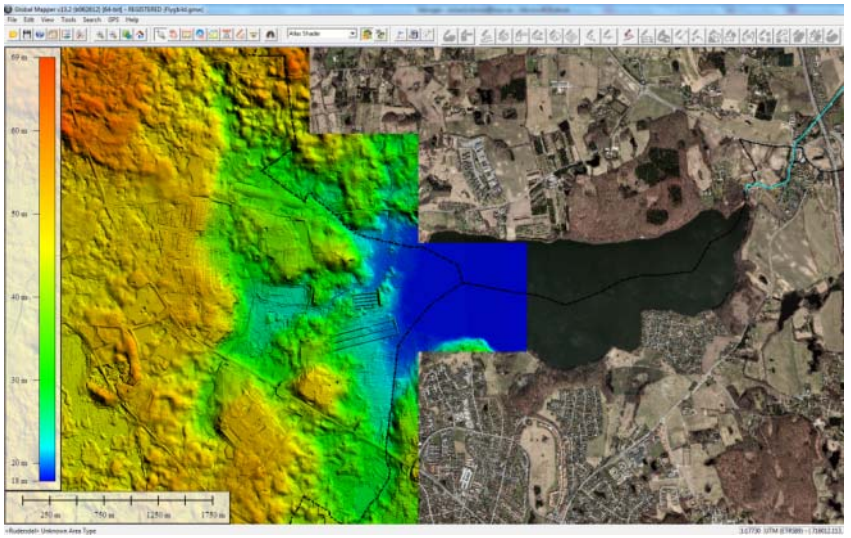
EUROPEISKA UNIONEN
Europeiska regionala utvecklingsfonden
Interreg IVA
ÖRESUND - KATTEGAT - SKAGERRAK

The Lakes


Helsingborg
Landskrona
Malmö
København
Lund
Kävlinge
Öresund

ABG in the Lakes and catchments

+



Long term effects!

EUROPEISKA UNIONEN
Europeiska regionala utvecklingsfonden
Interreg IVA
ÖRESUND – KATTEGAT – SKAGERRAK
Algae Be Gone!

The ”fishy” solution

Sjælsø
Ringsjön

- ✓ Predict where large bream are (spawn) in the lakes and reduce biomass by 90% over two years
- ✓ Increase the biomass of large perch by 20% in three years

Algae Be Gone!

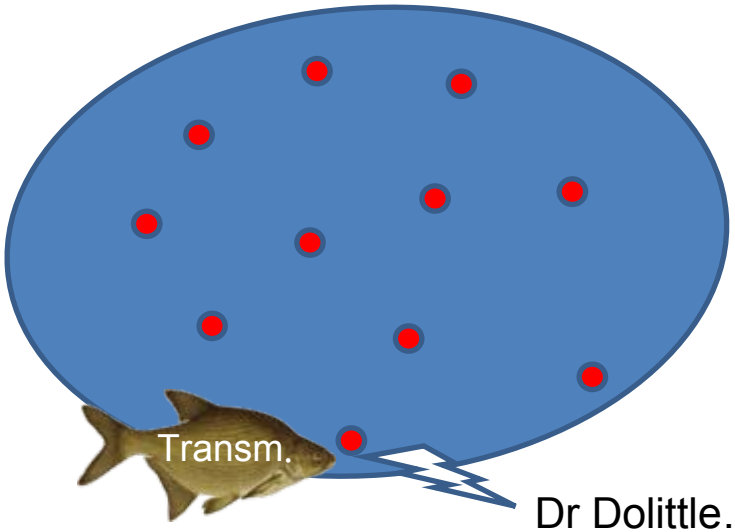
Catch the bad guys, keep the good guys

No large bream, just pike…

Houston… we have a problem…"over"

- ✓ Tagging of large bream
- ✓ Tracking of large bream during a year
- ✓ Correlate movements and spawning with abiotic factors (temp. air pressure, light etc)

Predictions



Dr Dolittle…
Bream no 12
Passing…
5 m depth…"over"

EUROPEISKA UNIONEN
Europeiska regionala utvecklingsfonden
Interreg IV A
ÖRESUND - KATTEGAT - SKAGERRAK

