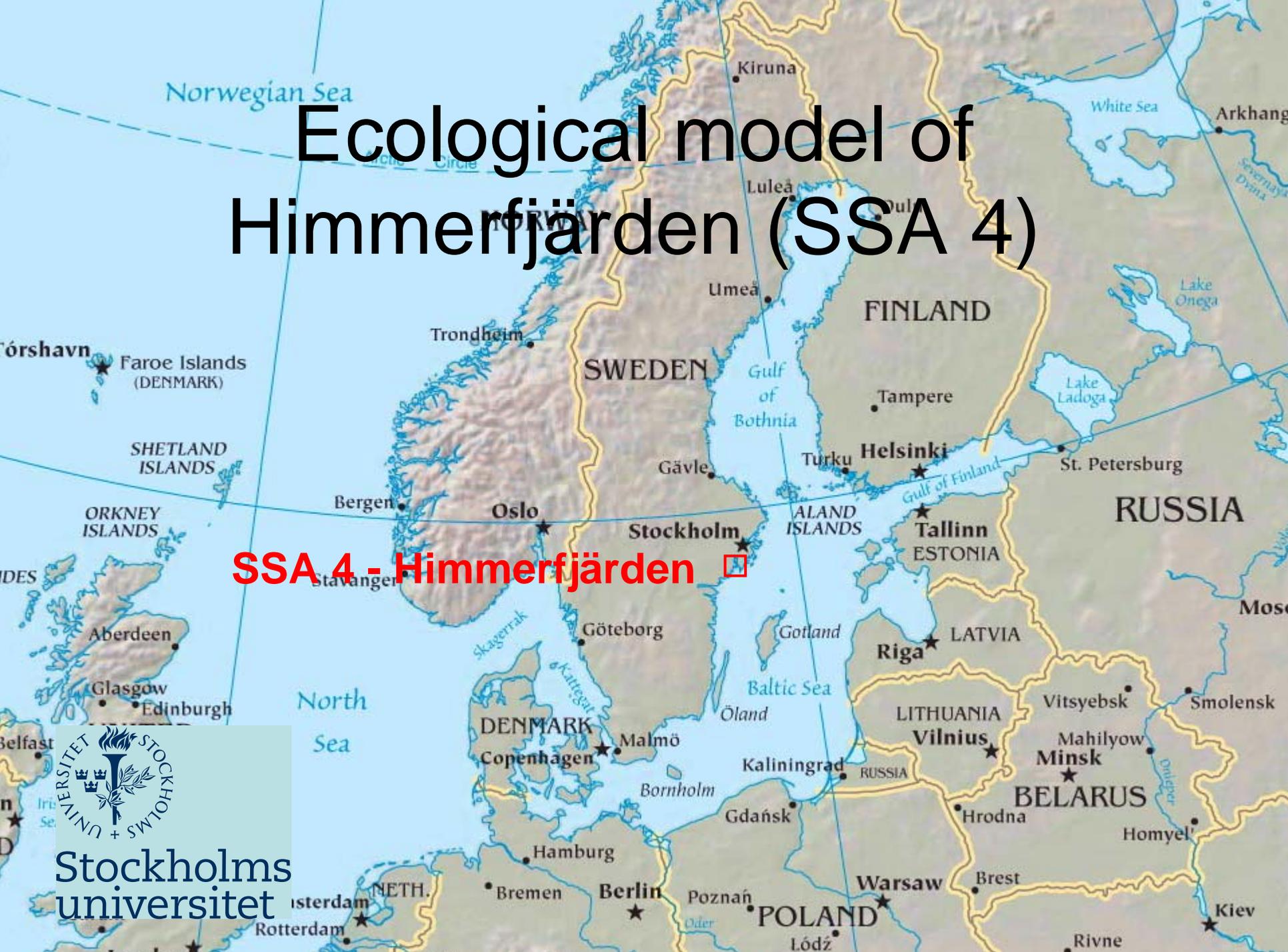


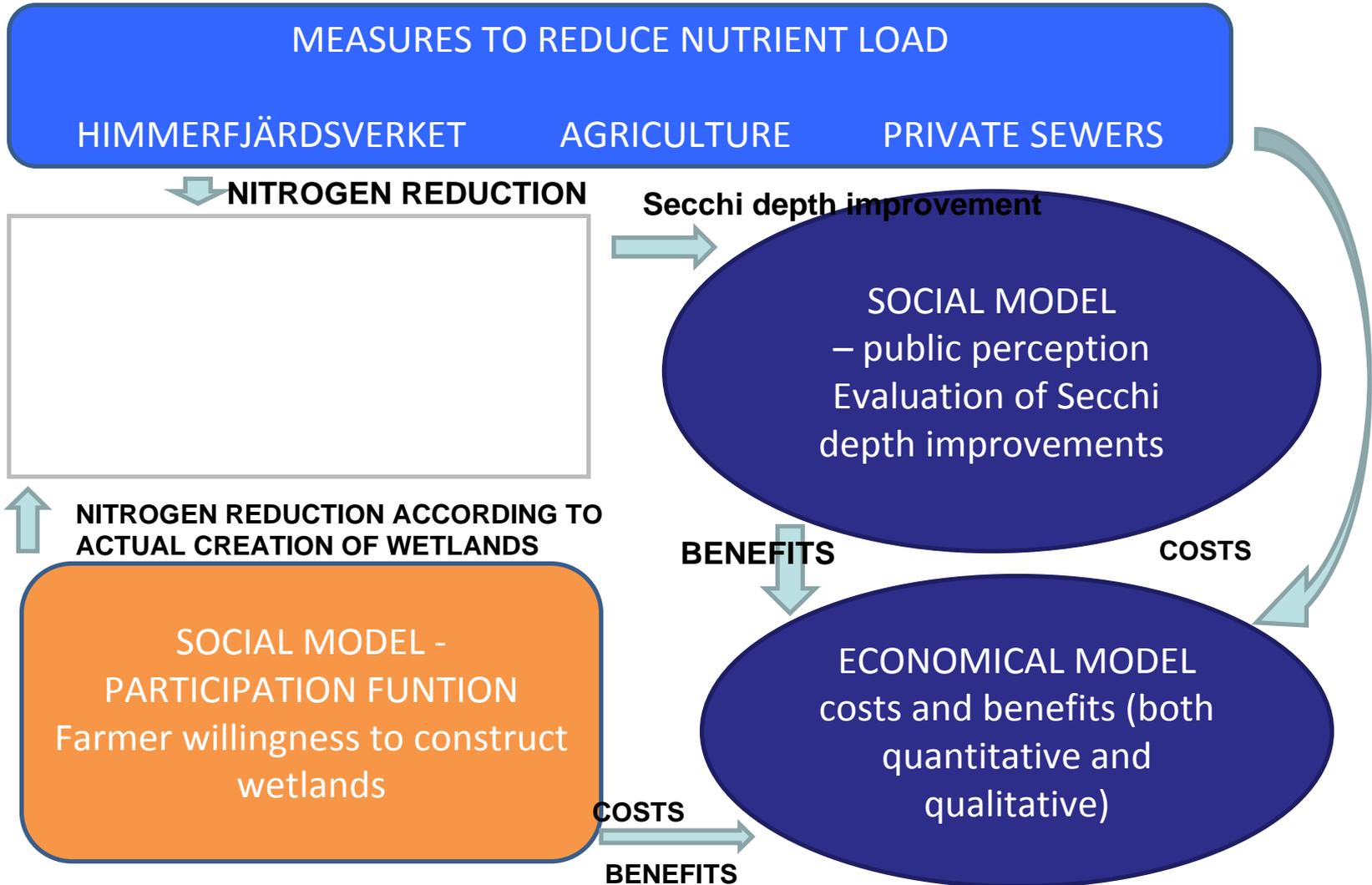
Ecological model of Himmerfjärden (SSA 4)

