Möjligheter med integrerad hydrodynamisk biokemisk modellering av övergödda sjöar.
/
Coupled hydrodynamic, biochemical and ecological 3D models for modelling of eutrophication in lakes – based on examples from Växjösjörna.

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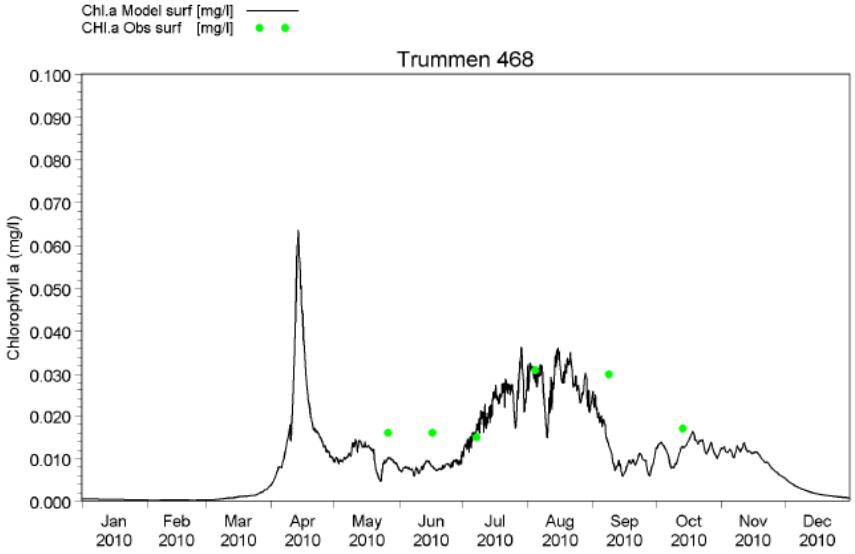
The traditional use of dynamic models in water quality management and administration

Exampel: Trummen

Average summer Chl.a (µg/l)		
Scenarios	Year 1	Year 9
Basis	15.3	12.7
Load reduction	14.9	10.8
Increased flow	7.8	12.7
Fish manipulation	12.3-9.2	
Vegetation establish.	10.4	

Kalibrering Trummen (2010)



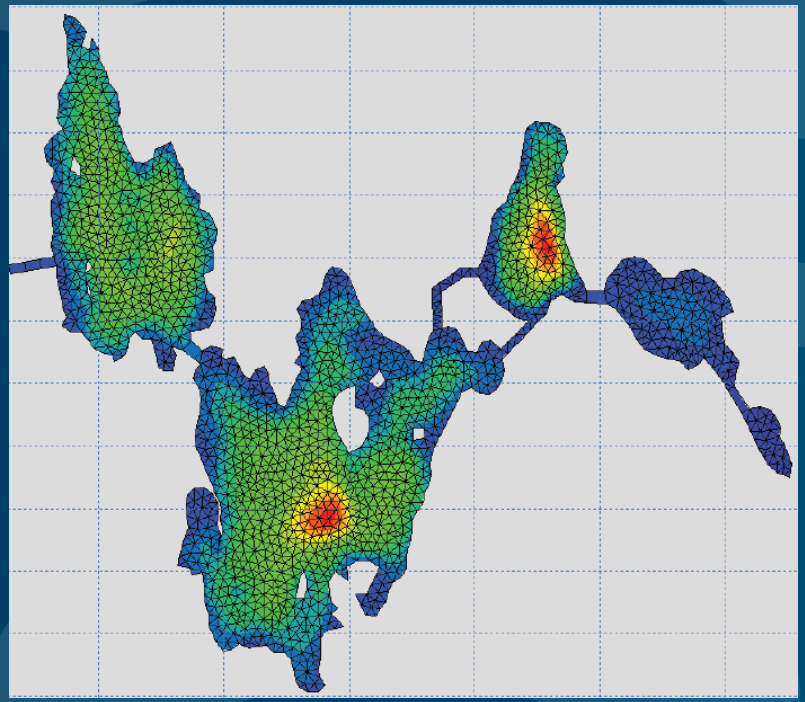
Agenda

1. Stratification of water masse and Phosphate concentration
2. Sediment water interaction – external load
3. Horizontal distribution of water quality variables – importance for understanding monitoring data - Blue Green Algae Blooms
4. Simulation of establishing Benthic Vegetation – Manegement the Fish Population (reduktionfiske)

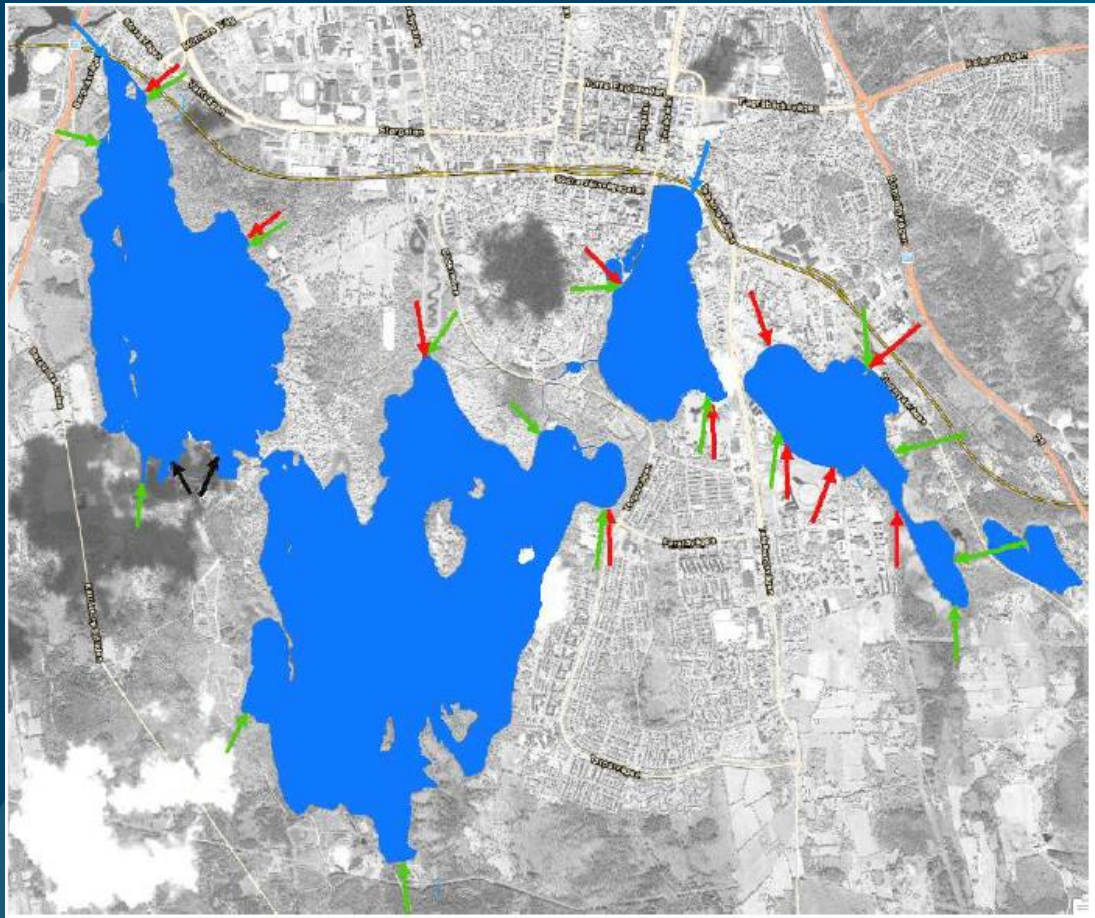
Model för Åtgärdsstrategi för Växjösjöarna