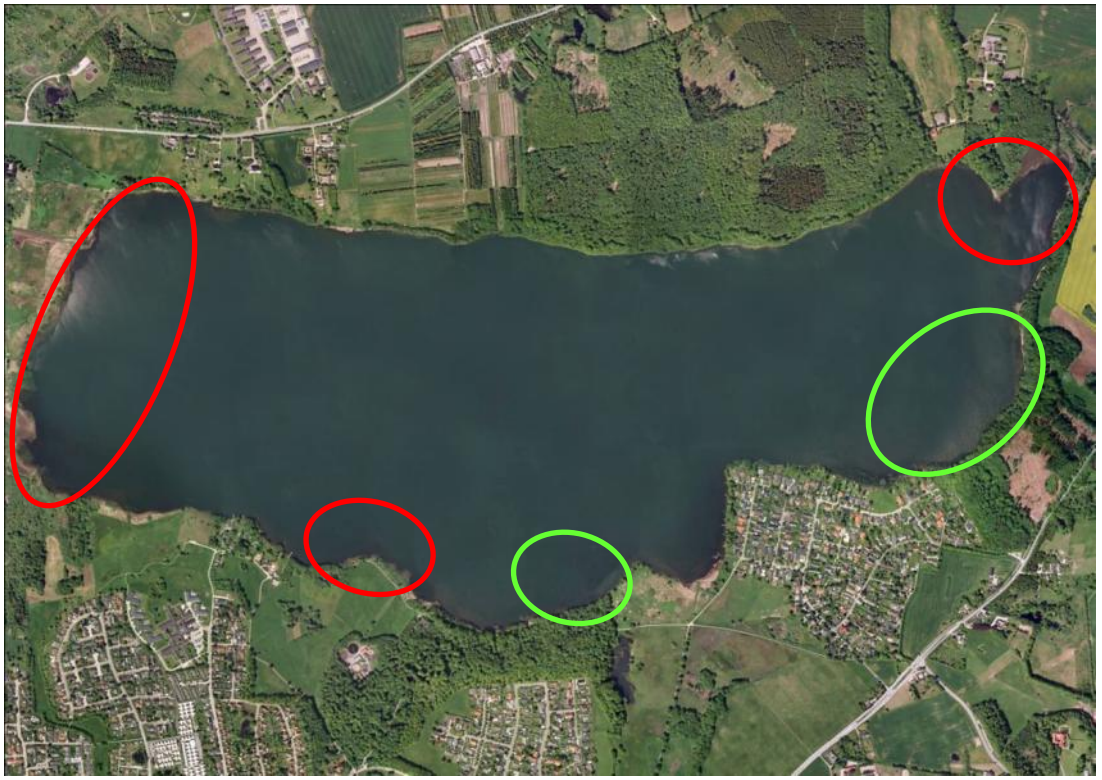
Catch the bad guys, keep the good guys

✓ Finding spawning sites

Reduce recruitment +
Removal of large bream

Catch the bad guys, keep the good guys

✓ Finding spawning sites (Gill nets, 85-135 mm)

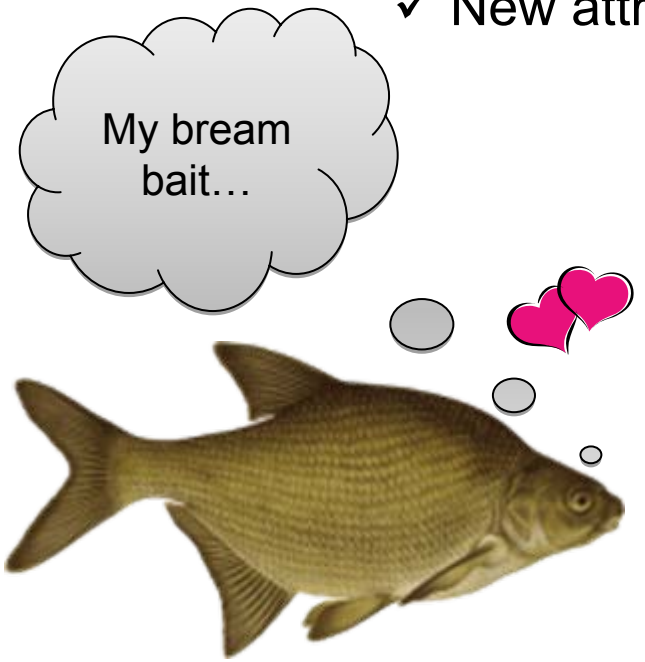


Spawning
No spawning

- Spawning 20 May
- 120-135 mm best catches
- 233 large bream (≈ 1 ton)
- No by-catches of piscivores