SSA 4 - Himmerfjärden 

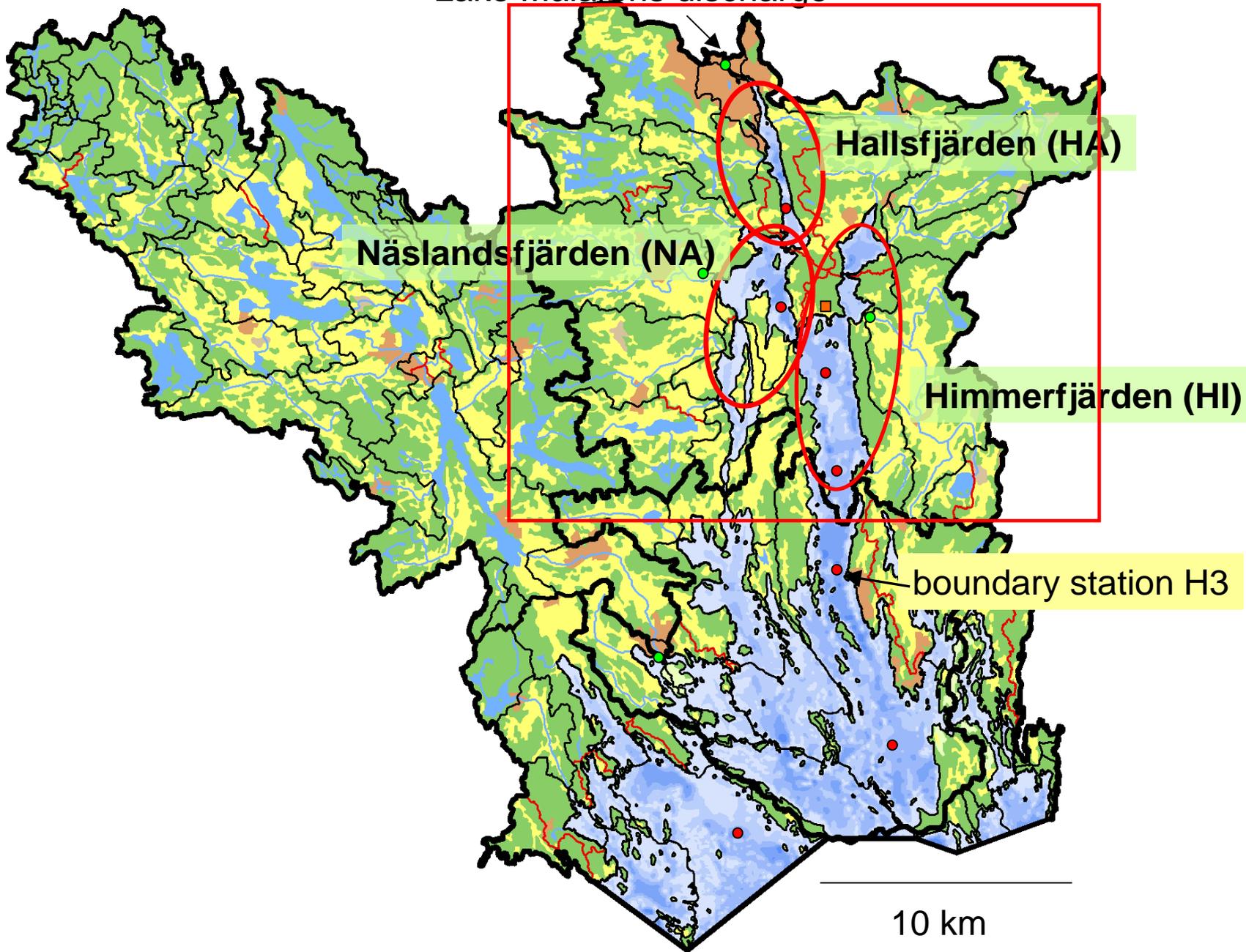


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HIMMERFJÄRDEN - OVERALL CONCEPTUAL MODEL



Lake Mälarens discharge



Hallsfjärden (HA)

Näslandsfjärden (NA)

Himmerfjärden (HI)

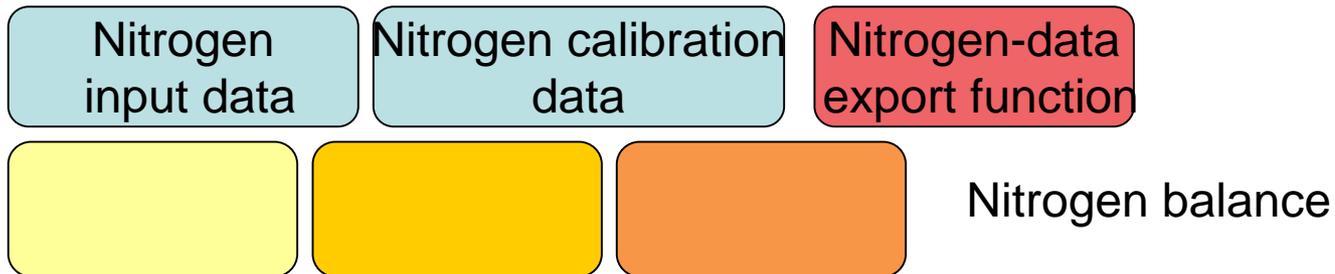
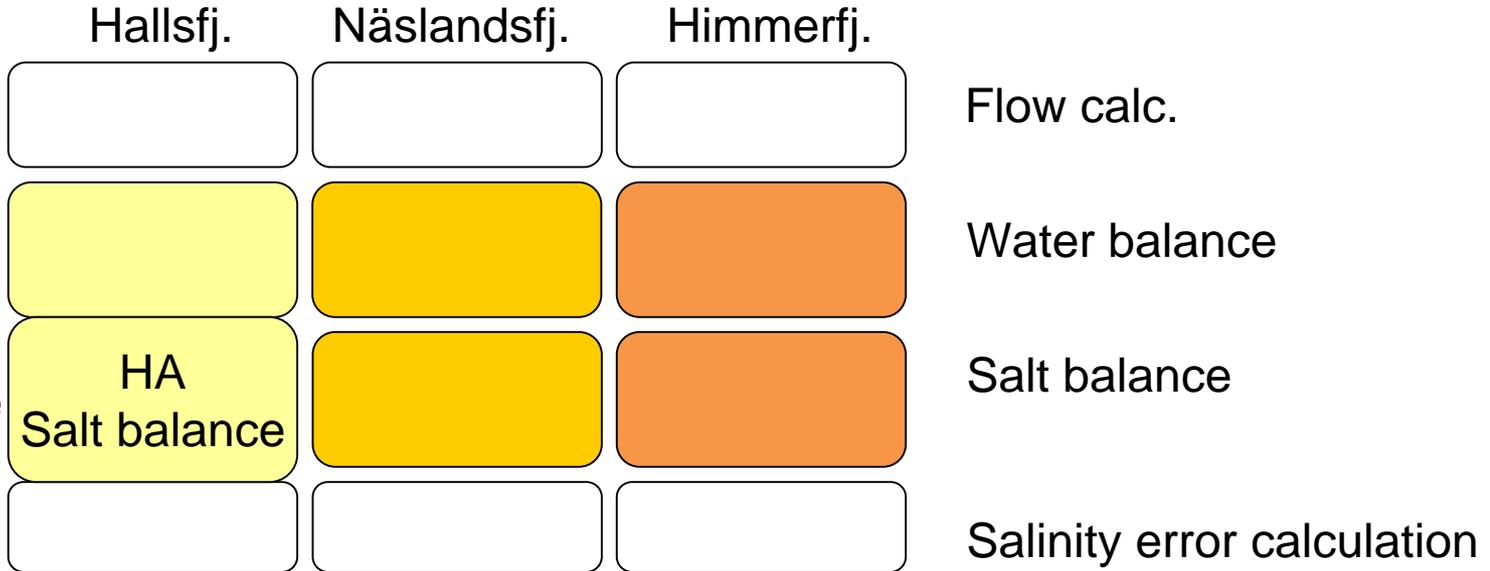
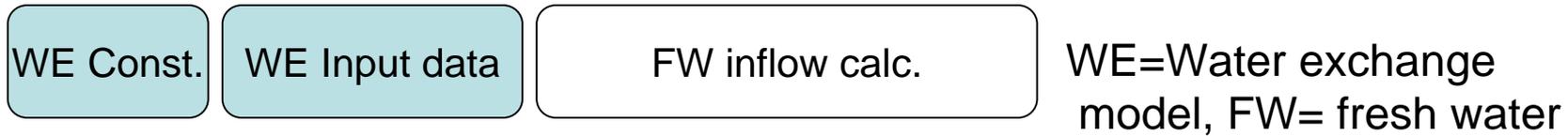
boundary station H3