- Horisontal diskretisering som vist - horisontal upplösningen ca 100 m:

- Vertical diskretisering med vandlag af 0,5 cm tykkelse

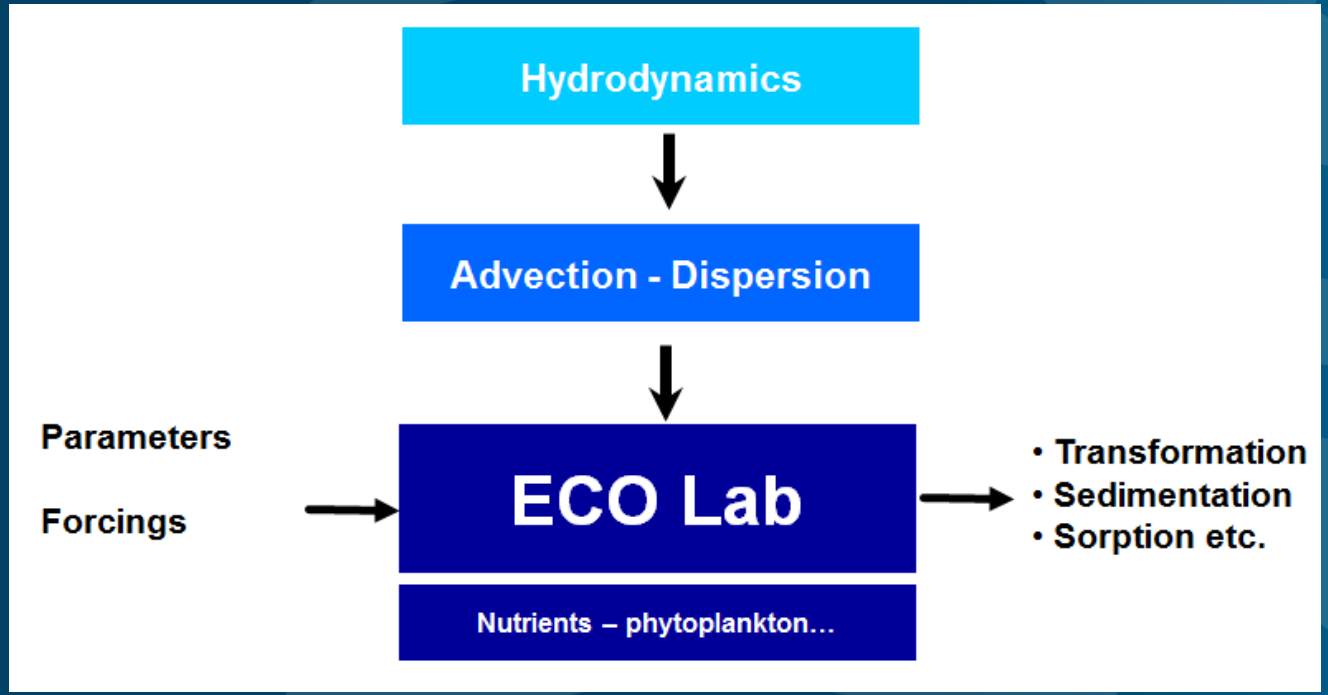


- källor som belastar sjöarna



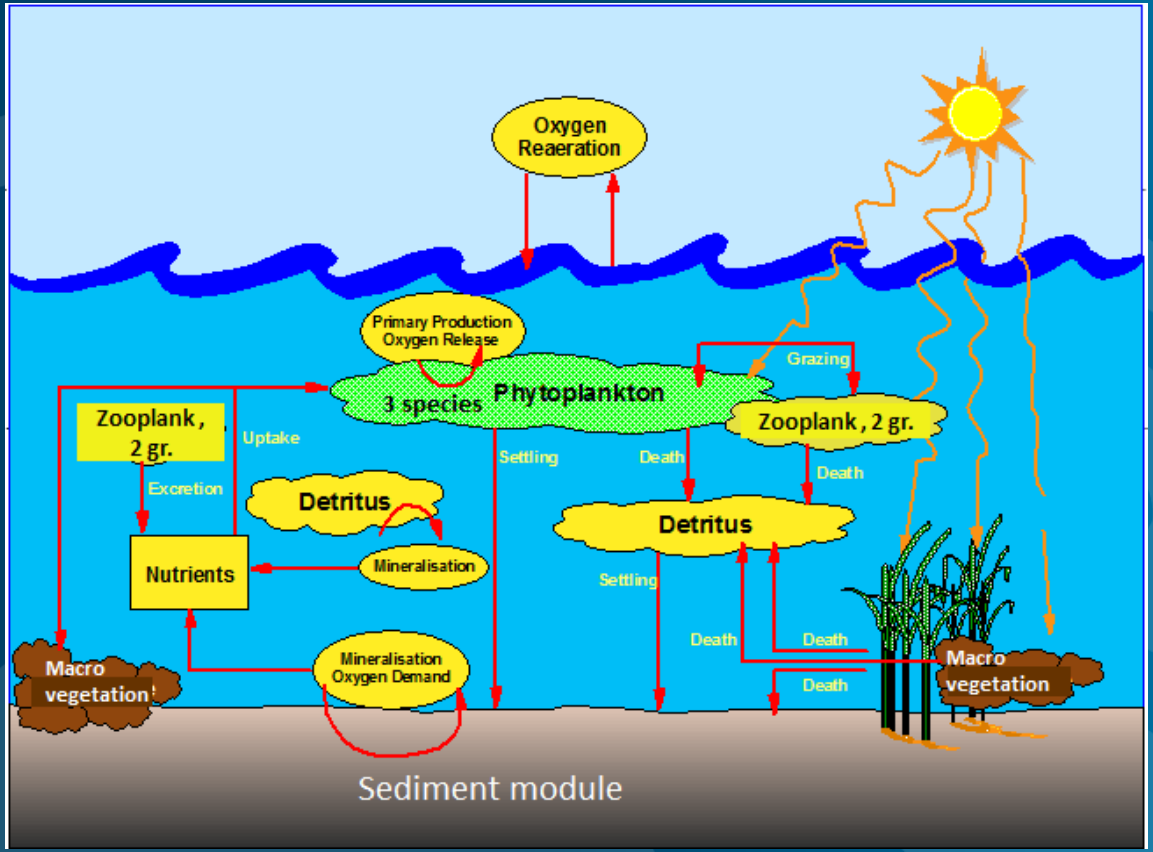
Figur 88. Externa källor som belastar sjöarna. Grön pil=naturmarksavrinning; röd=dagvatten; blå=helgasjövatten och svart=avloppsreningsverk.

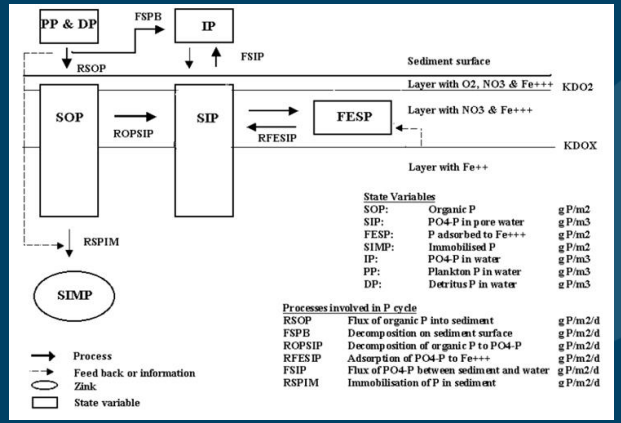
Dynamisk Kobling mellem hydrodynamisk model, transport model og biokemisk model (ECOLab)



- Struktur for Biokemisk – økologisk model (ECOLab)

- Sediment model med N og P puljer , omsætninger og frigivelser mv





1. + 2.

