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HELCOM-BONUS BALTICAPP workshop
29-30 March 2017,Stockholm

Modeling nutrient retention in the coastal zone of an eutrophic sea- A model study in the Stockholm Archipelago

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cocoa
Nutrient cocktails in the coastal zone of the Baltic Sea

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Nutrient COcktails in the COAstal zone of the Baltic Sea

Identify major pathways of nutrients and organic material across the diversity of coastal ecosystems and assess management implications.

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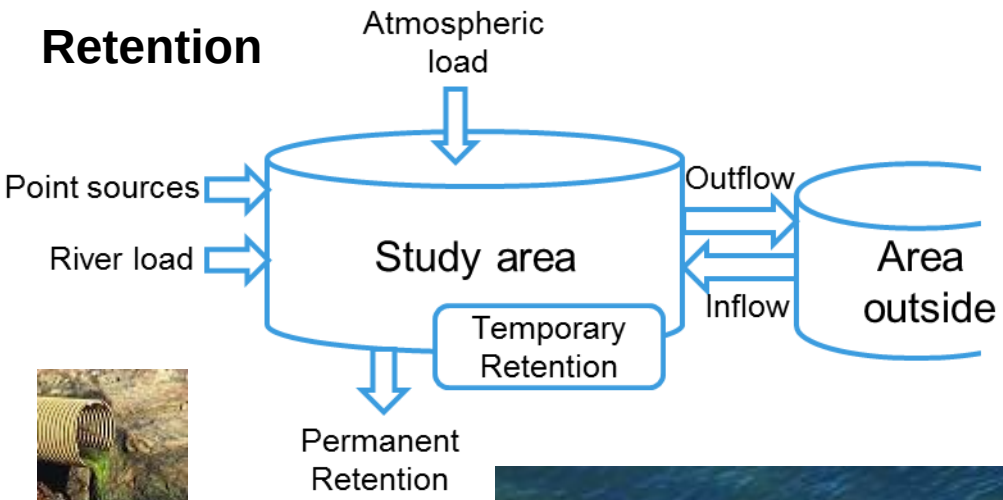
Nutrient cocktails in the coastal zone of the Baltic Sea

The coastal zone as a filter for nutrients

Retention

The coastal filter of nutrients

Retention

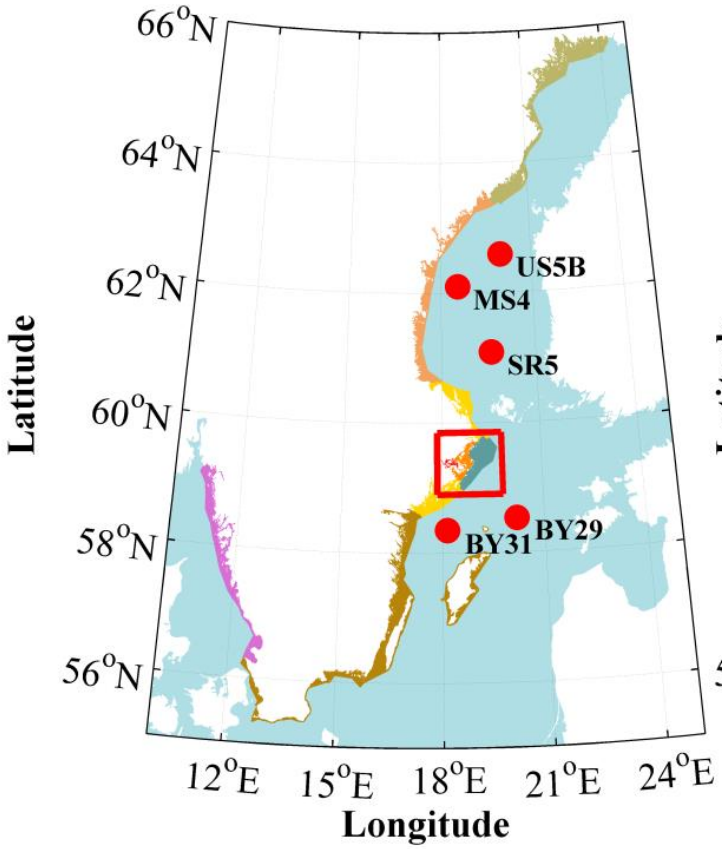


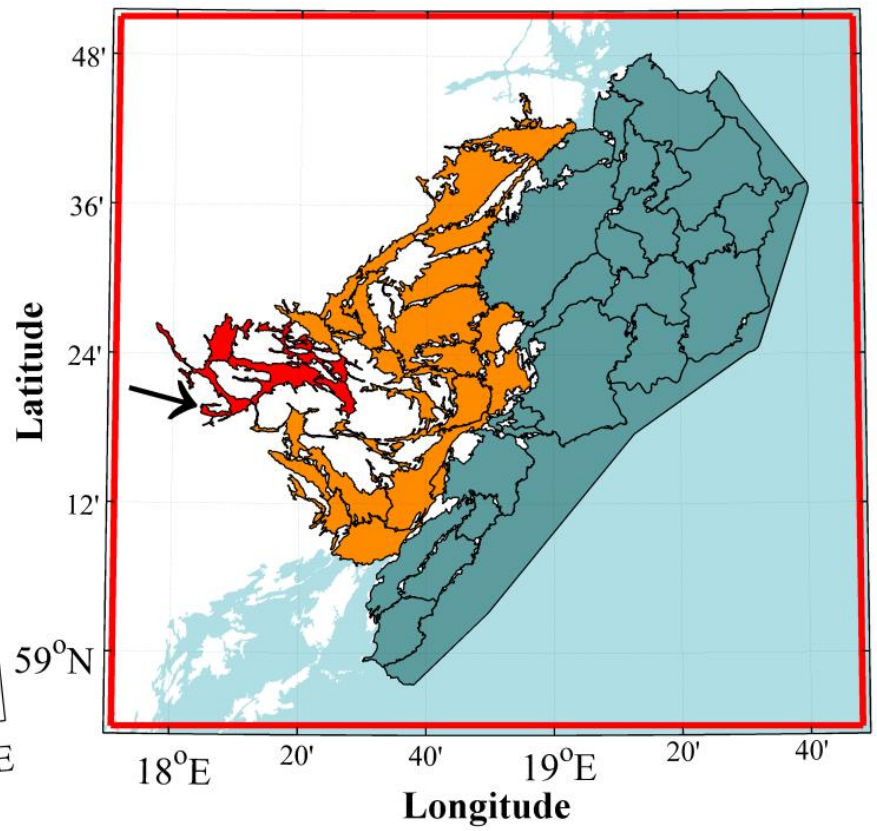
Permanent retention
Burial
Denitrification (nitrogen)