10 km

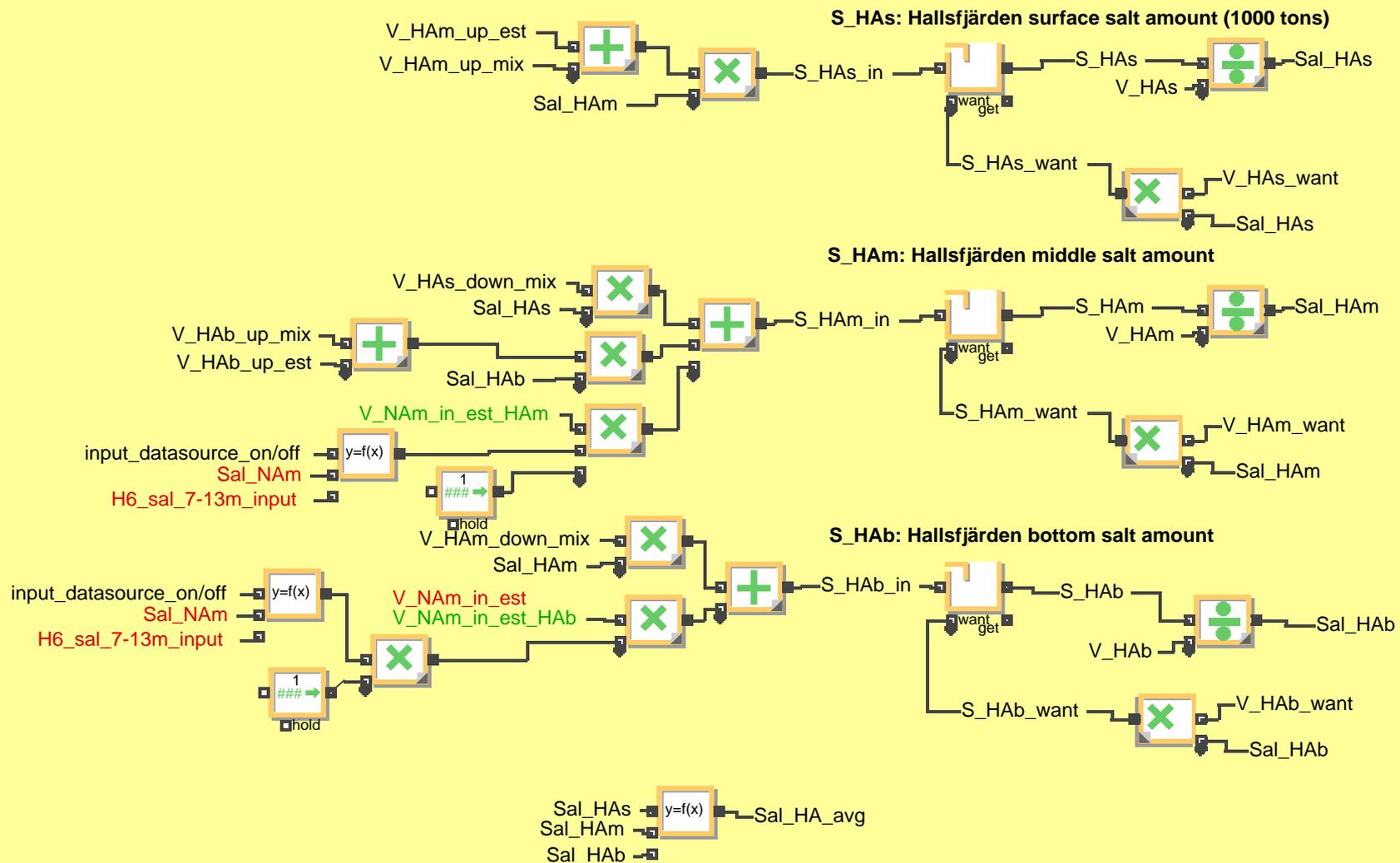
Ecological model status

- Improvements in water exchange model
- Total-N model
- Currently no phytoplankton model

Extend layout for Ecological model

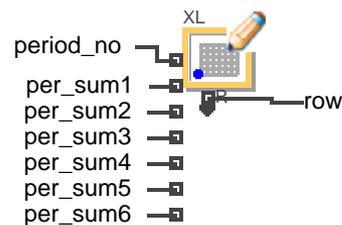
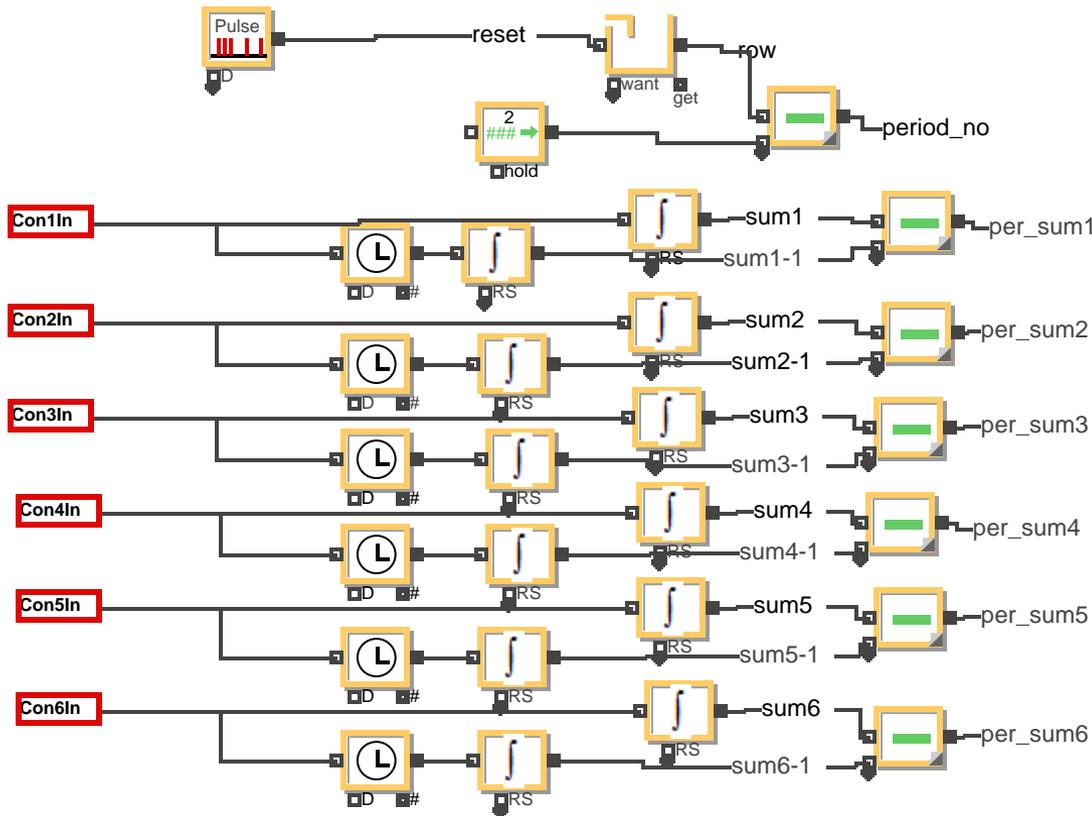