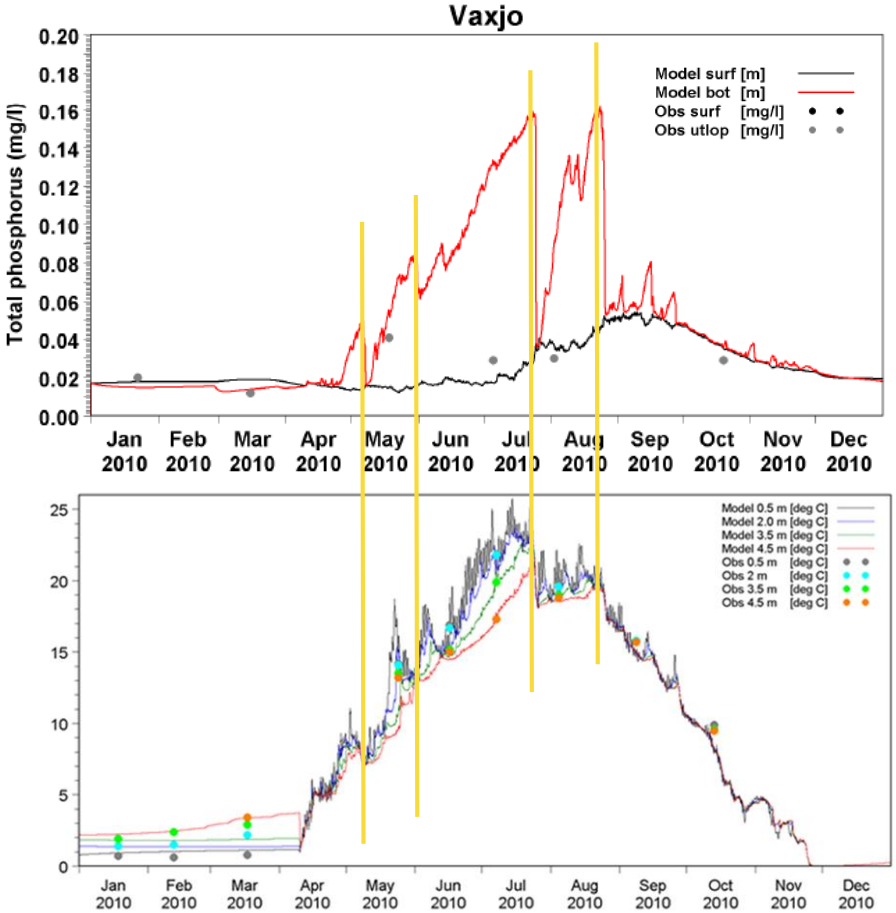
1. Stratification and P concentrations
2. Importance of sediment-water interaction and external load

Modelling analysis of importance of stratification

- Calibration against 2010 problematic because few data. However bottom layer data form 2013-14 up to 0.17-0.21 mg TP/l

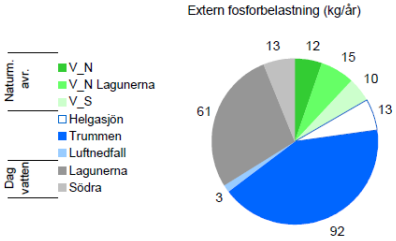
- Stratification and mixing is highly important for the P concertation in bottom and surface water.

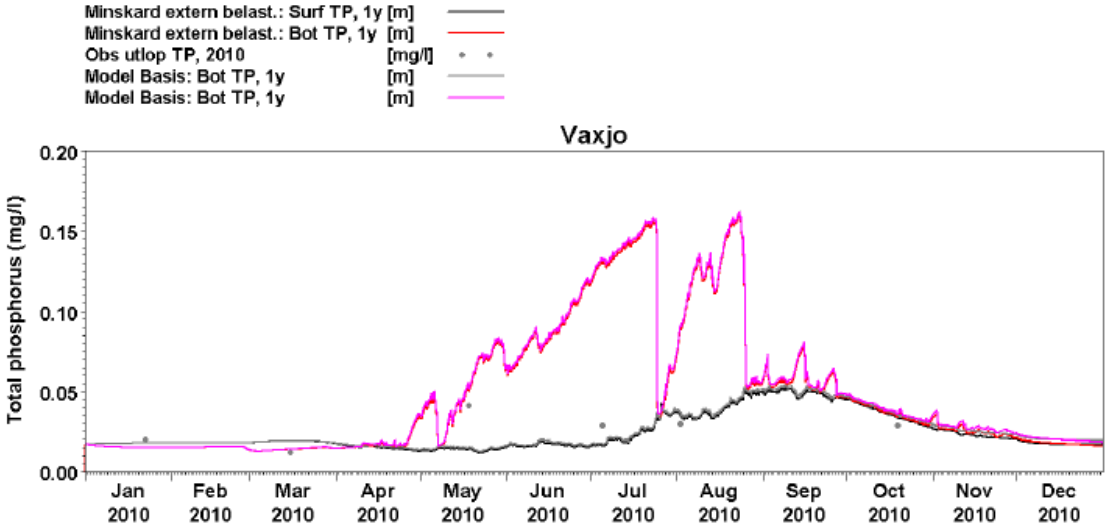
- Information about internal hydraulic in Växjösö is important for understanding the dynamic in the lake and measured concentrations



Impact of reduced P load from externat sources

- Ca 80% av vattnet som passerar Lagunerna leds till Södra Bergundasjön. Den föreslagna åtgärden reducerar tillförseln i modellkörningen för 2010 med ca 53 kg P/år.

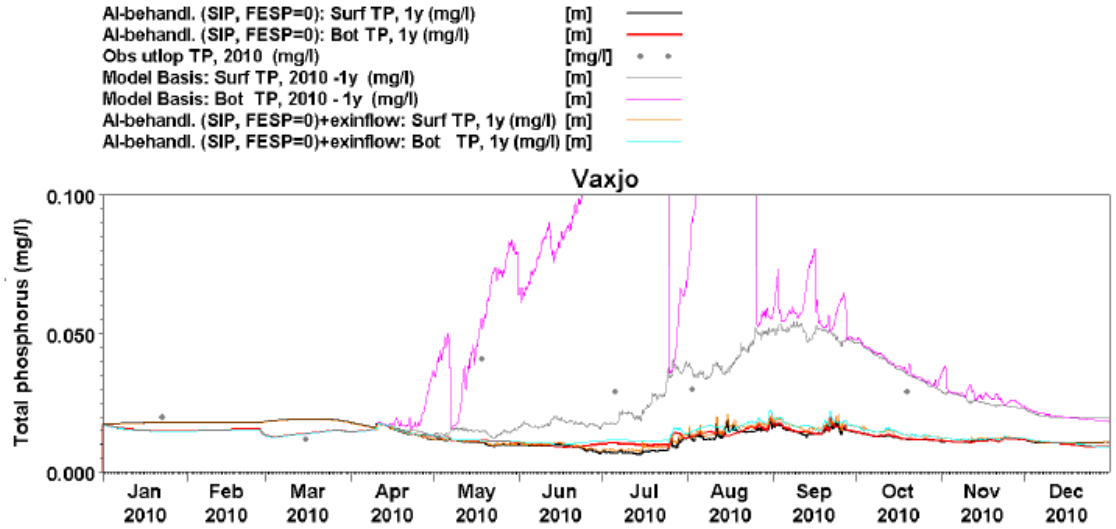




Figur 192. Beräknad yt- och bottenkoncentration totalfosfor (mg/l) i Växjösjön före (grå – rosa) och efter åtgärder (svart - röd) för år 1 och uppmätta ytvärden (svarta punkter).