Temporary retention
Changes in pelagic and benthic pools

Study Sites

- Stockholm Archipelago, 1990-2012

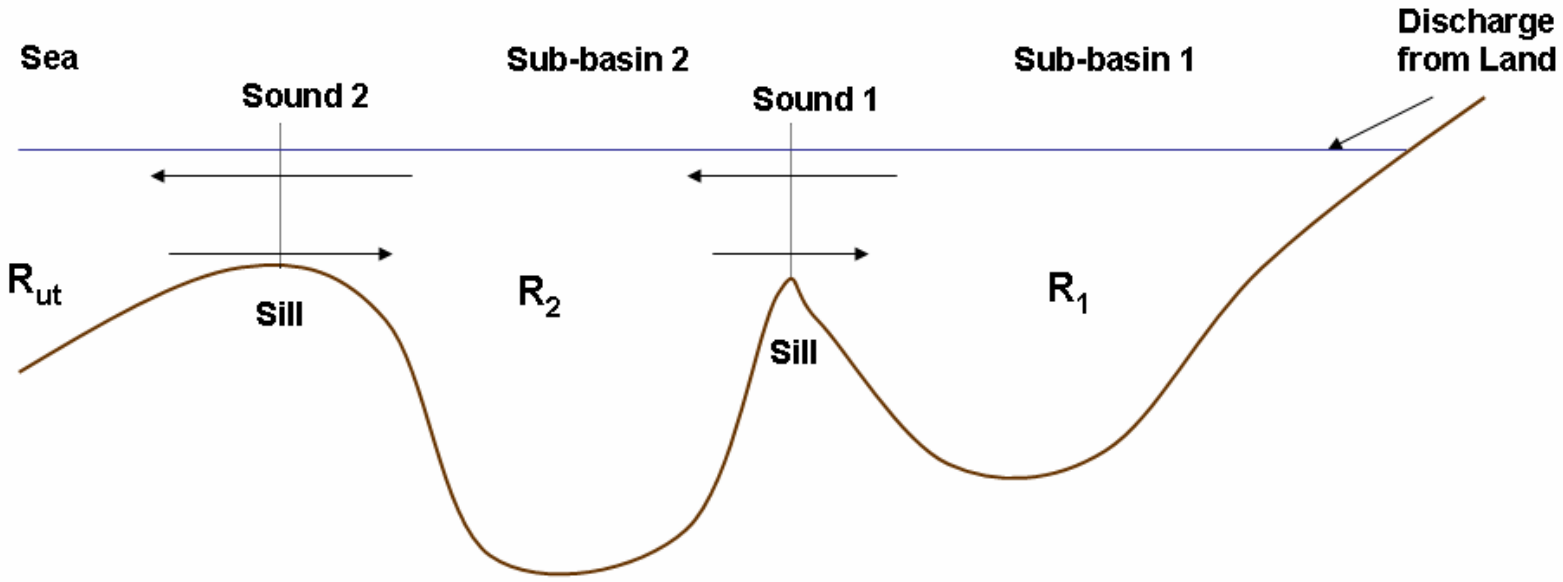




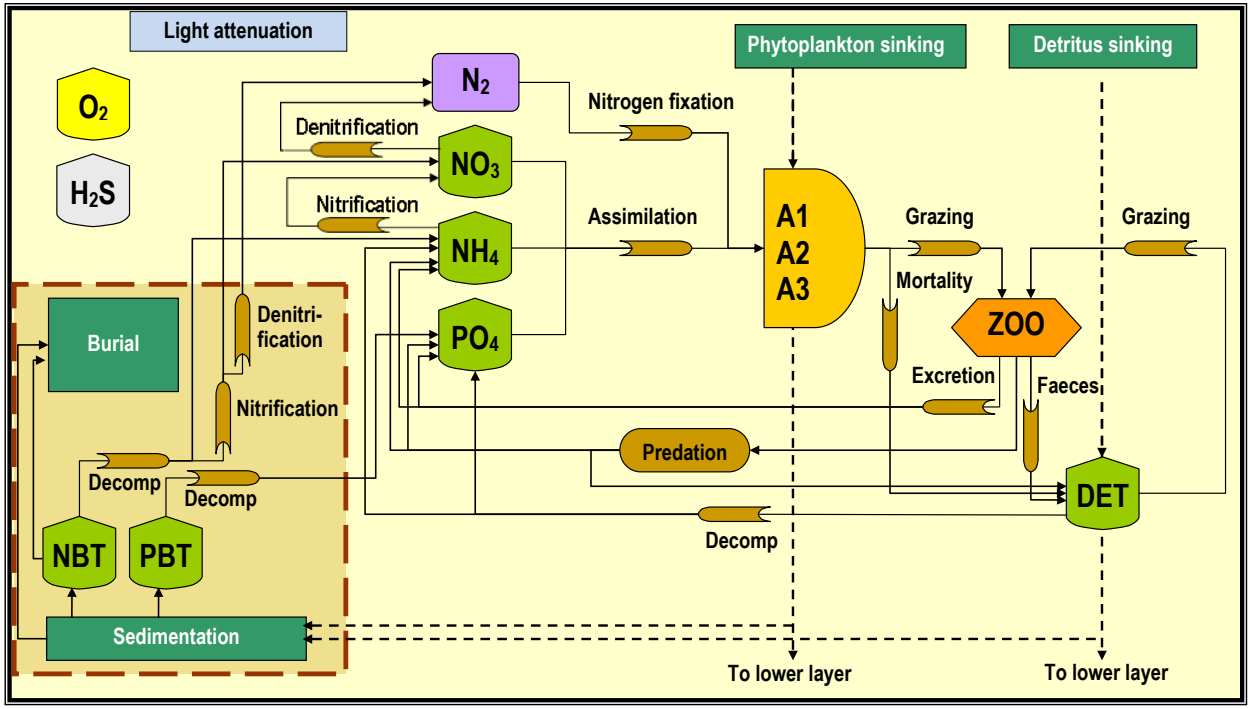
Model system

The Swedish Coastal zone Model (SCM)

- multi-basin 1D-model
- based on the equation solver PROgram for Boundary layers in the Environment (PROBE)
- coupled to the Swedish Coastal and Ocean Biogeochemical model (SCOBI)
- Vertical resolution 0.5-10 m