HALLSFJÄRDEN (HA) SALT BALANCE



Daily
input
export

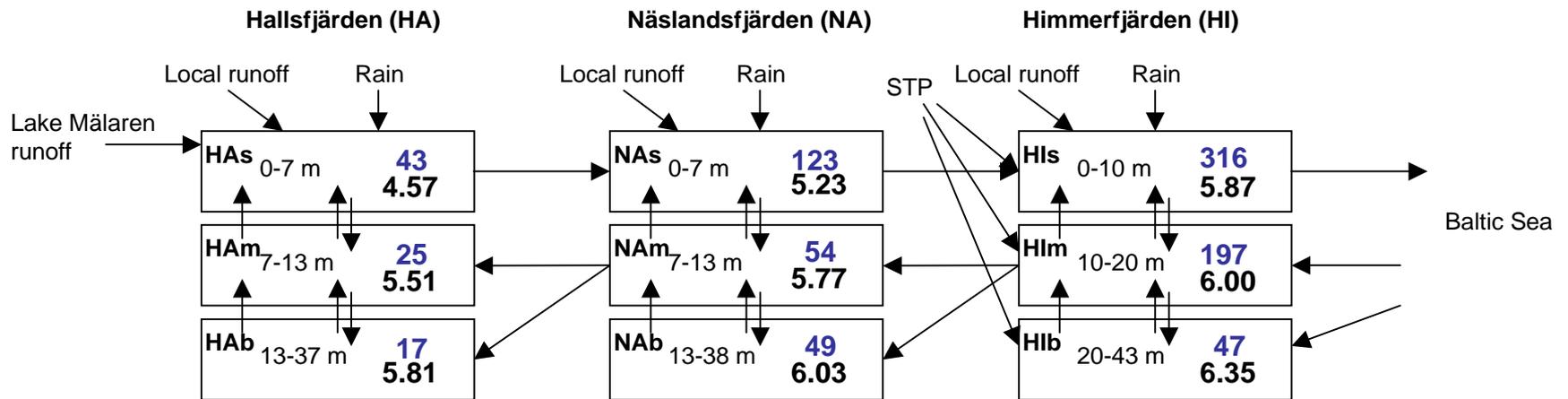
Generic model blocks



- Exports flows as daily values to selected Excel-file

Model structure

Water exchange model



Box name	Volume (Mm ³)
depth	Salinity (avg. for 1997-2000)

Calculation of estuarine water inflow ($F_{\text{bottom inflow}}$)

- This is done using salinity data to calculate a variable "salt factor" in the Knudsen equation based on salt and volume balance

face)

ace)

ere is rarely steady state. Inflowing deep water
r will affect salinity of out-flowing water with