Catch the bad guys, keep the good guys

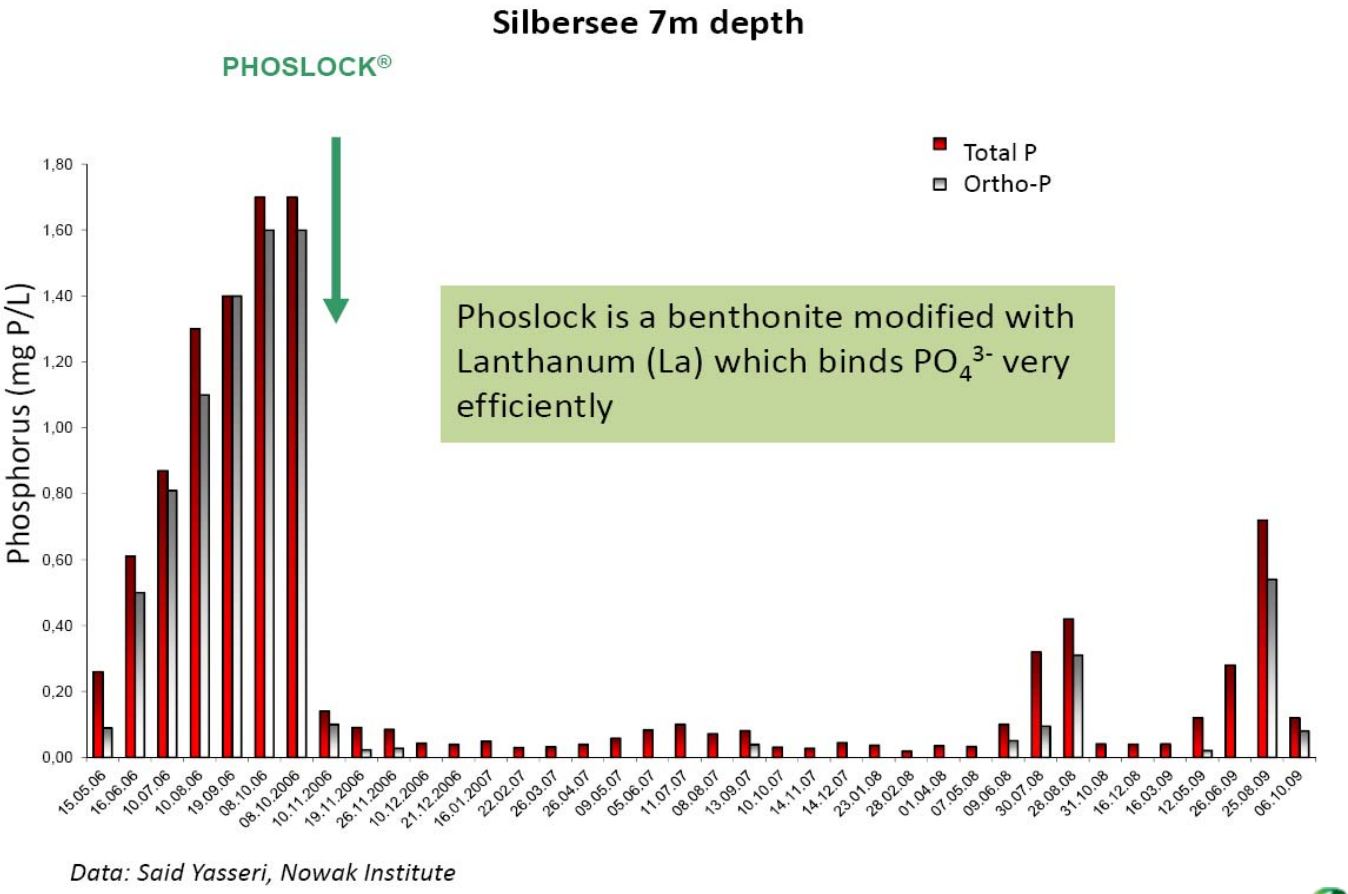
- ✓ New attraktive bait for catching bream



The internal ”P” solution

”Stuffed lake”

Sjælsø
Ringsjön



Data: Said Yasseri, Nowak Institute

Note: Aluminium may also do the job, but controversial...