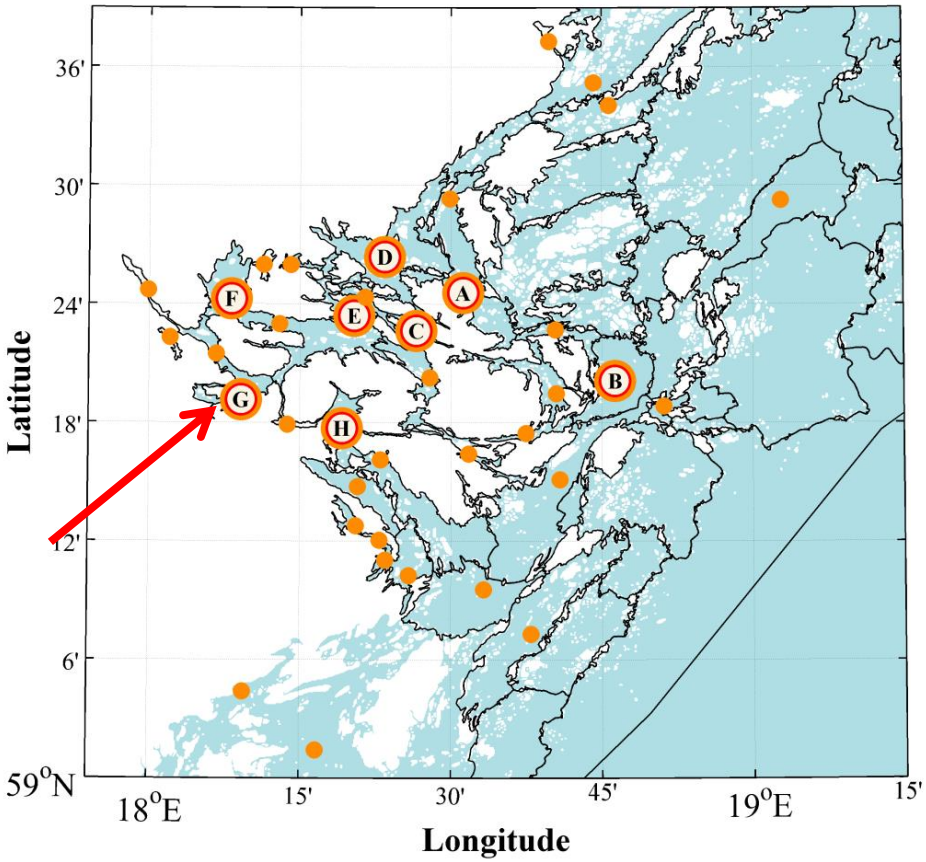


Model system, SCOBI



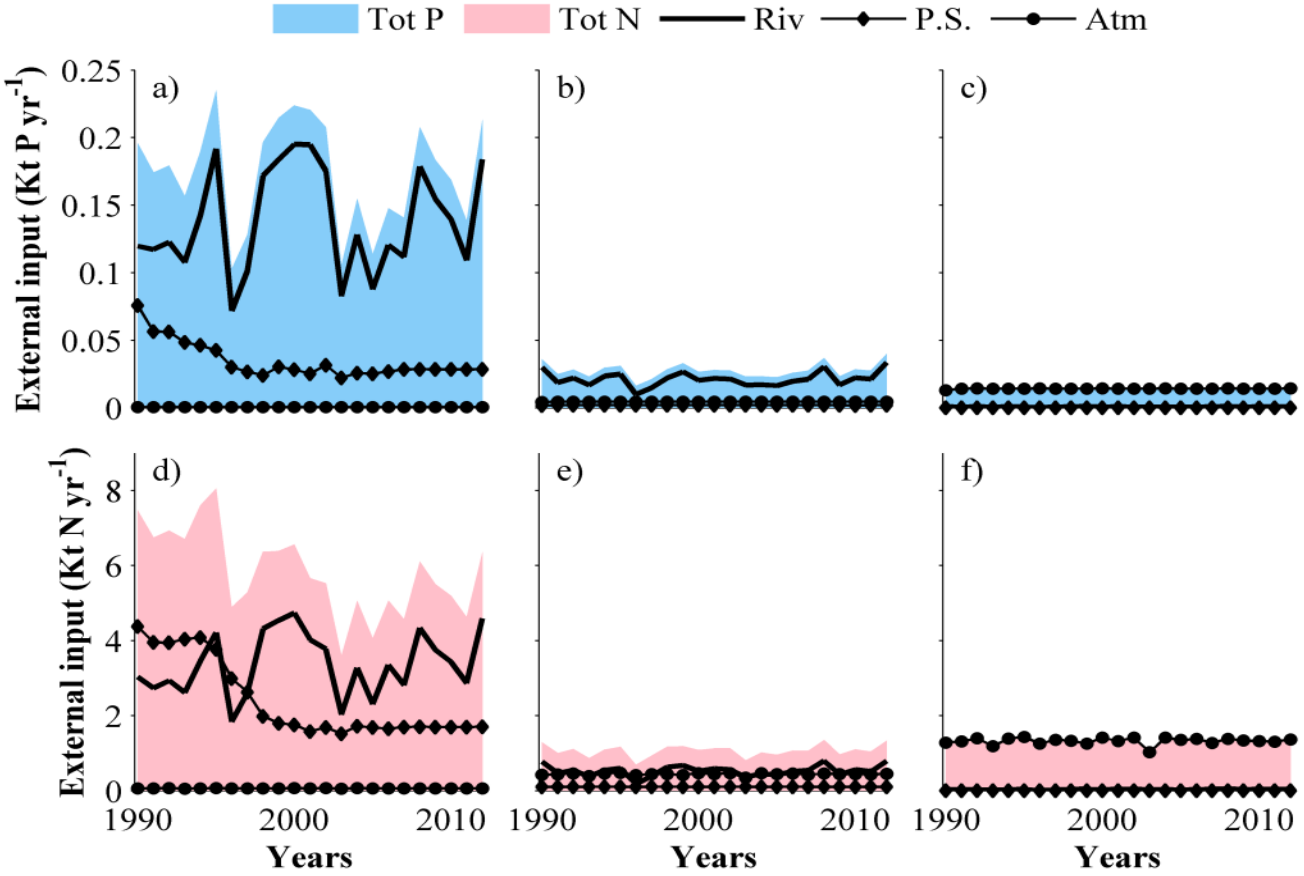
- inorganic nutrients
- nitrogen fixation
- particulate organic matter
- sediment
- oxygen
- hydrogen sulphide
- denitrification
- nitrification
- burial

Evaluation, model results



	Basin name	NoS occ	NoS Years
A	Sandöfjärden	209	23
B	Kanholmsfjärden	206	23
C	Solöfjärden	213	23
D	Trälhavet	215	23
E	S. Vaxholmsfjärden	131	23
F	Stora Värtan	141	23
G	Strömmen	249	23
H	Baggensfjärden	173	20

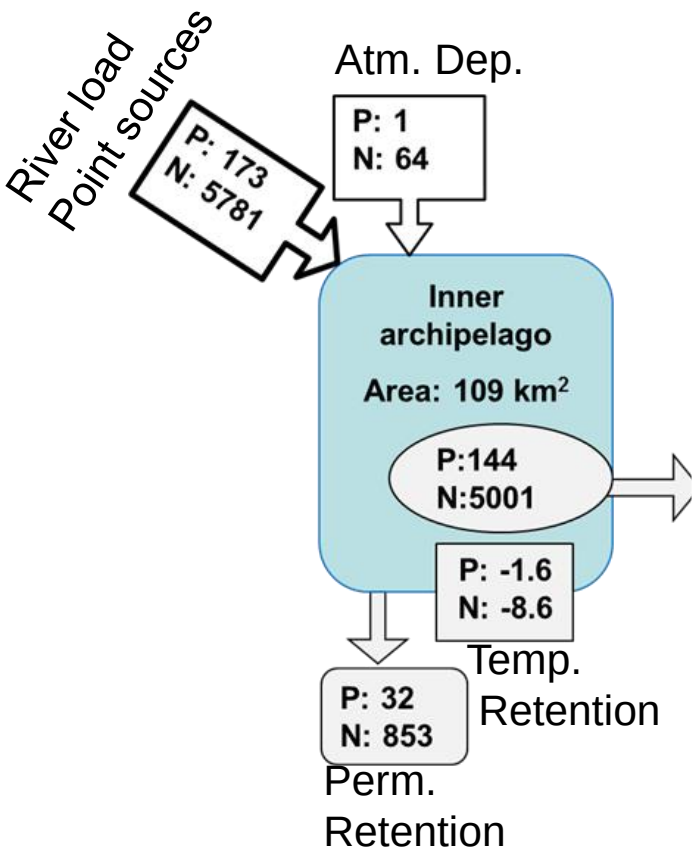
Nutrient loads to the Stockholm Archipelago