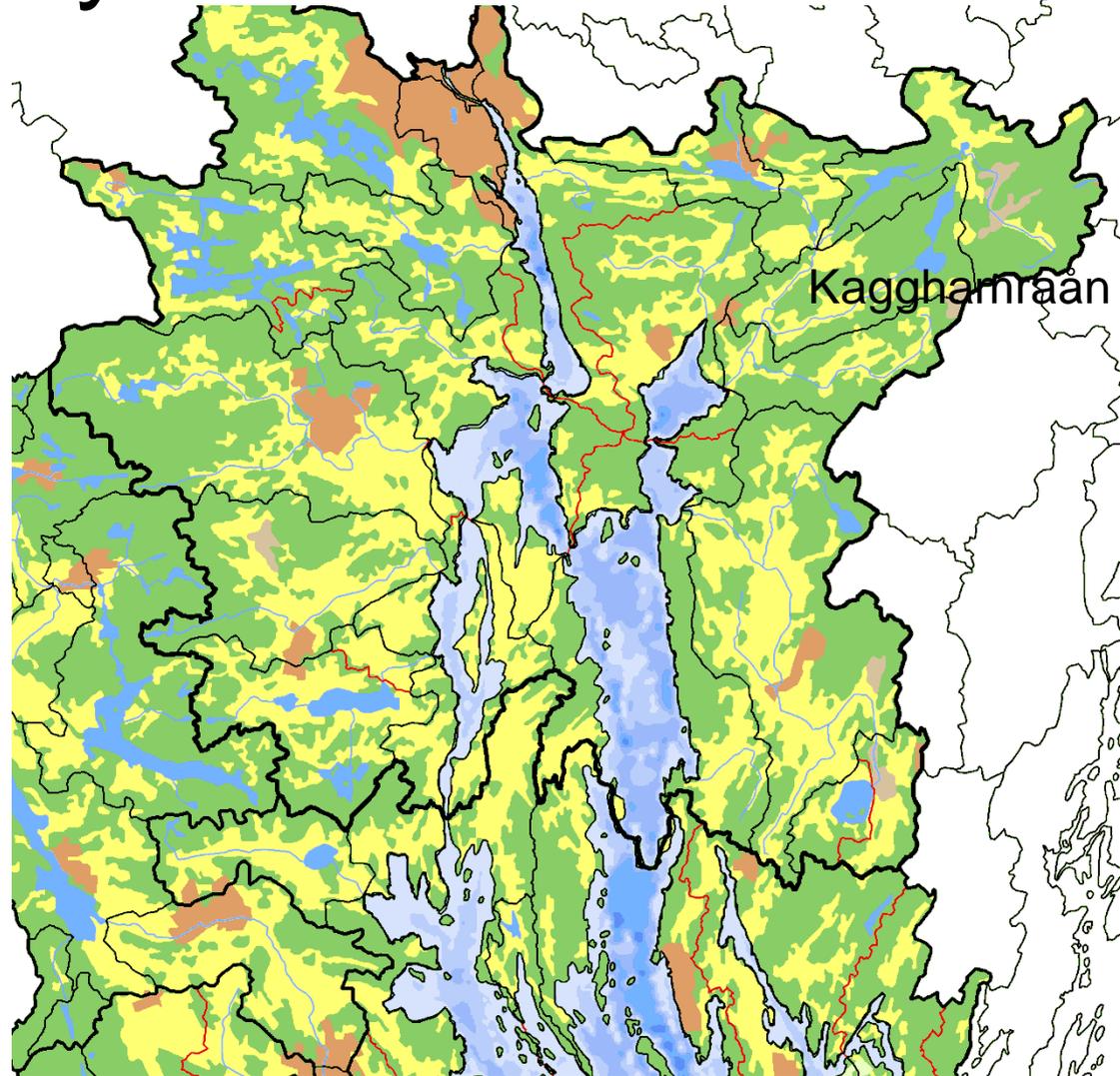
delay

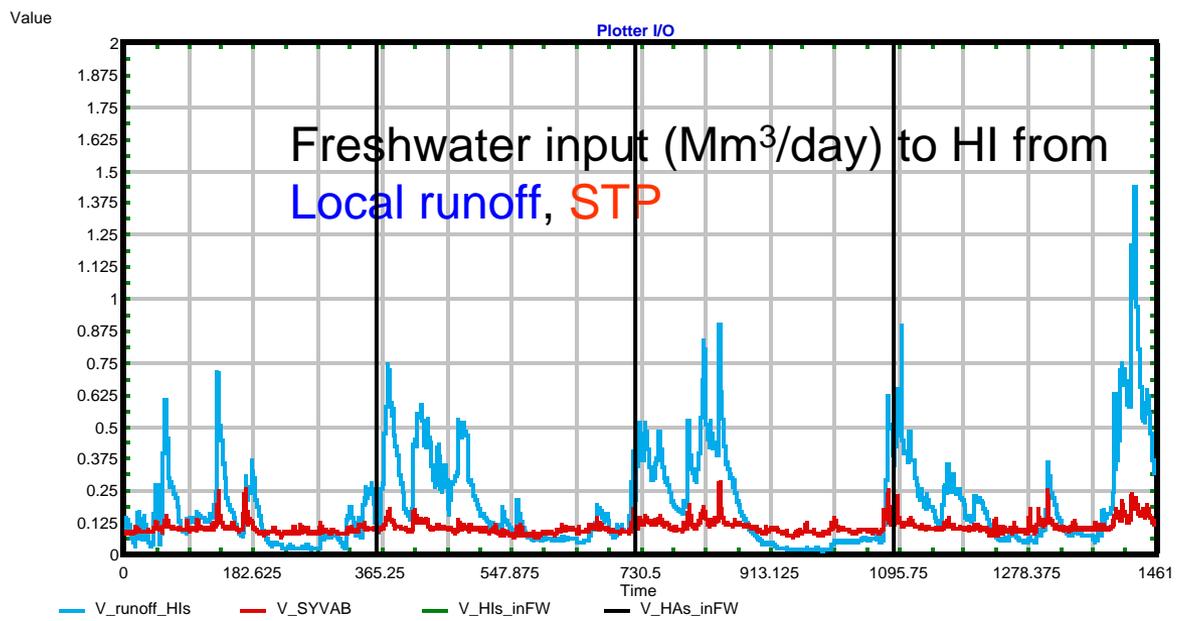
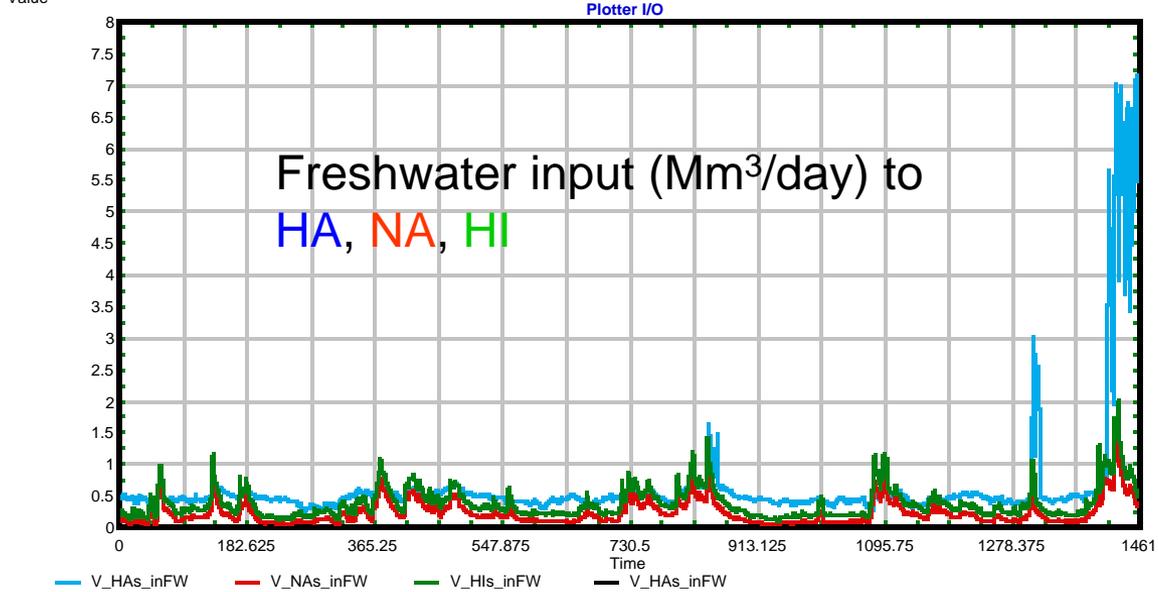
delay

elay

Distribution of monthly flows as daily flows

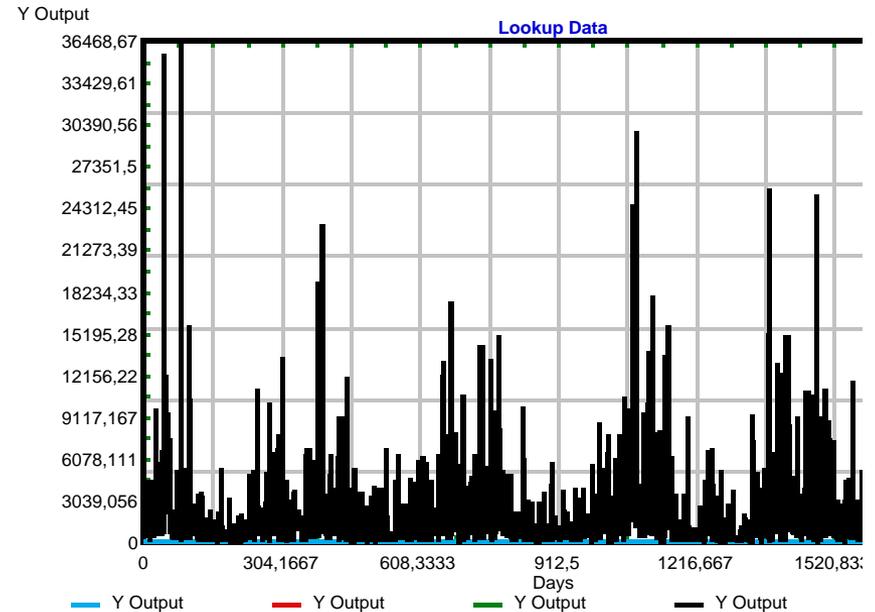
- Daily flow measurements were found for one brook. This data is used to distribute monthly flow data to daily flows for all local runoff.