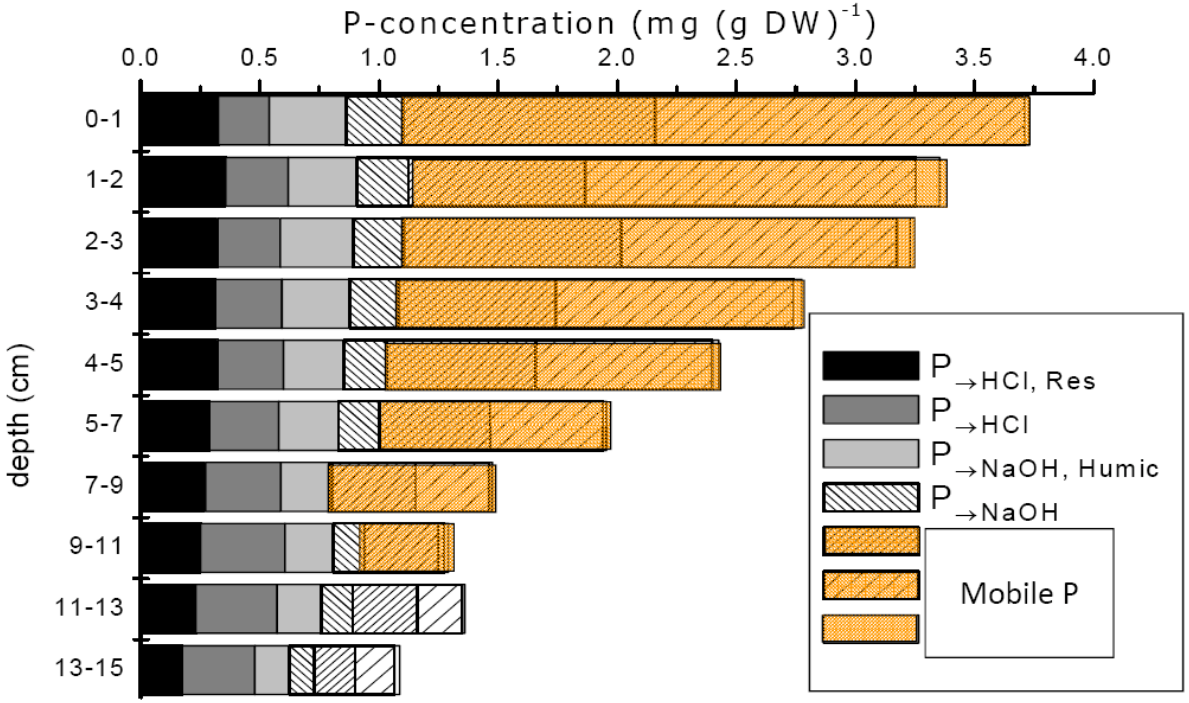
Algae Be Gone!

The internal ”P” solution

”Stuffed lake”

Sjælsø
Ringsjön

✓ P-release mechanisms are Lake dependent



Determine size of mobile P-pool in the sediment!

Lake Sønderby, 2001, HS Jensen CLEAR

Algae Be Gone!

The external ”P” solution

✓Identify important sources/areas of external P

- Habitat mapping (land use, buffer zones, pipes etc)

- Monitoring of P by combining the use of SorbiCell* (hope not to miss peaks) and measurements

*Passive water quality monitoring 

Algae Be Gone!