Reduced P release from sediment (Al-treatment)

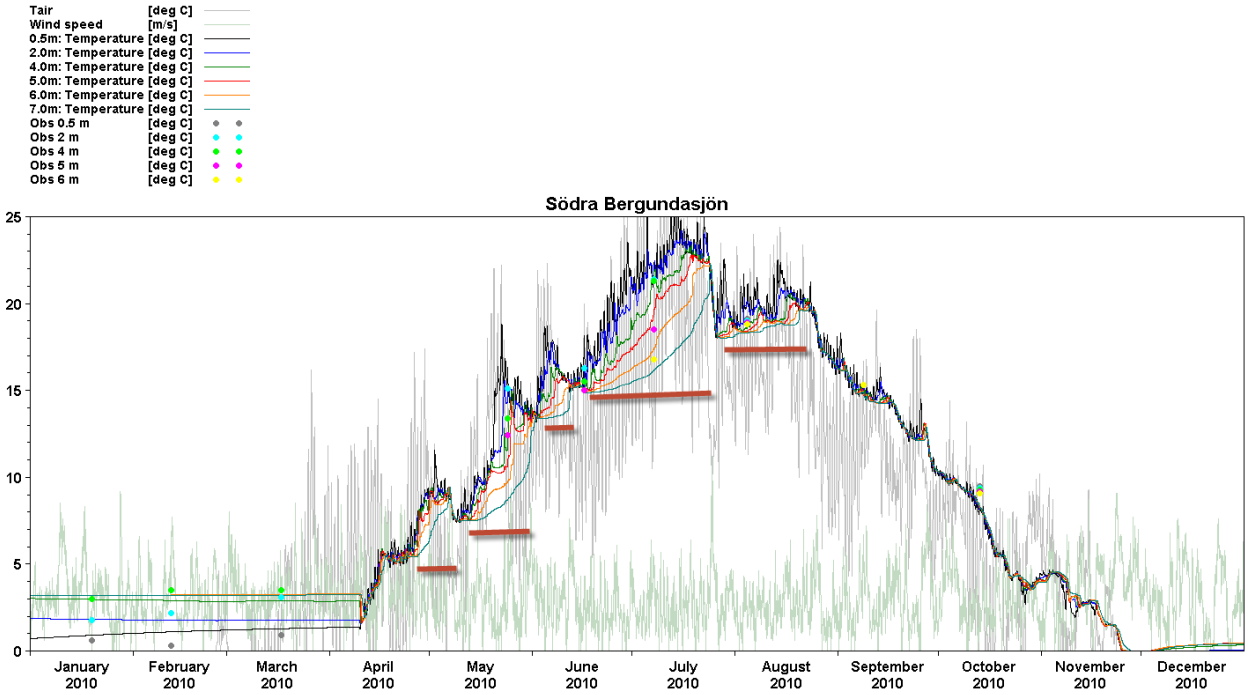
- den mobila oorganiska fosfor poolen = 0, dvs.
- sedimentets porvatten (SIP) sätts till 0
- järnbundet fosfor (FESP) i sedimentet sätts till 0.



Figur 208. Beräknad yt- och bottenkoncentration totalfosfor (mg/l) i Växjösjön före (grå – turkos) och efter åtgärder (svart - röd) samt uppmätta utloppskoncentrationer (svarta punkter) för år 1. Orange kurva visar scenario med Al behandling och ökat flöde från Helgasjön via Trummen.

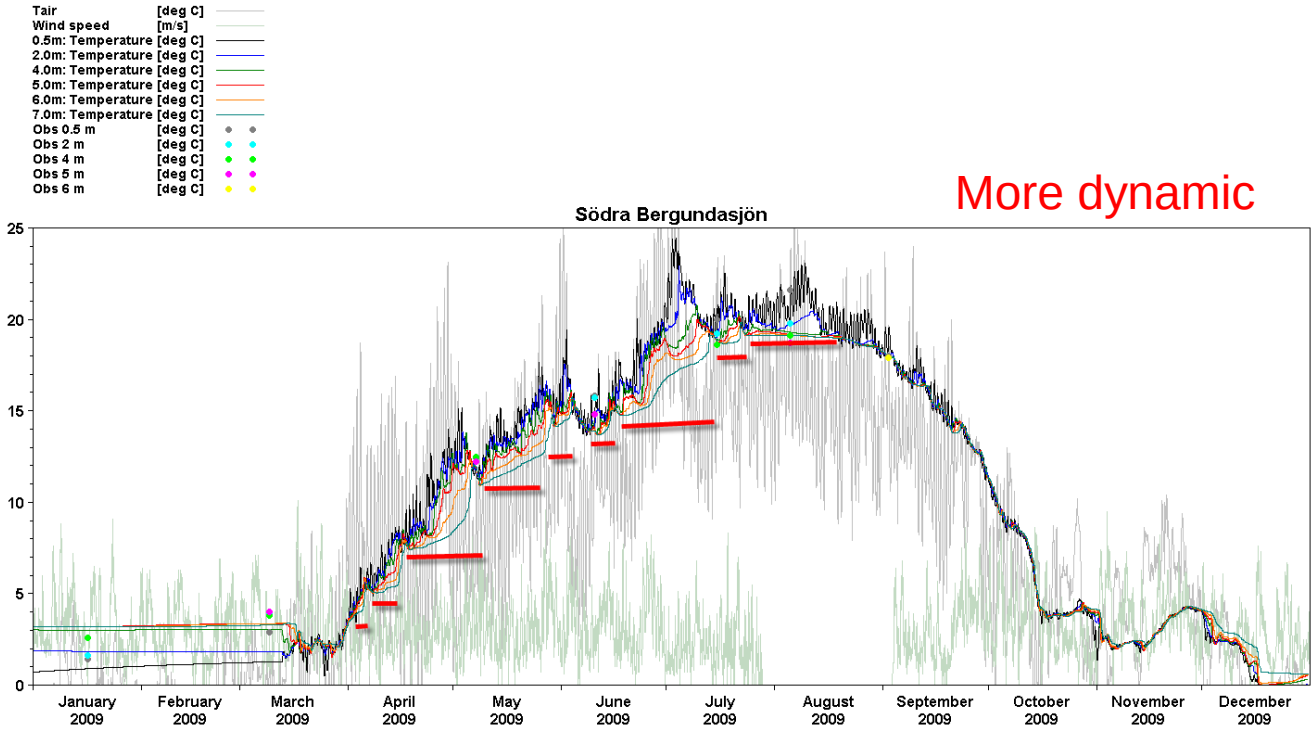
Södra Bergundasjön (217)

Stratification 2010 – implication for P concentration in surface



Södra Bergundasjön (217)