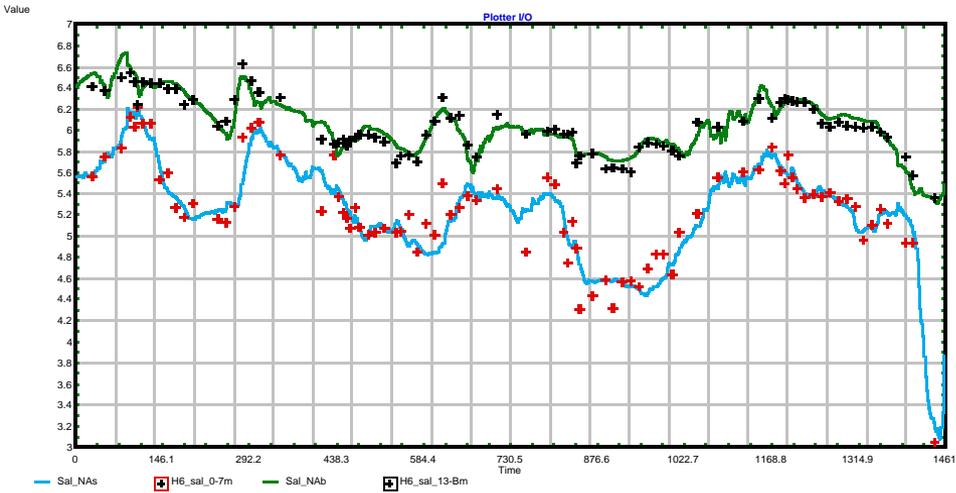


New wind mixing data and formulations

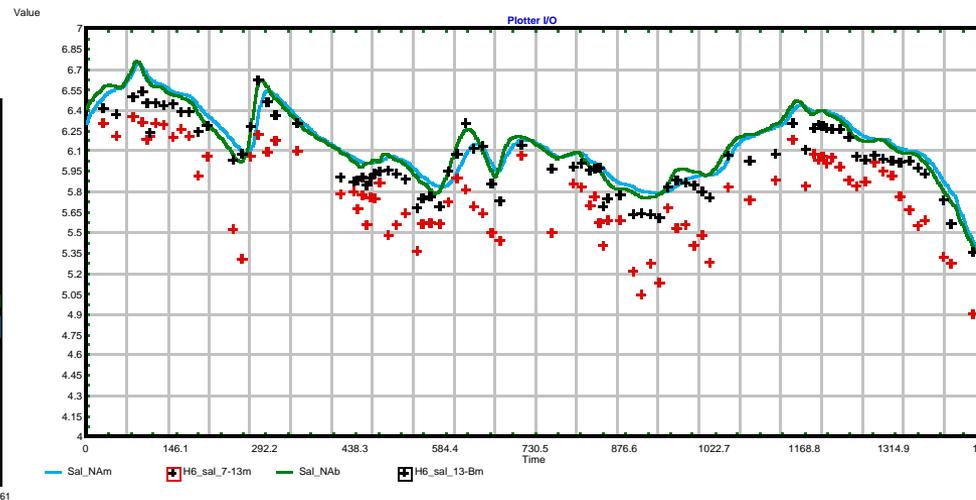
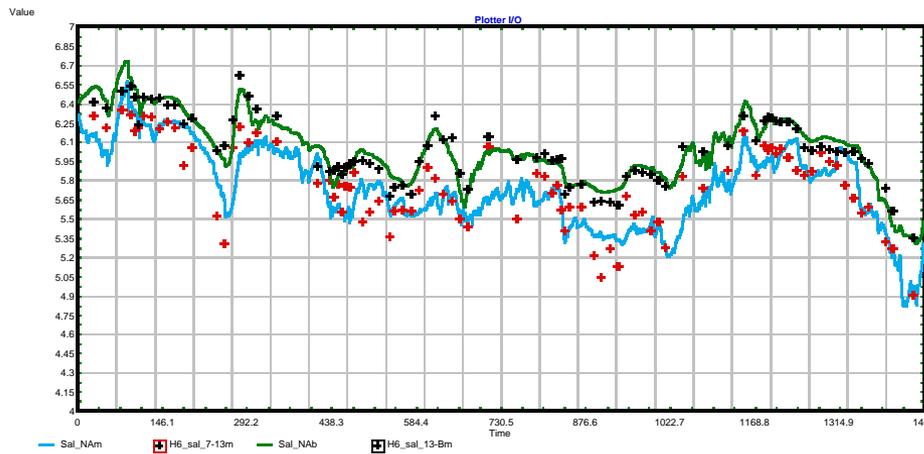
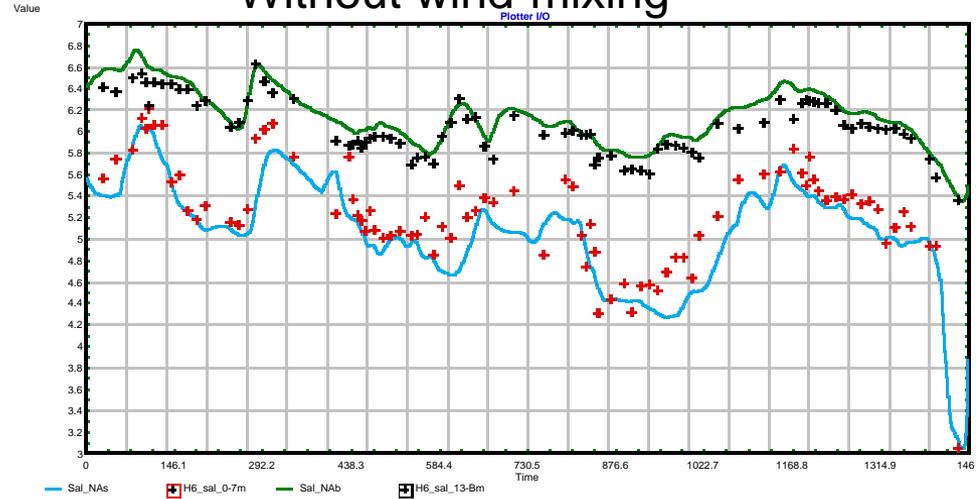
- Wind speed data are used to calculate daily wind forcing (cubic relationship), modified by wind direction relative to basin excentricity (length to width relation) and basin tilt relative geographical north
- Wind mixing is dependent on wind force and density stratification (stronger stratification= less mixing)