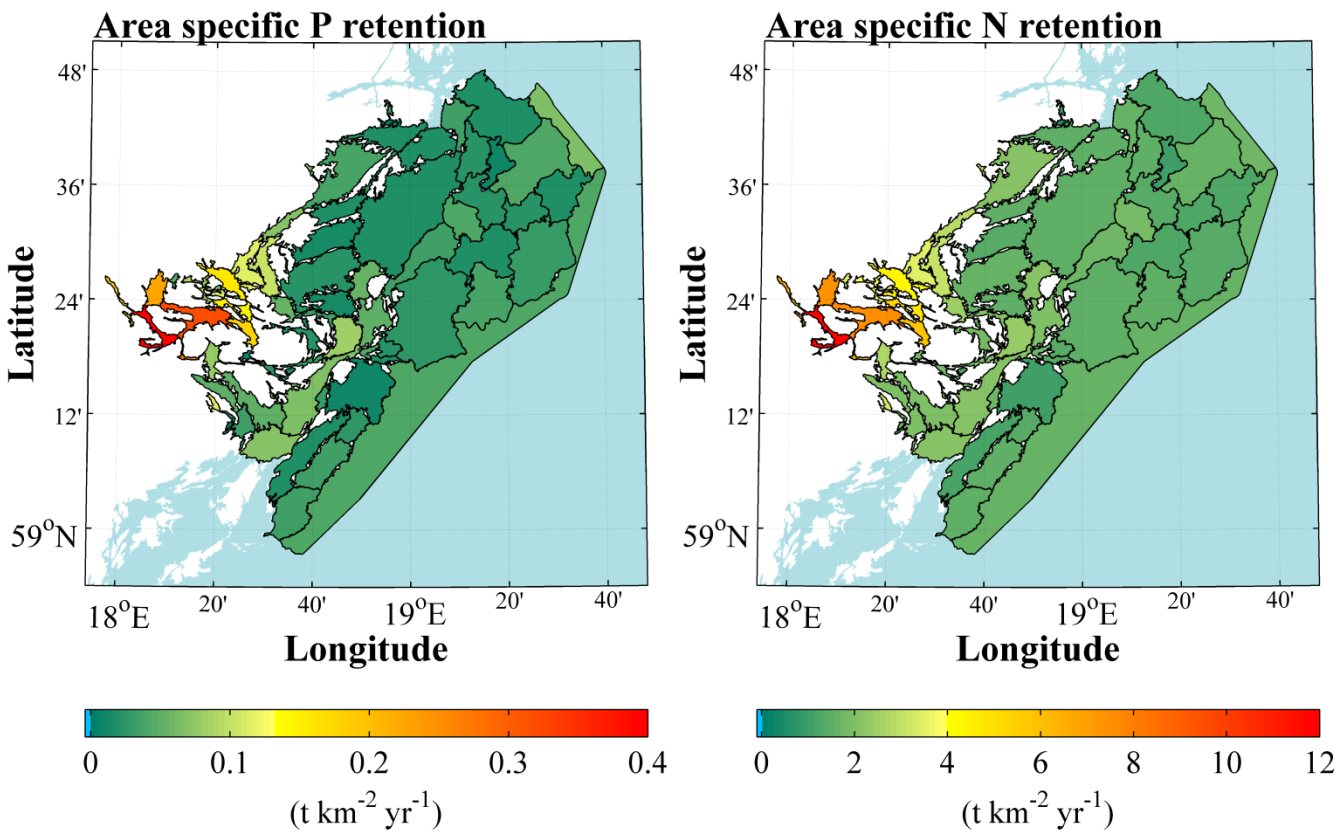
Inner, Intermediate, Outer archipelago

Results, retention of N and P

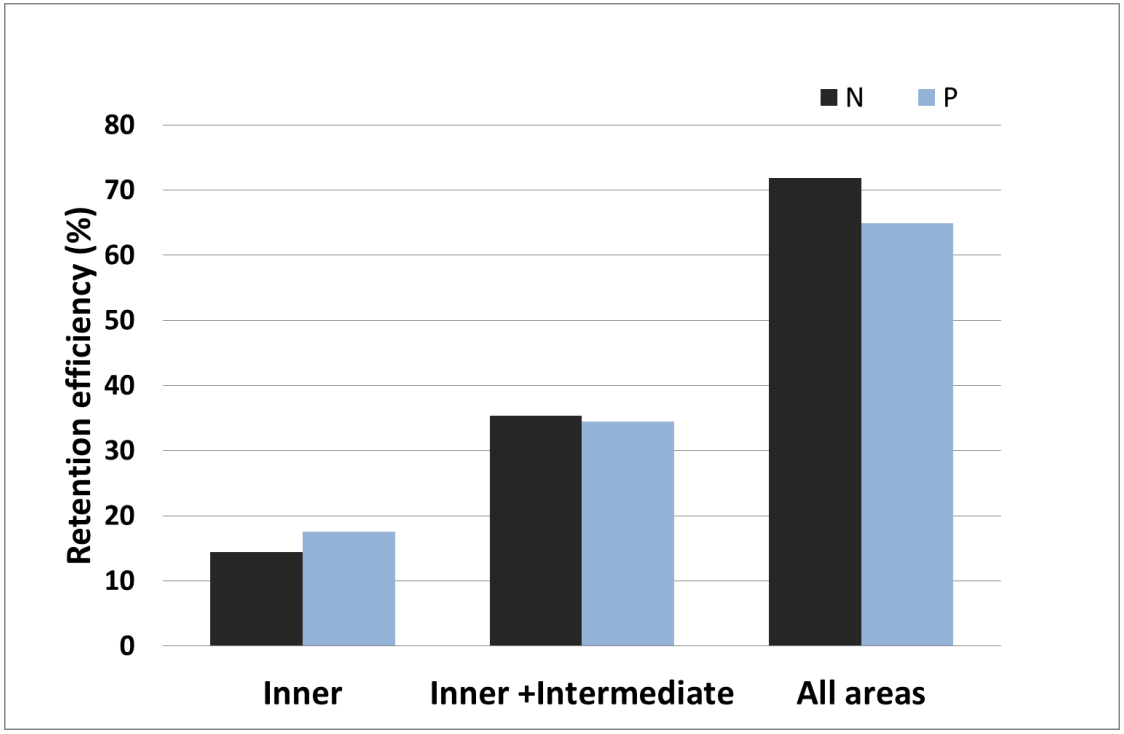
t yr^{-1}



Results, area specific retention



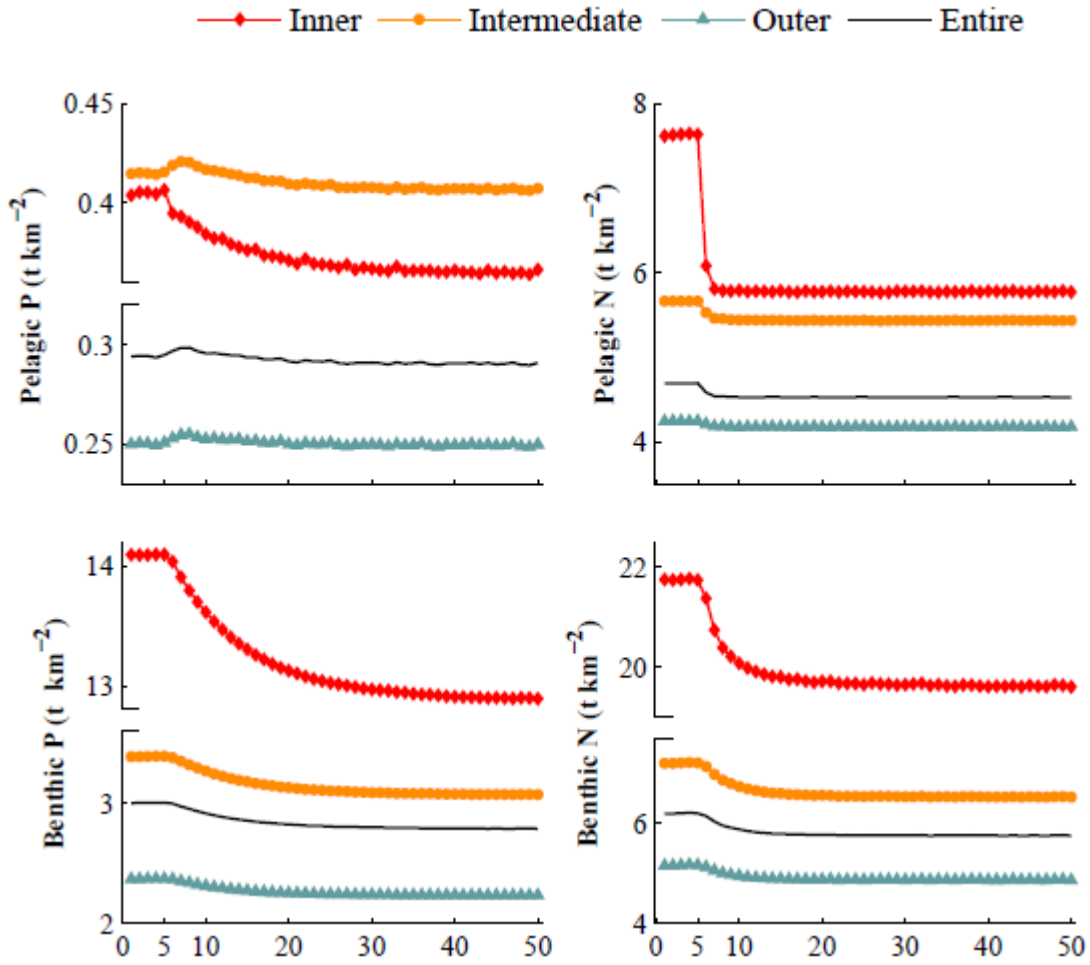
The coastal filter



$$F_{\mathrm{eff}} = \frac{R_{\mathrm{tot}}}{\mathrm{Nu}_{\mathrm{land}}} \times 100$$

At least 65 % and 72 % of the supplied P and N, respectively, from land and atmosphere were retained in the Stockholm archipelago.