Stratification 2009 – implication for P concentration in surface

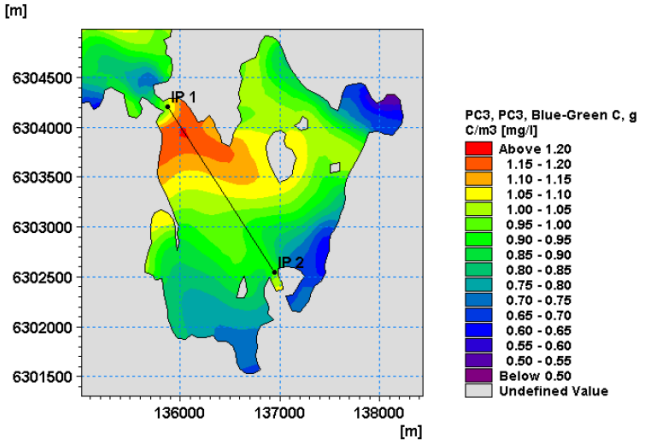


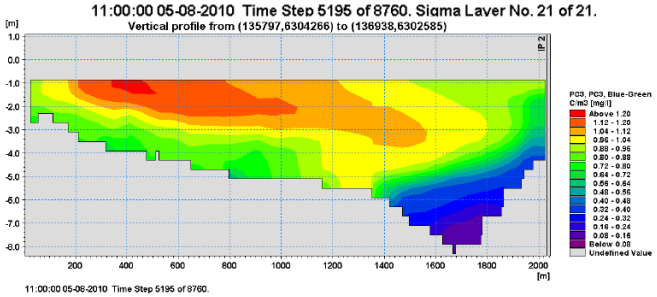
3.

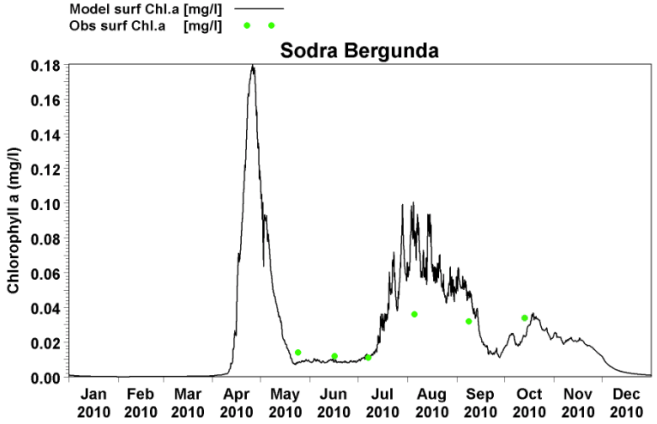
Horizontal and vertical distribution of water quality variables

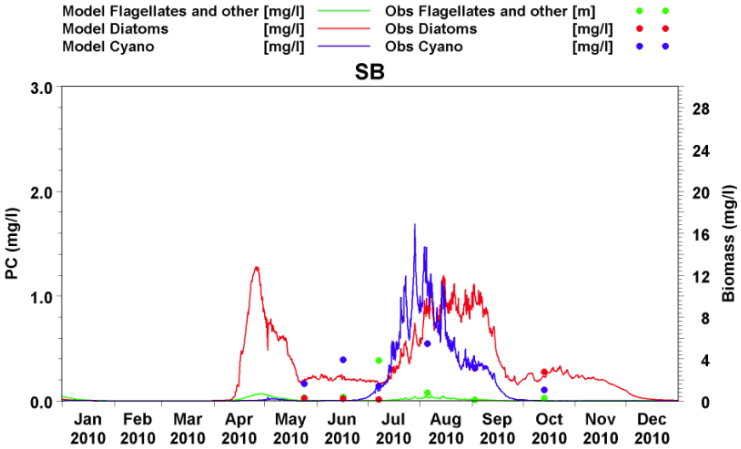
Importance for interpretation/understanding of monitoring data