The external ”P” solution

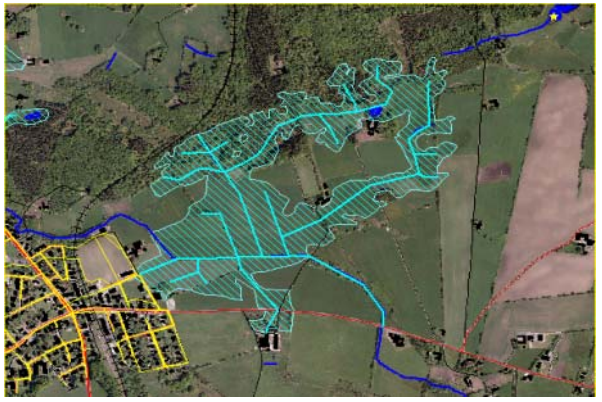
✓Identify important sources/areas of external P

- Compile data from own investigations and existing data on e.g

  - soil types
  - land use
  - ditches and drainage pipes
  - altitude and slope
  - water quality monitoring data
  - soil P content etc from farmers?

Hot spots!

All collected data are digitalized



Algae Be Gone!

All On Board…

- ✓ Arrange public days in catchment

Algae Be Gone!

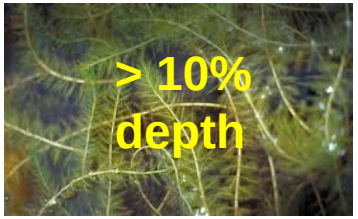
All On Board…

✓ Organize landowners and let them participate

Kvesarumsåns vattendragsgrupp

Algae Be Gone!

Cost efficient?



✓ *”I would like to increase macrophytes…*
I have 1 milj SEK, what should I do?”

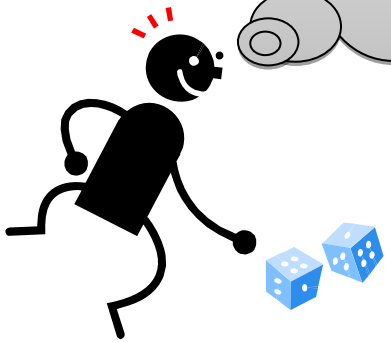
Biomanipulation

Phoslock

Buffer zones
Wetlands
Meandering

Ok, lets look in the cards...wetlands

and now, dices...5
5 wetlands!

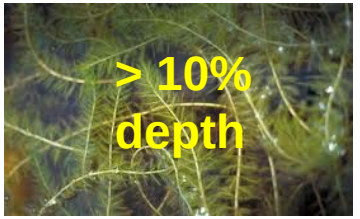


EUROPEISKA UNIONEN
Europeiska regionala utvecklingsfonden

Interreg IVA
ÖRESUND - KATTEGAT - SKAGERRAK

Algae Be Gone!

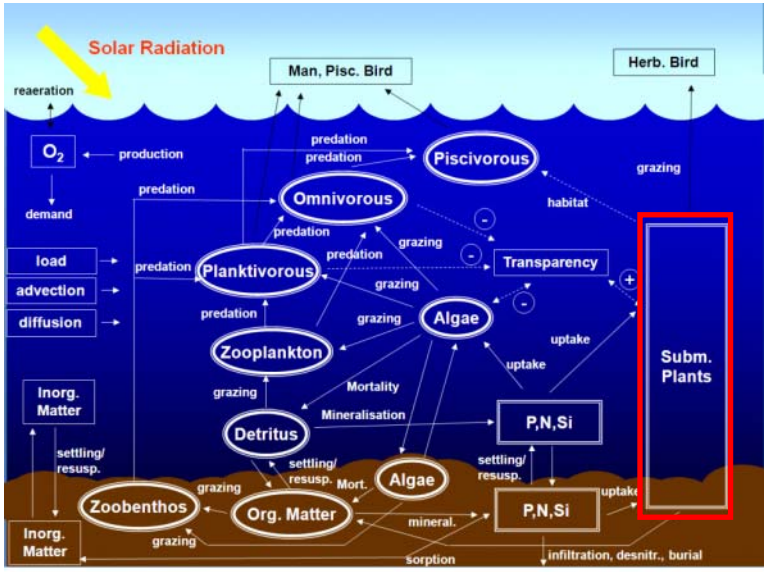
Cost efficient?