Nutrient Scenario

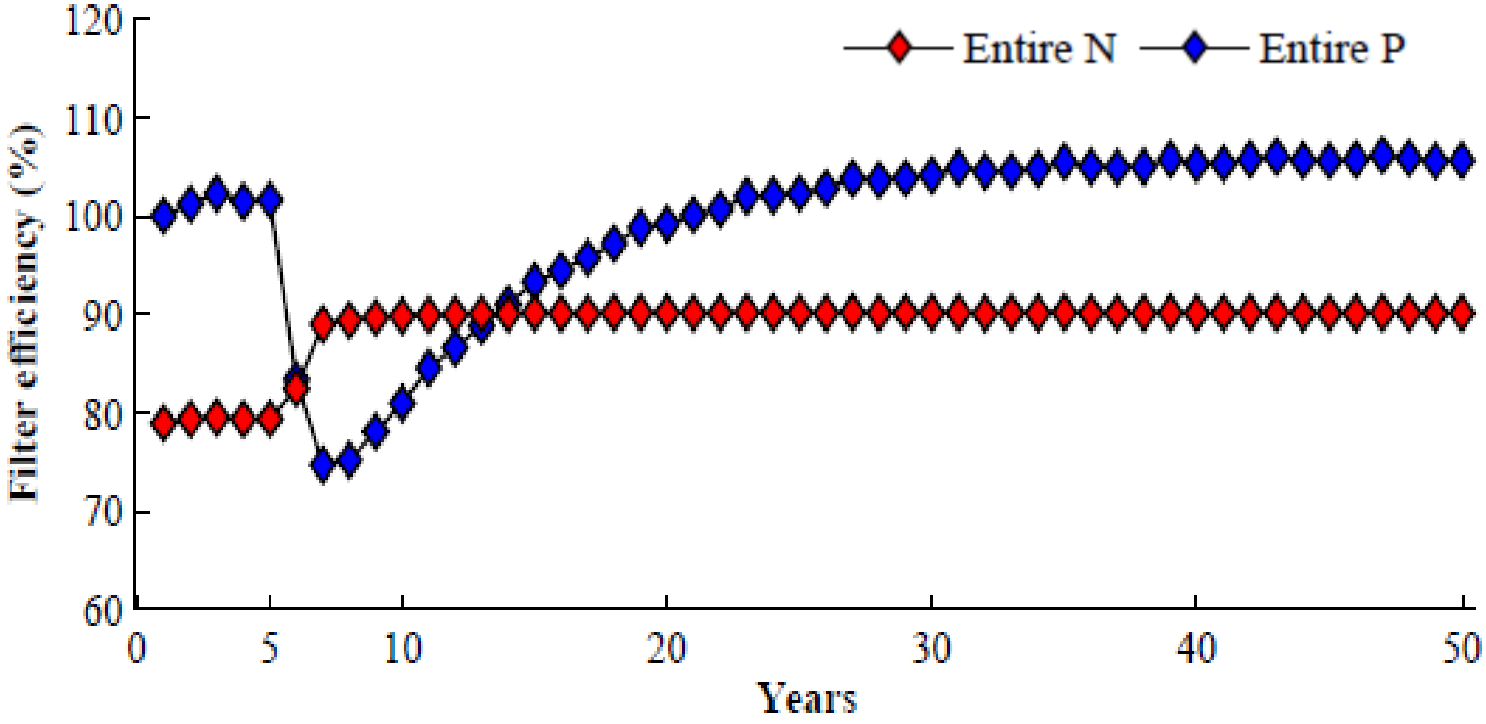


- Forcing from year 2010
- Spin-up period fo 45 years

New run

- 20 % decreased N-load
- 12 % decreased P-load

Nutrient Scenario



Conclusions

- The Stockholm archipelago works as a filter for the land loads of nutrients
- There is an export of nutrients from the coast to the outer sea during the period 1990-2012.
- The filter efficiency is dependent on the spatial dimensions of the coastal area

- The pools of nutrients in the water and in the sediment changes with nutrient loads

and therefore

- the time aspect needs to be taken into account for the balance between nutrient loads and nutrient pools.

Photo: Astrid Hylén

Thank you!

Almroth-Rosell, E., Edman, M., Eilola, K., Meier, H.E.M., Sahlberg, J., 2016. Modelling nutrient retention in the coastal zone of an eutrophic sea. Biogeosciences 13, 5753-5769

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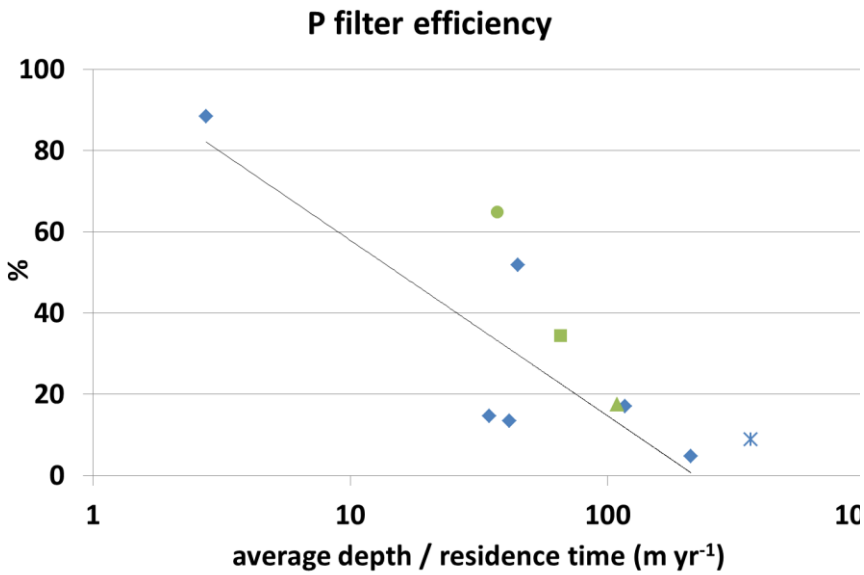
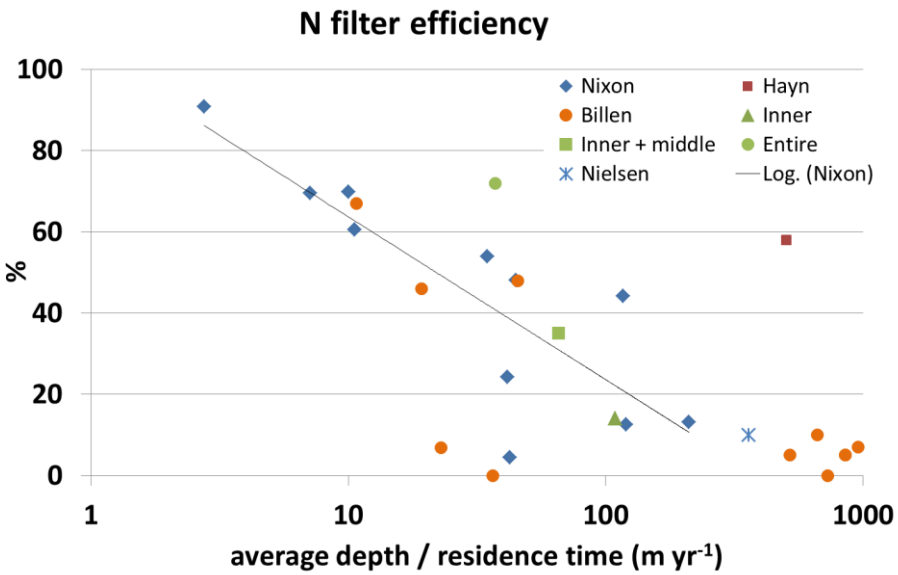
Processes/Characteristics affecting the retention