Södra Bergundasjön 2010
Phytoplankton

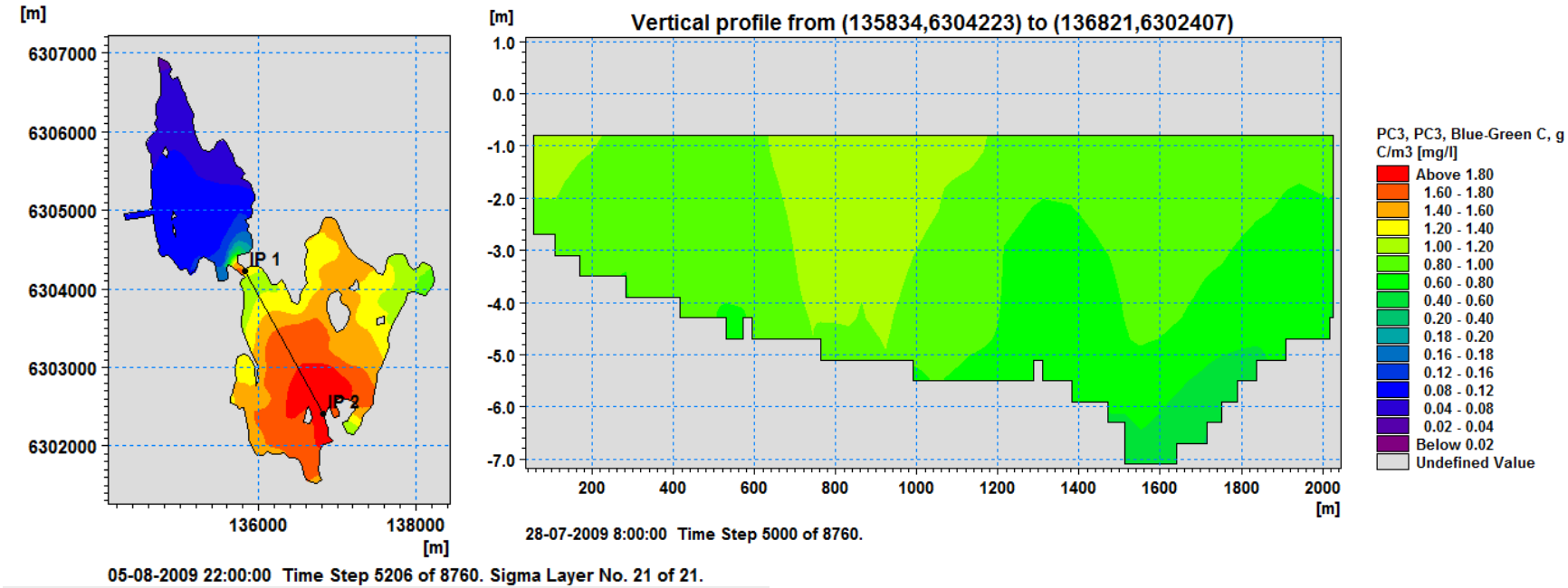






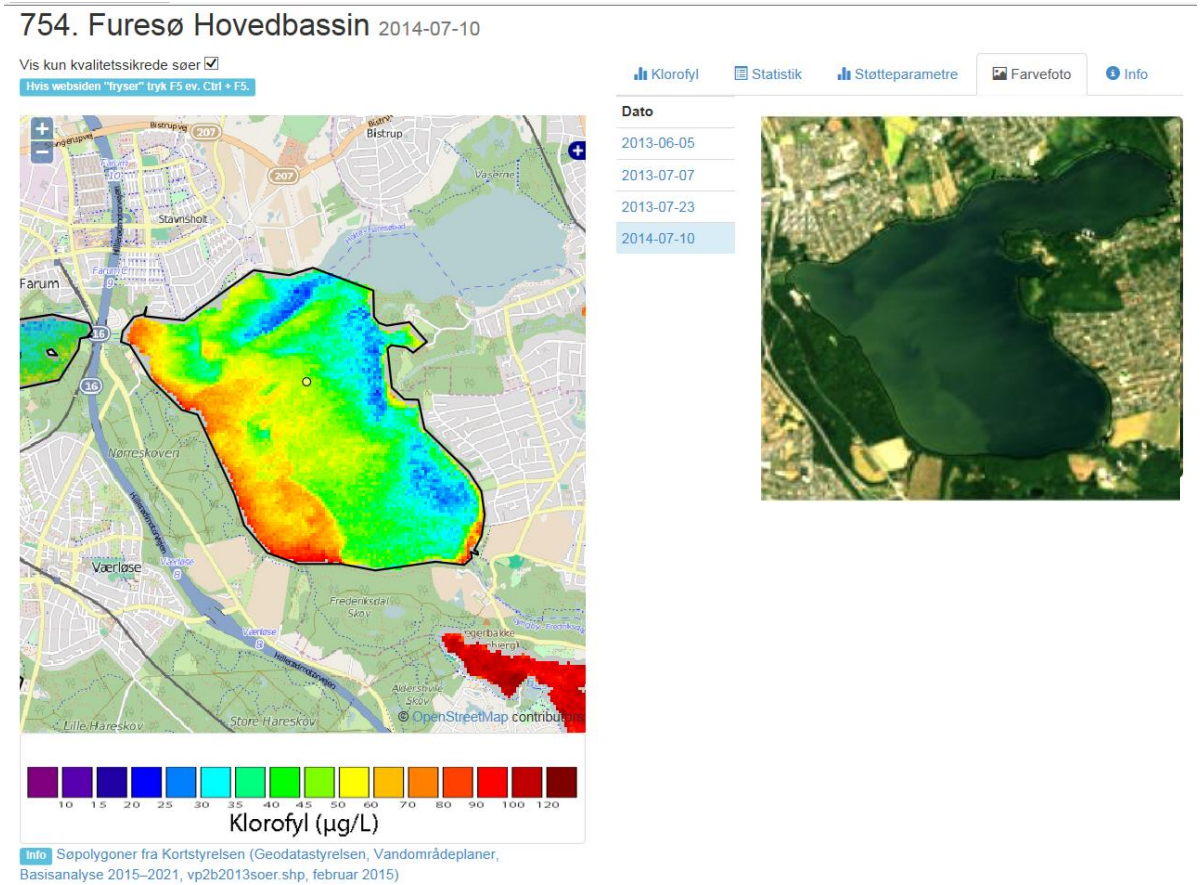


Animation of … Blue Green Algae - Södra Bergundasjö 2009



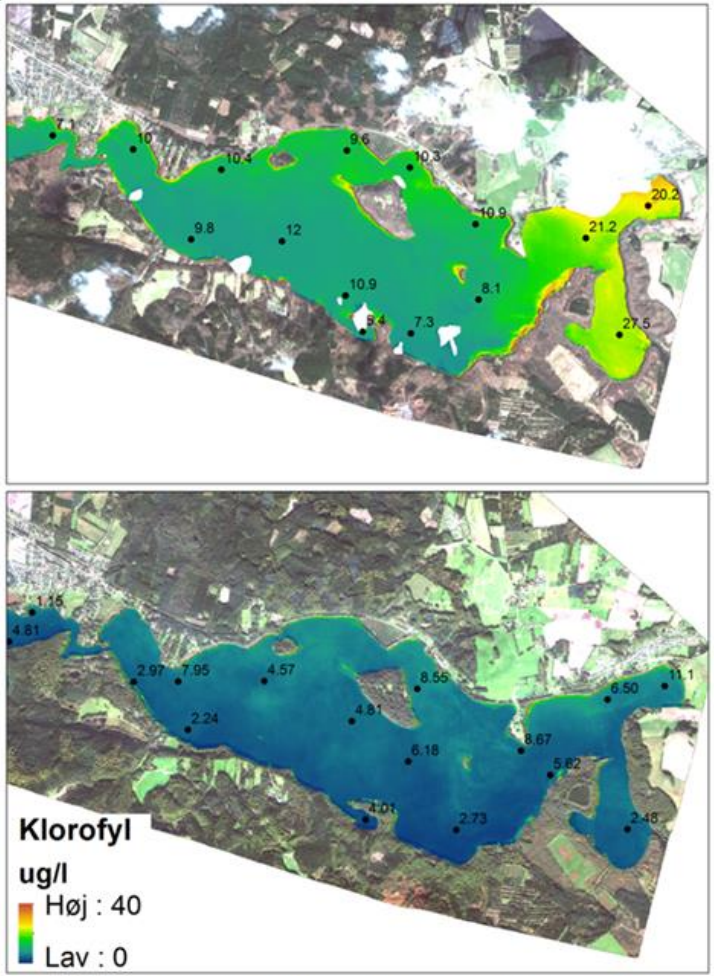
Example: Furesø

- http://
- amos.vanudsigten.dk



Exampel: Juul Sø

- Remote sensing af søers klorofylindhold. Miljøstyrelsen. Naturstyrelse, Danmark; Aarhus Universitet; Gras; DHI. 2012



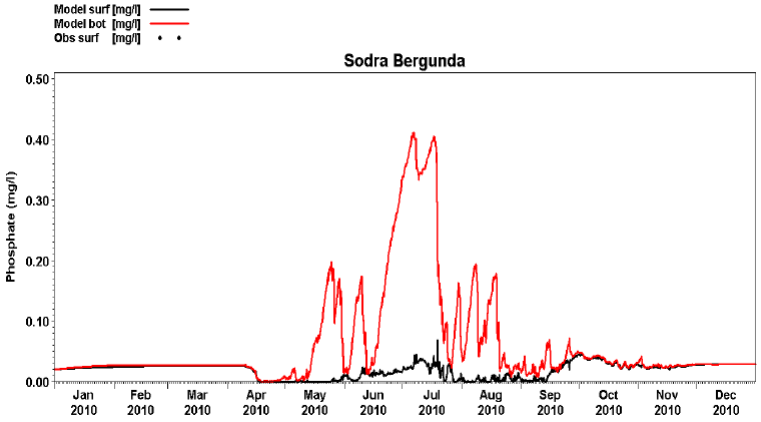
14.04.2010

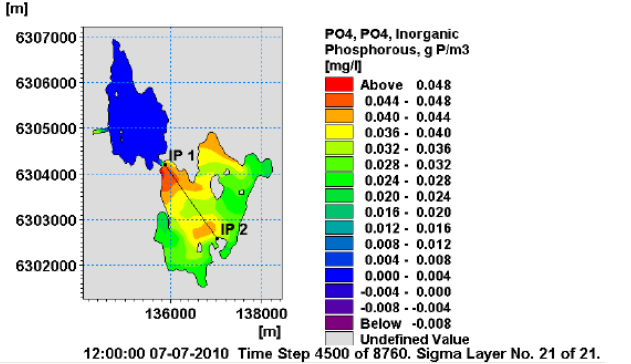
29.09.2010

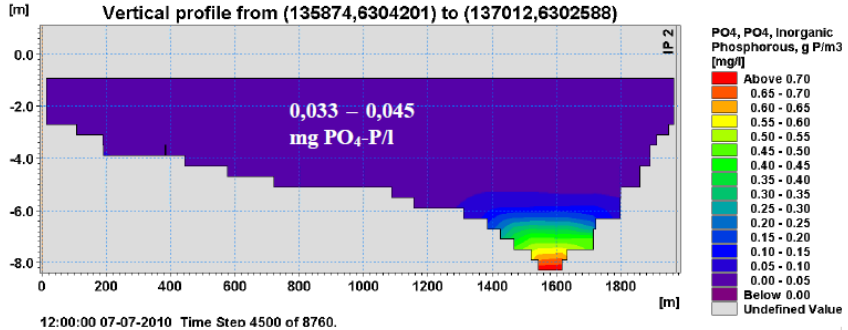
Figur 11 Udsnit over Julsø af de beregnede satellitbaserede klorofylkort for 14. april (øverst) og 29. september (nederst). Punkterne angiver, hvor der er lavet traditionel klorofylmåling samt den målte værdi.