✓ Dynamic models: of actions and respons variables

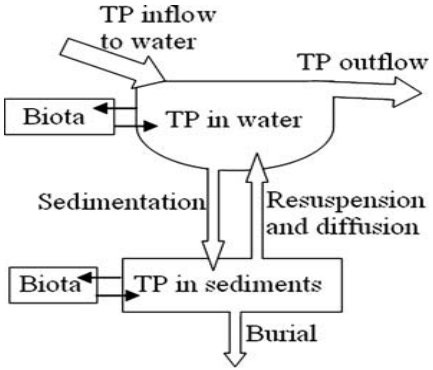
+ Simulate changes over time (chemical, ecological, physical)
+ Can be used to predict effects of actions (e.g reduced external loading of P)

- Many input variables
- Differential equations



PCLake Model (≈ 20 variables)

Summary of concept



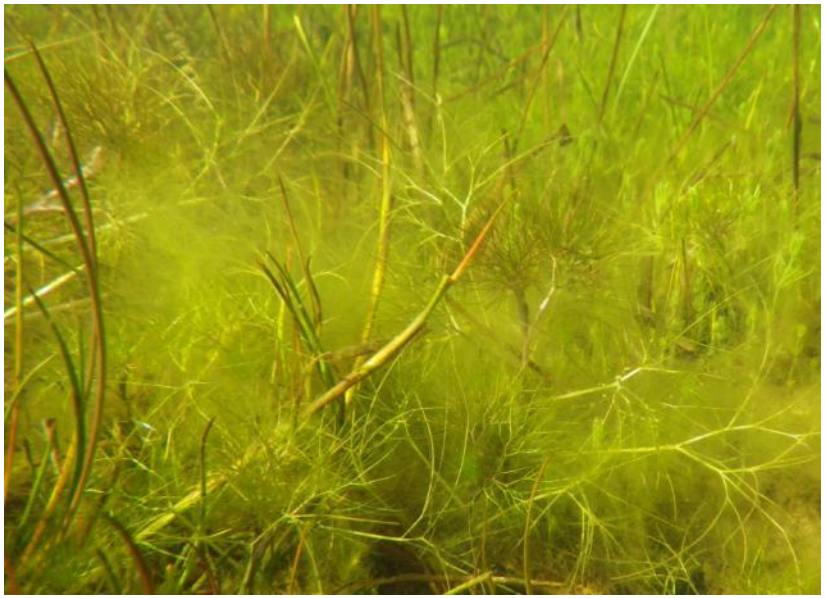
EUROPEISKA UNIONEN
Europeiska regionala utvecklingsfonden

Interreg IVA
ÖRESUND - KATTEGAT - SKAGERRAK

Future?

- ✓ Climate change: wetter and warmer!
  - enhanced phytoplankton growth and prolonged seasons?

VS



Future?

- ✓ Climate change: wetter and warmer!
  - external loading of P may increase

Algae Be Gone!

Future?

- ✓ Climate change: wetter and warmer!
  - reducing external loading is to eliminate underlying reasons for e.g. algal blooms. Wetland construction?

VS

From: Pia Kynkäänniemi 2011, SLU, Soil and environment (jordbruksinformation 11-2010)

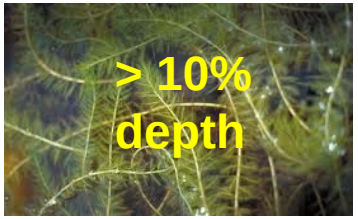
Algae Be Gone!

Future?

- ✓ Ecosystem modelling results must be shared between scientists and water quality managers. Copy right?

We need a new forum!

Future?

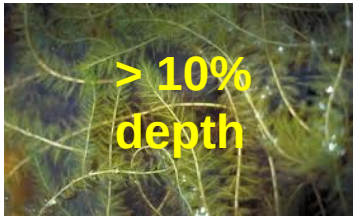


- ✓ The role of nitrogen in affecting macrophytes in P-rich and shallow lakes?

”If N concentration in summer exceeds 1-2 mg/l, macrophytes were absent in 44 Danish lakes (Jeppesen et al. 2007)”

P-wetlands
+
N-wetlands

Future?



✓ How can we reinforce growth/establishment of macrophytes?

Thanks!
Questions?

Algae Be Gone!

www.algaebegone.eu

EUROPEISKA UNIONEN
Europeiska regionala utvecklingsfonden
Interreg IV A
ÖRESUND - KATTEGAT - SKAGERRAK