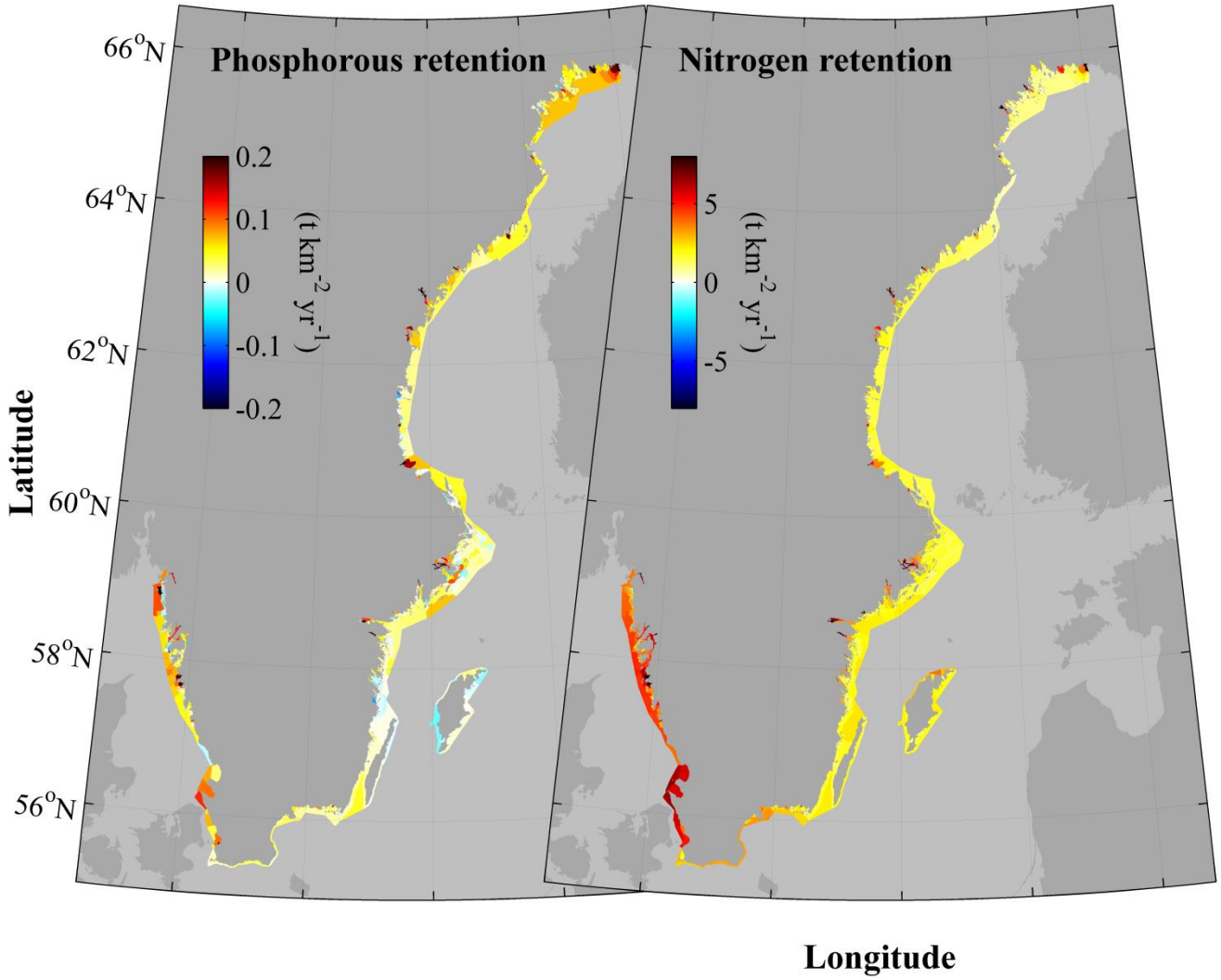




Billen et al., 2011; Hayn et al., 2014; Nixon et al., 1996

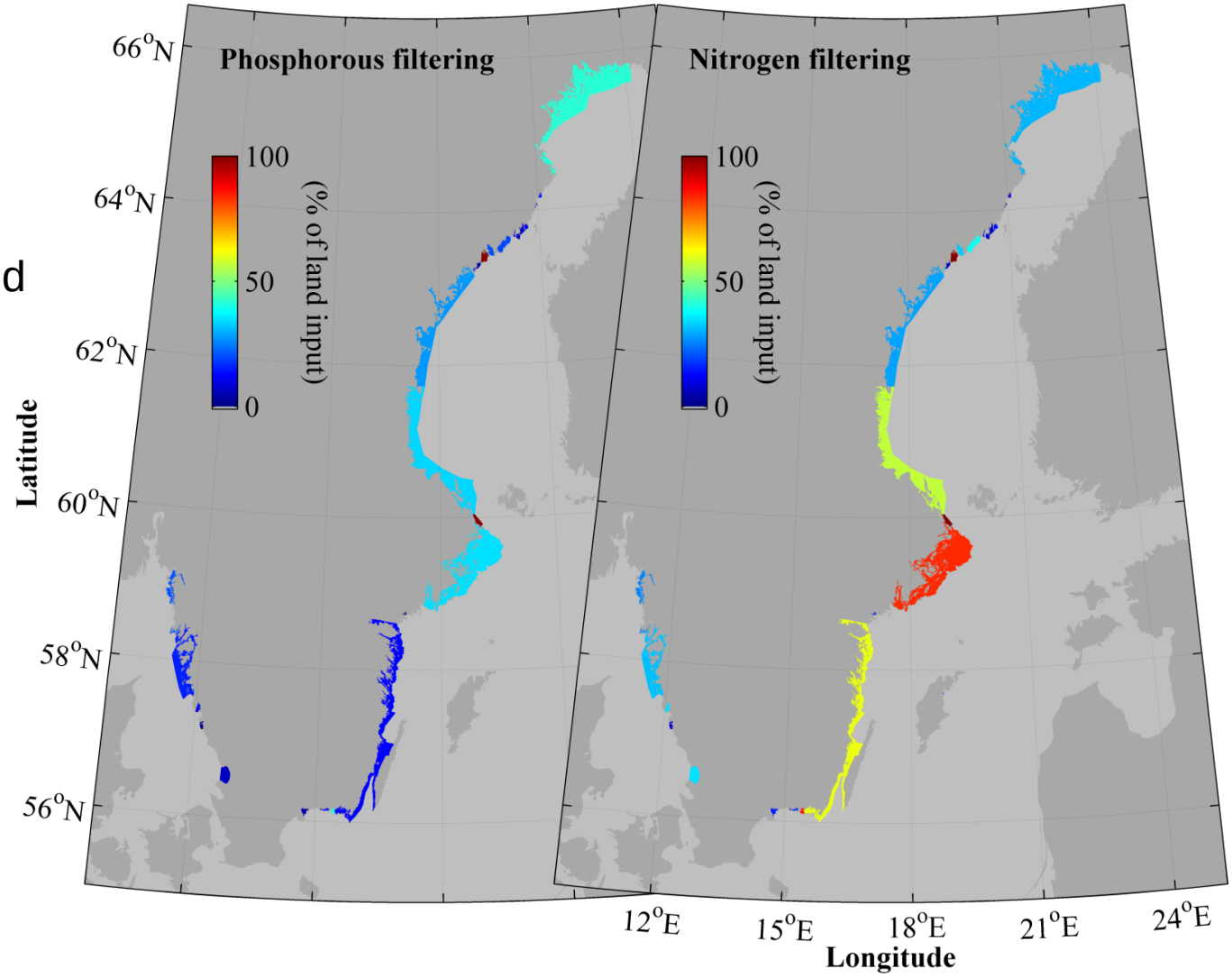
SCM retention calculations along the swedish coast

Retention per area unit:
 Permanent sinks and temporary storage.