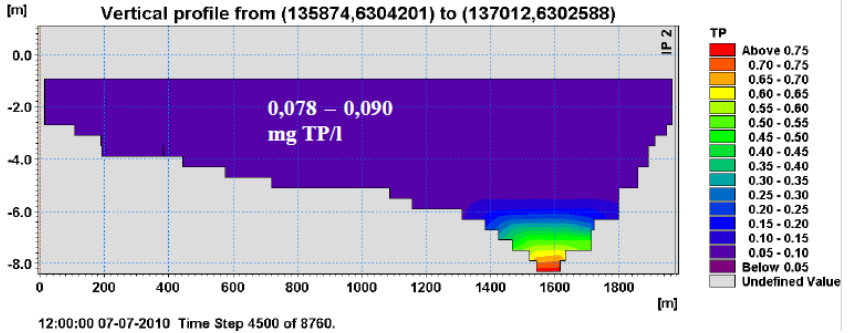
Södra Bergundasjön
Dissolved inorg. P

Ex. from 07.07.2010



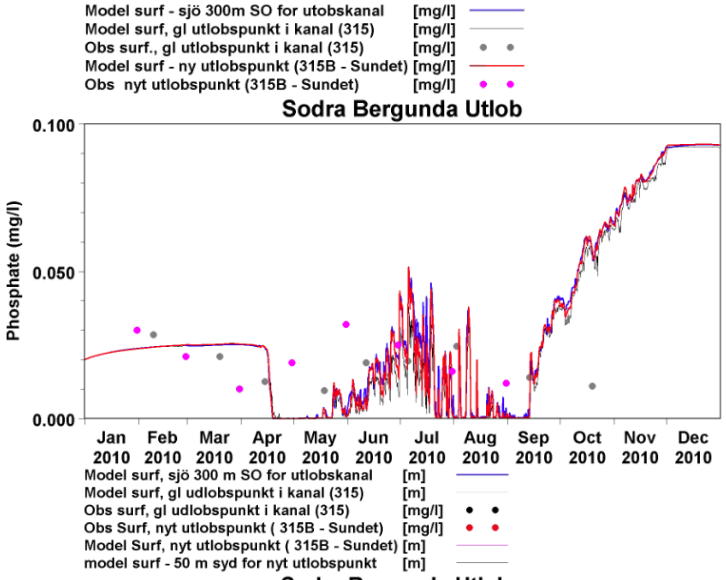


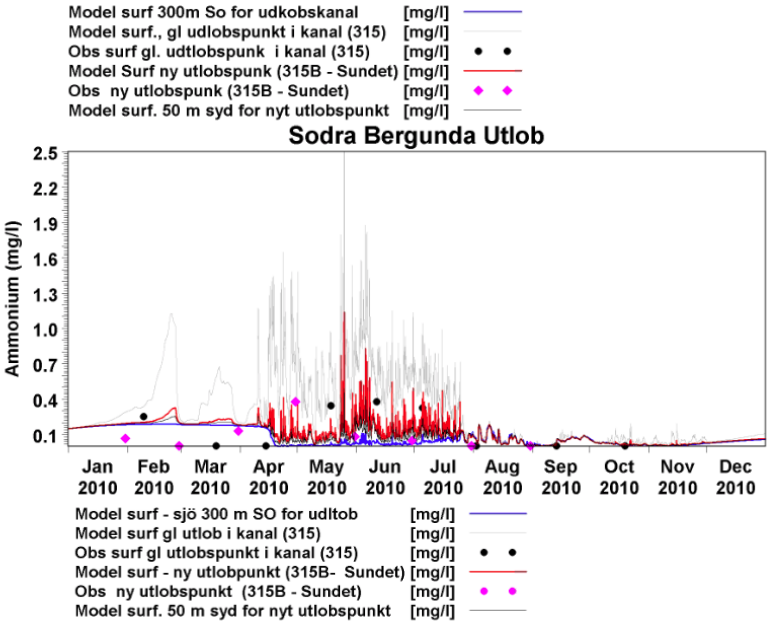


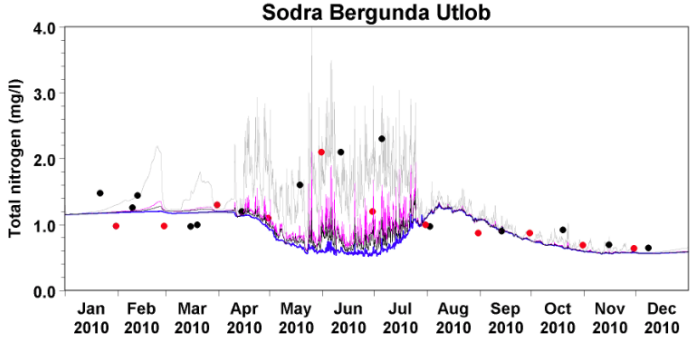


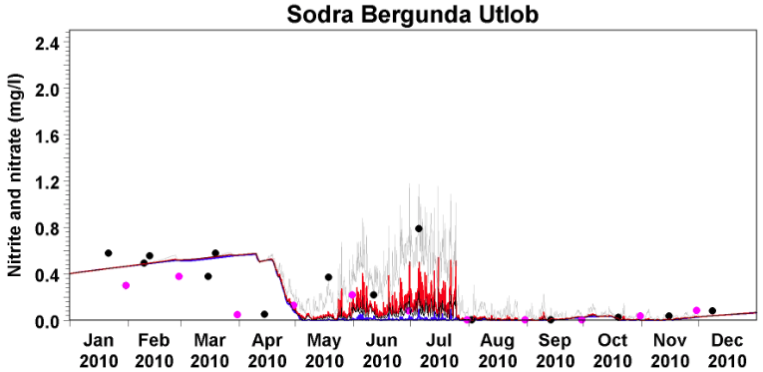
Phosphorous monitoring and modelling outlet Södra Bergundasjön 2010

Södra Bergundasjön 2010 (217)









4.