With wind-mixing

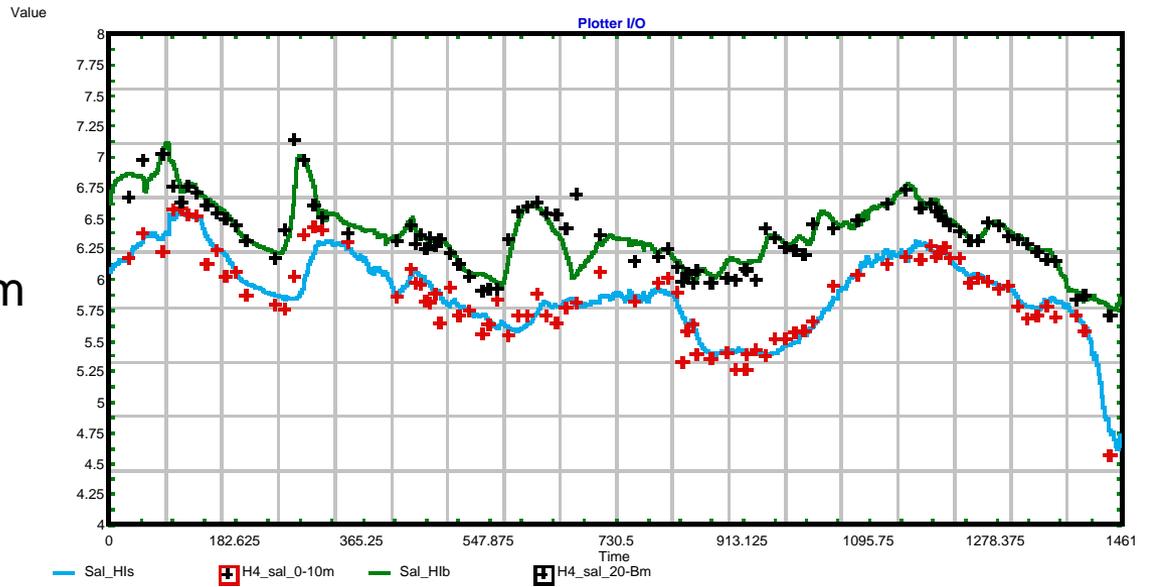


Without wind-mixing

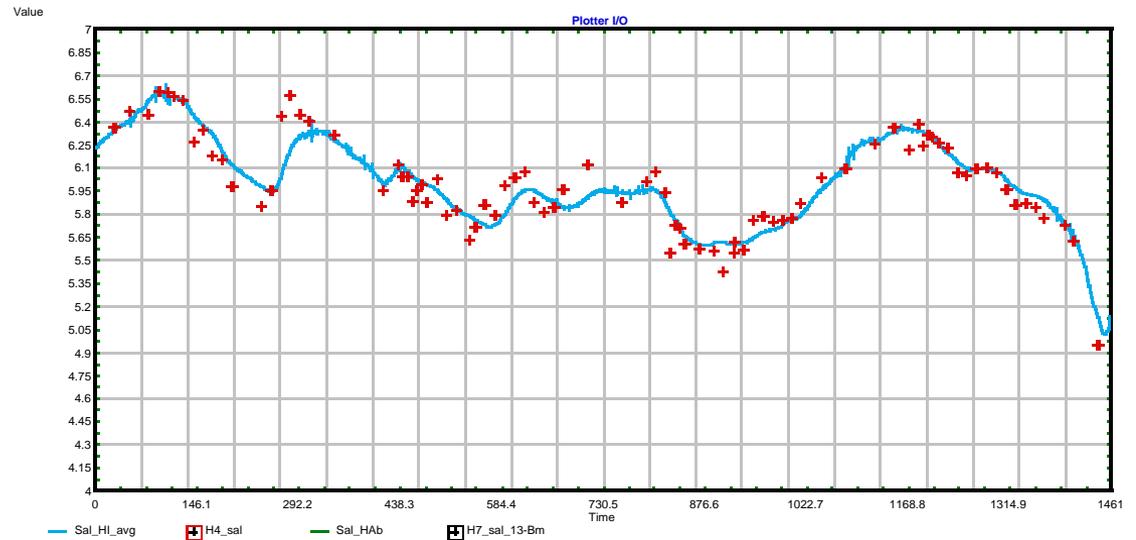


Himmerfjärden

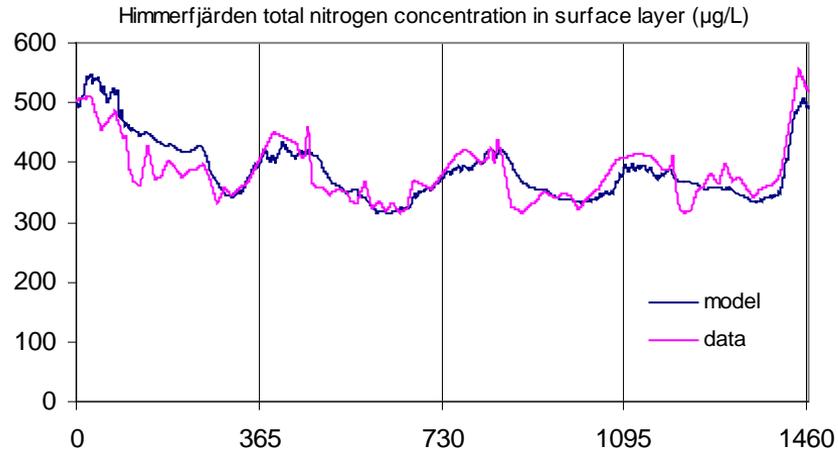
bottom 20m-
surface 0-10m



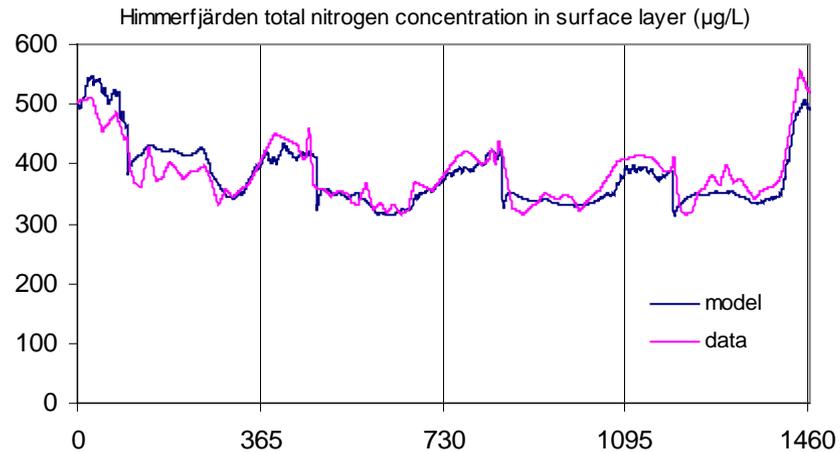
All layers



Total nitrogen in HI

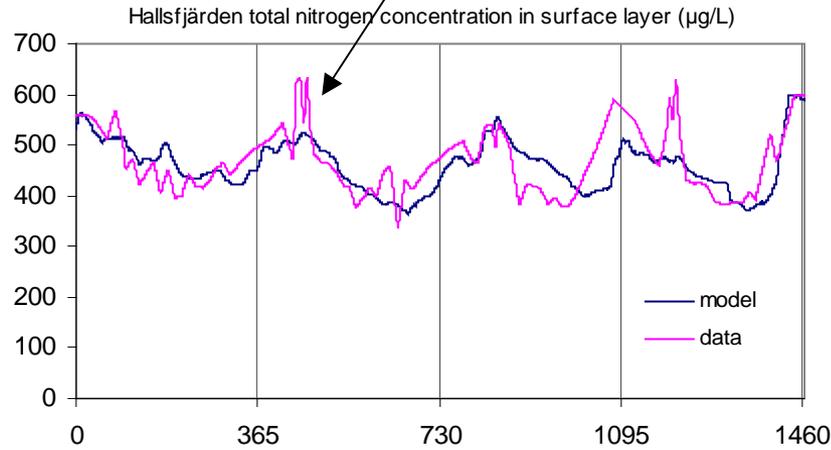


Total nitrogen in HI with spring bloom loss of nitrogen due to sedimentation

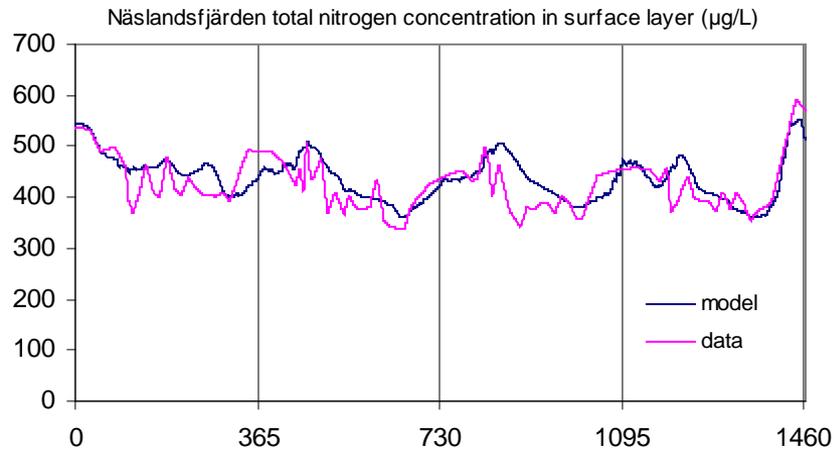


Errors in nitrogen loading or
Error in water turnover (too fast?) ?

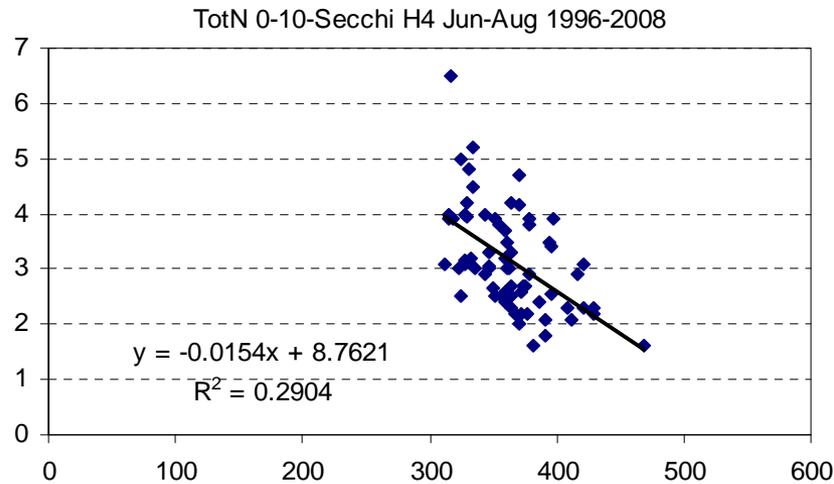
HA



NA



Secchi depth vs. Total nitrogen relationship is used to calculate Secchi depth from modeled nitrogen