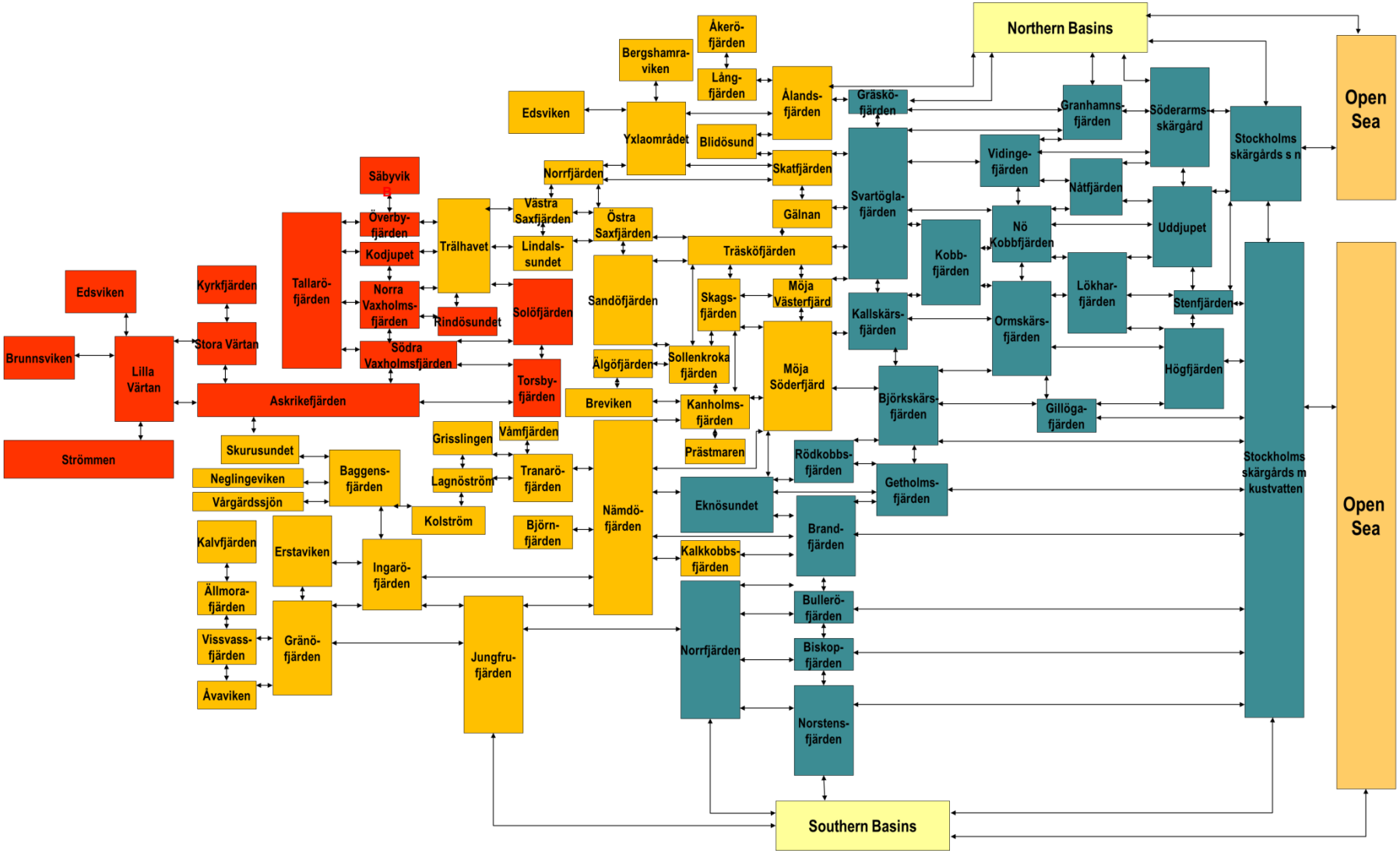


SCM retention calculations along the swedish coast

Nutrient filter: The retained fraction of land load

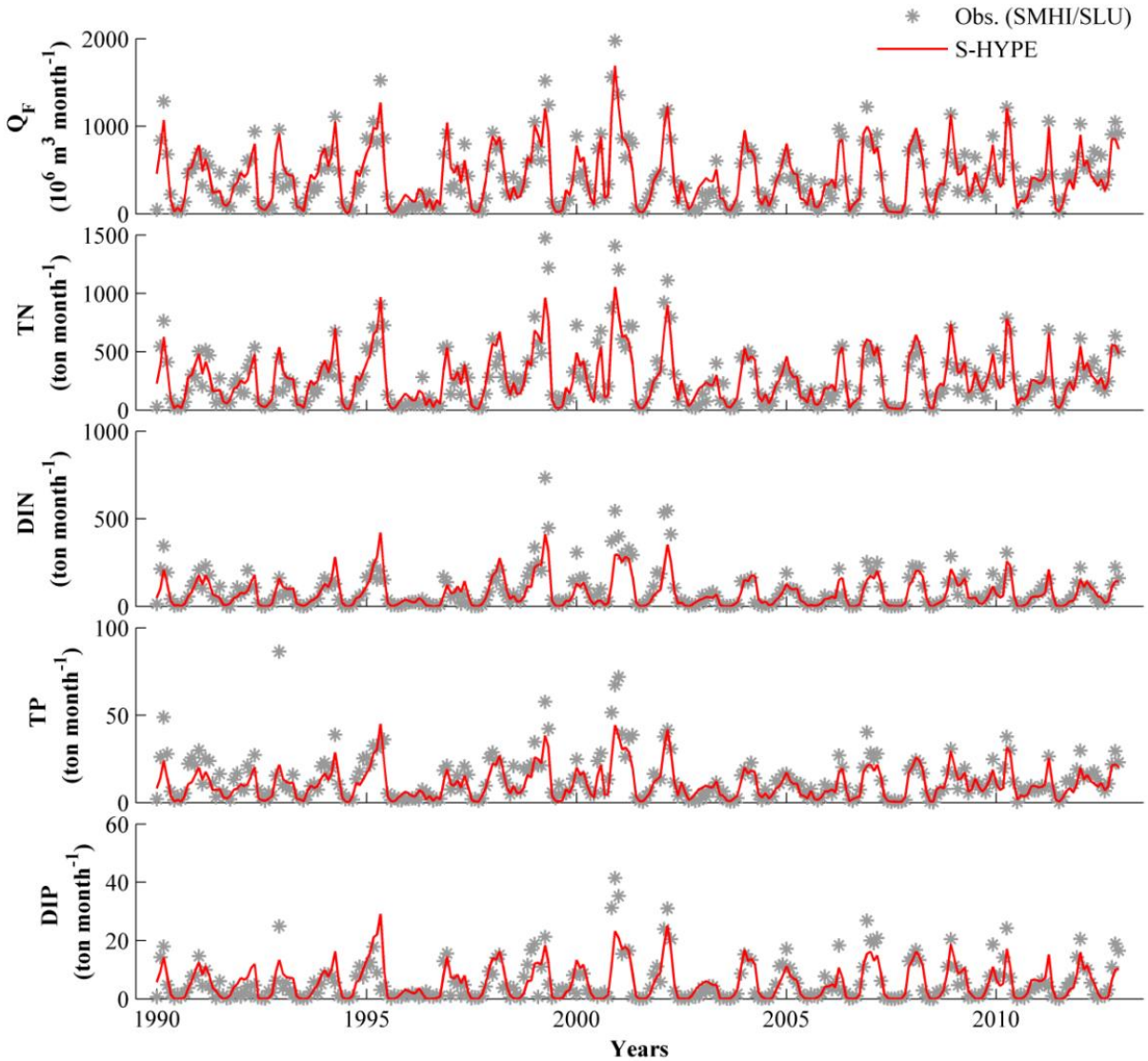


Model system and study site

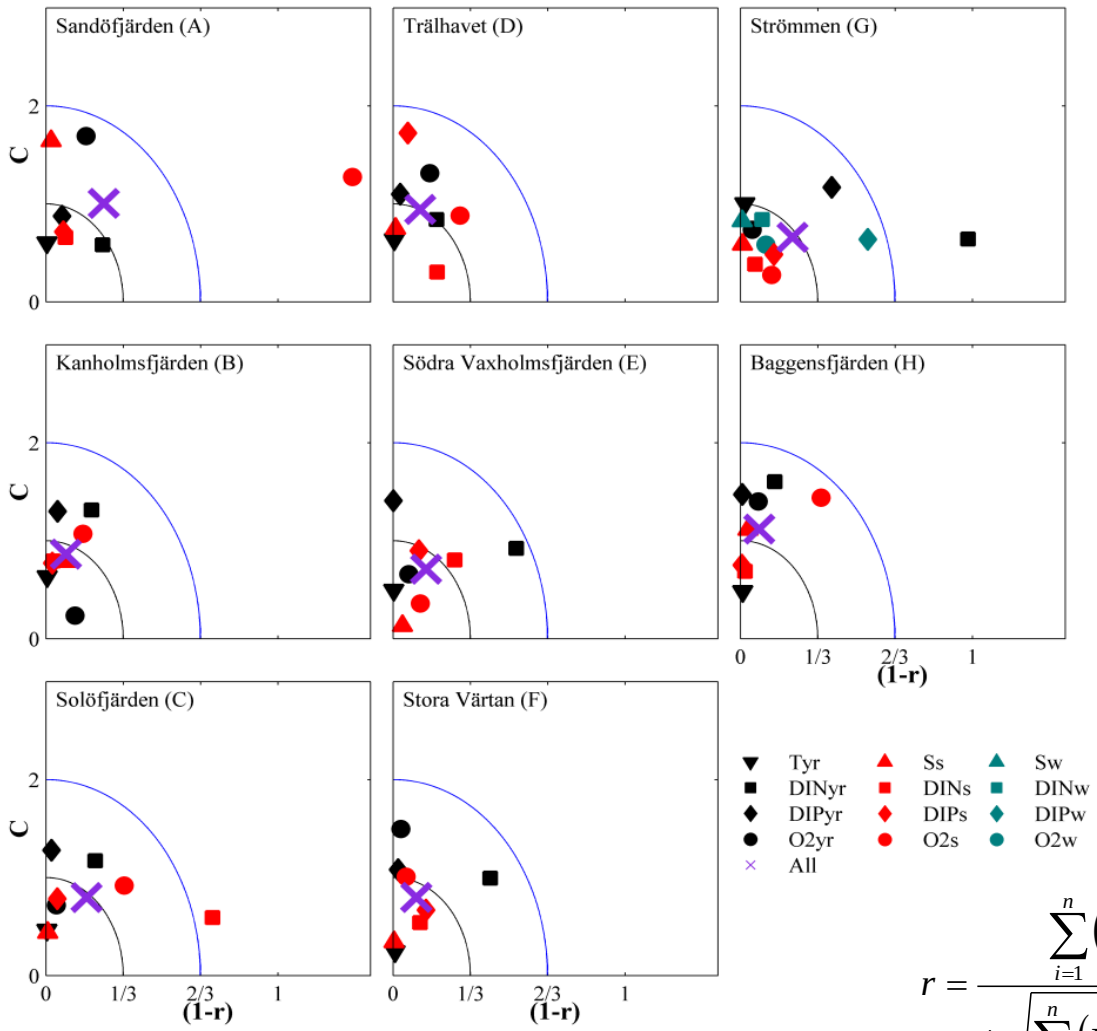


	Units	Average obs	Average S-HYPE	r
Q_F	10^6 m^3 $month^{-1}$	421	422	0.94
TN	t $month^{-1}$	270	271	0.93
DIN	t $month^{-1}$	83	76	0.86
TP	t $month^{-1}$	13	11	0.87
DIP	t $month^{-1}$	5.7	5.7	0.79

Evaluation, river forcing



Evaluation, model results



The combined model skills for all variables are shown by the purple cross.