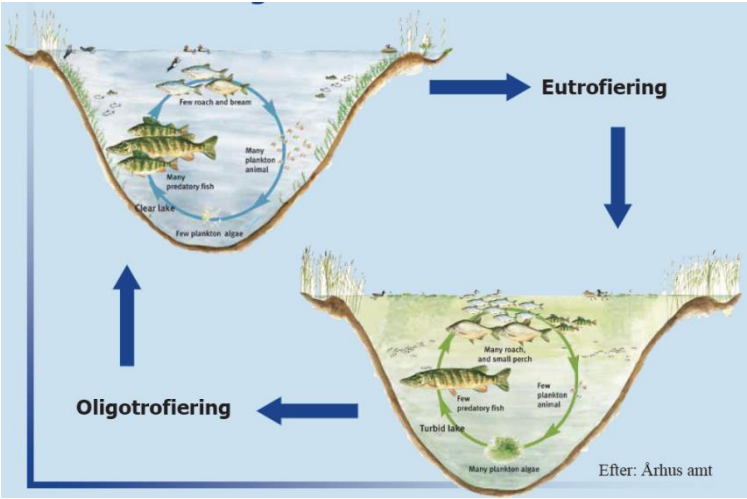
Benthic Vegetation – Management Fish Population

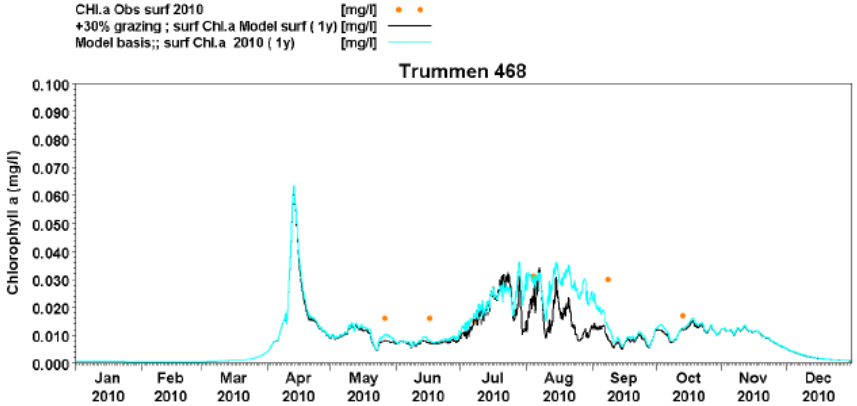
Example from Trummen

Fish Population Management

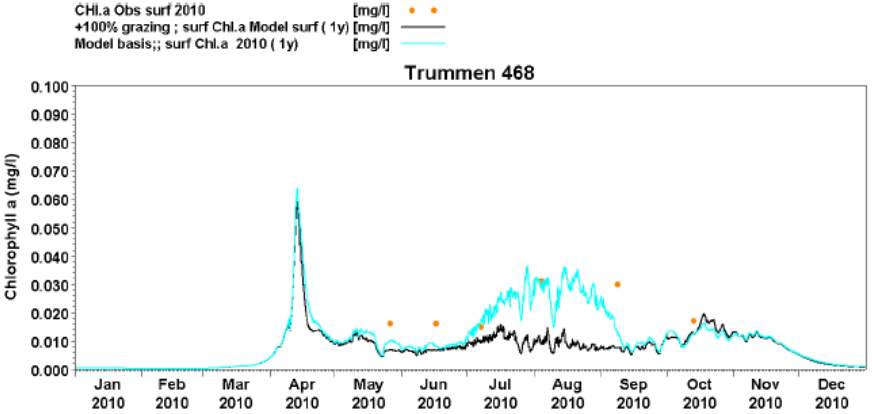
ökat potentiellt maximalt betningstryck med

- 30%
- 100%





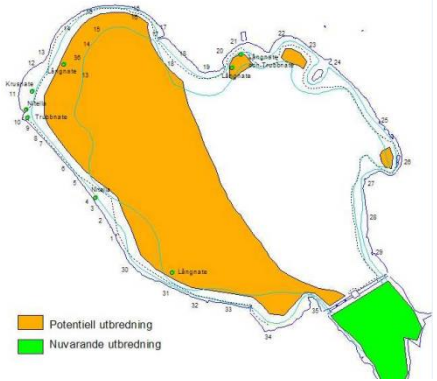
Figur 176. Beräknad koncentration klorofyll för Trummen (mg/l) vid 30% ökat betningstryck (svart) och basfall (turkos). Orange punkter=uppmätt.

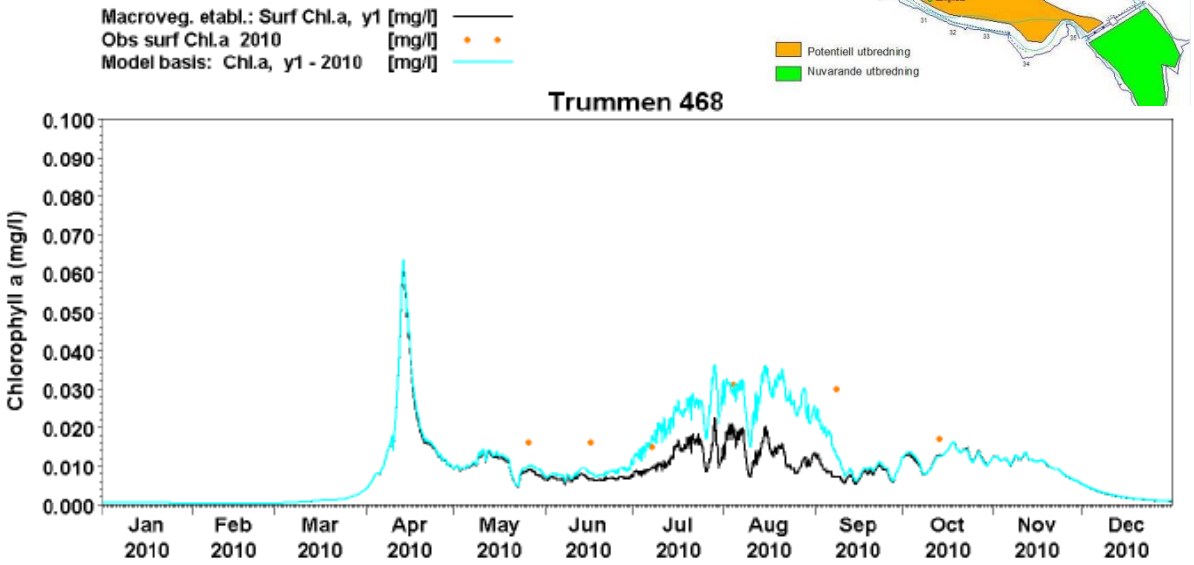


Figur 177. Beräknad koncentration klorofyll för Trummen (mg/l) vid 100% ökat betningstryck (svart) och basfall (turkos). Orange punkter=uppmätt.

Establishment of Benthic Vegetation

- bottenvegetation etableras i ungefär halva Trummen (med max.100 g torrvikt/m2)
- fördubbling av max. ljusdämpningen i juli och augusti. (använts i Skirviken i basfallen)
- skydd för zooplankton så predation reduceras med ca 15%





Figur 178. Beräknad koncentration klorofyll i Trummen (mg/l) (turkos kurva=basfall; svart kurva=under första året efter åtgärd; orange punkter = uppmätt).

Conclusions: Use of Coupled hydrodynamic, biochemical and ecological 3D models

- Scenarios Quantifying impact from: load reduction, changed flow, changed meteorology, and different alternative management scenarios
- Evaluating importance of external pressures and internal processes
- Introducing alternative management strategies that introduce “new” processes - Conclusions evaluated based on sensitivity analysis.
- Evaluating monitoring data - horizontal and vertical variations, variations within the year between sampling date, and variation from year to year.
- Much more than a tool to conclude on selection of management options - A tool assisting in understanding the ecosystem – though dynamic mass balance that include turnover processes

Thank you