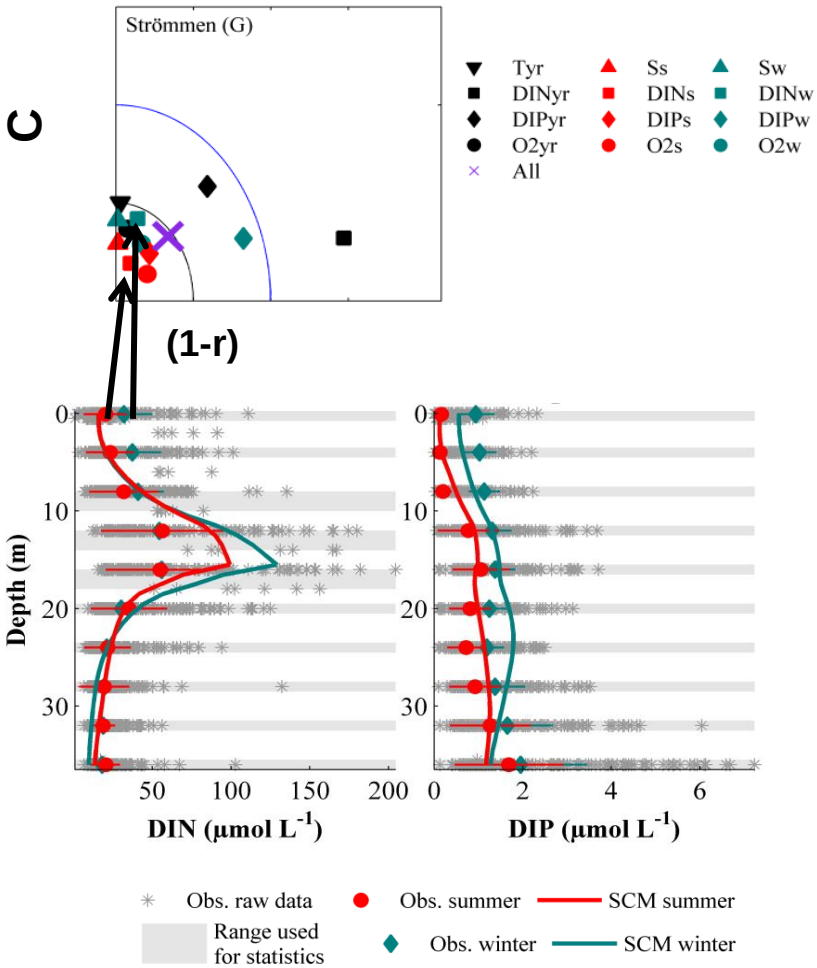
Variables within:

- the inner half circle are considered to be good
- between the two half circles are acceptable
- variables outside the circles are not well captured.

$$r = \frac{\sum_{i=1}^{n}(P_i - \bar{P})(O_i - \bar{O})}{\pm\sqrt{\sum_{i=1}^{n}(P_i - \bar{P})^2 \sum_{i=1}^{n}(O_i - \bar{O})^2}}$$

$$C = \frac{\sum_{i=1}^{n}\left|\frac{P_i - O_i}{sd(O_i)}\right|}{n}$$

Evaluation, model results, 1990-2012



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Evaluation, model results, 1990-2012