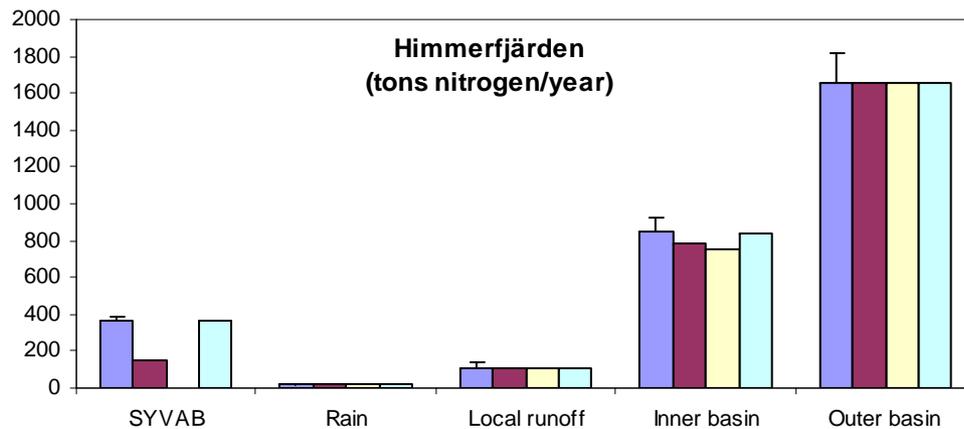
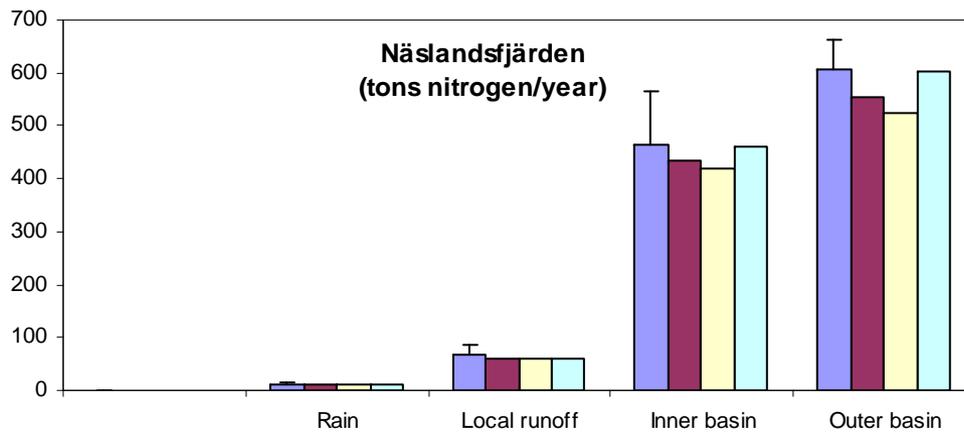
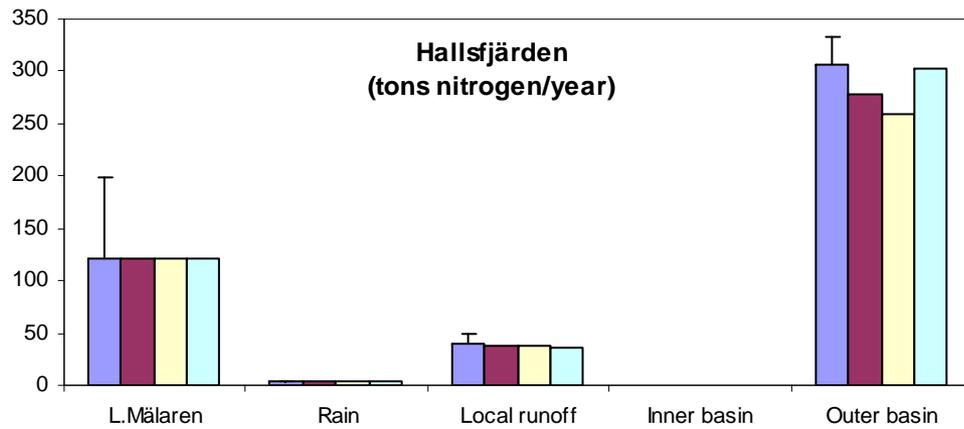


Model run	Model basin	Year	Tot-N model ed (µg/l)	Tot-N data (µg/l)	diff . µg/l	diff . %	Secchi depth calc. from modeled totN	Secchi depth calc. from tot-N data	Secchi depth data	SD Secchi depth data
2	HA	1997	484	424	59	14	1.3	2.2	3.0	0.6
2	HA	1998	424	410	13	3	2.2	2.4	3.3	0.6
2	HA	1999	459	403	56	14	1.7	2.6	2.6	0.5
2	HA	2000	410	397	13	3	2.5	2.6	2.9	0.6
2	NA	1997	483	426	57	13	1.3	2.2	2.3	0.7
2	NA	1998	394	391	2	1	2.7	2.7	3.2	0.6
2	NA	1999	414	376	38	10	2.4	3.0	2.8	0.6
2	NA	2000	378	392	-14	-4	2.9	2.7	2.6	0.2
2	HI	1997	425	385	40	10	2.2	2.8	2.5	0.8
2	HI	1998	341	343	-2	-1	3.5	3.5	3.4	0.7
2	HI	1999	343	337	7	2	3.5	3.6	3.6	1.0
2	HI	2000	340	373	-33	-9	3.5	3.0	2.6	0.3

Scenario results (averages for 1997-2000)

Model basin	Scenario	Secchi		Tot N ($\mu\text{g/l}$)	SD tot N ($\mu\text{g/l}$)
		depth (m)	SD Secchi (m)		
HA	1	1.7	0.34	457	22
HA	2	2.2	0.35	426	23
HA	3	2.5	0.36	408	23
HA	4	1.8	0.33	450	21
NA	1	2.1	0.32	432	21
NA	2	2.7	0.30	394	20
NA	3	3.0	0.30	374	20
NA	4	2.2	0.31	423	20
HI	1	2.8	0.22	386	14
HI	2	3.5	0.15	345	10
HI	3	3.9	0.14	318	9
HI	4	2.9	0.22	383	14

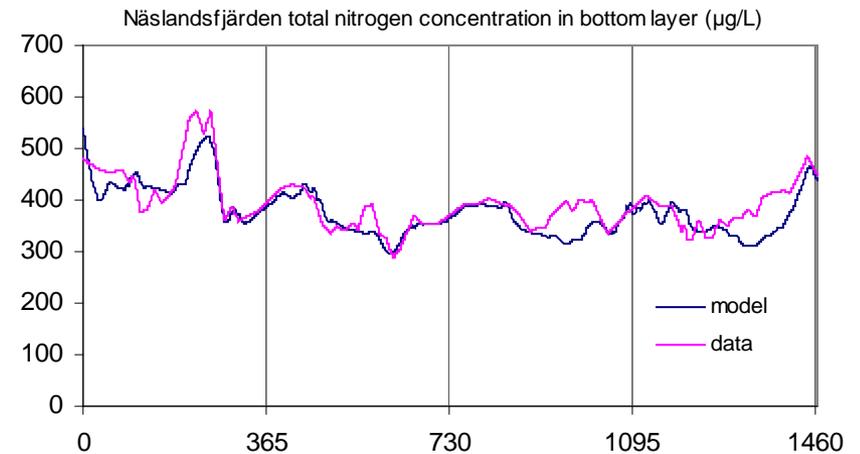
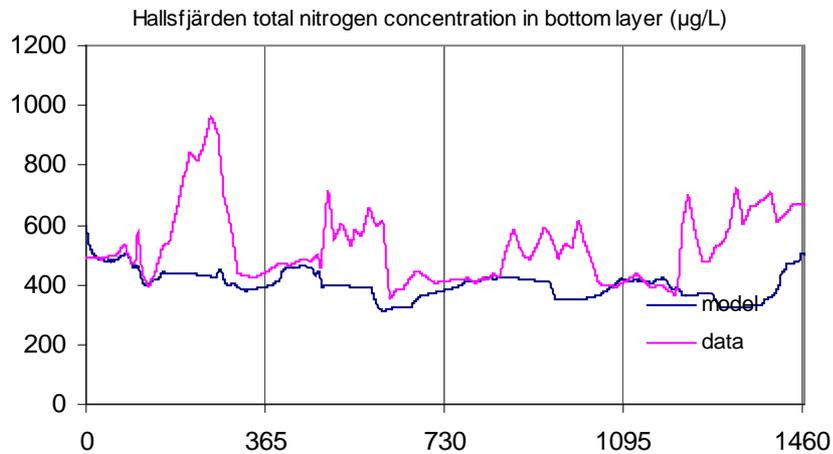
Loads of nitrogen for scenarios 1-4



Problems/Room for improvements

- Recruitment depth of deep water inflows – sensitivity tests needed
- Deep water flow events not controlled by fresh water inputs may be significant, especially for outer basin
- Spring bloom loss of nitrogen depends on relative nitrogen to phosphorus availability. Spring bloom loss also in middle layer.
- Sediment nitrogen release and denitrification in deep-water can be roughly estimated from budget analysis
- Nitrogen conc. of in-flowing deep water affected by scenarios?
- The nitrogen-Secchi depth relationship could be improved (more data, seasonal averages)

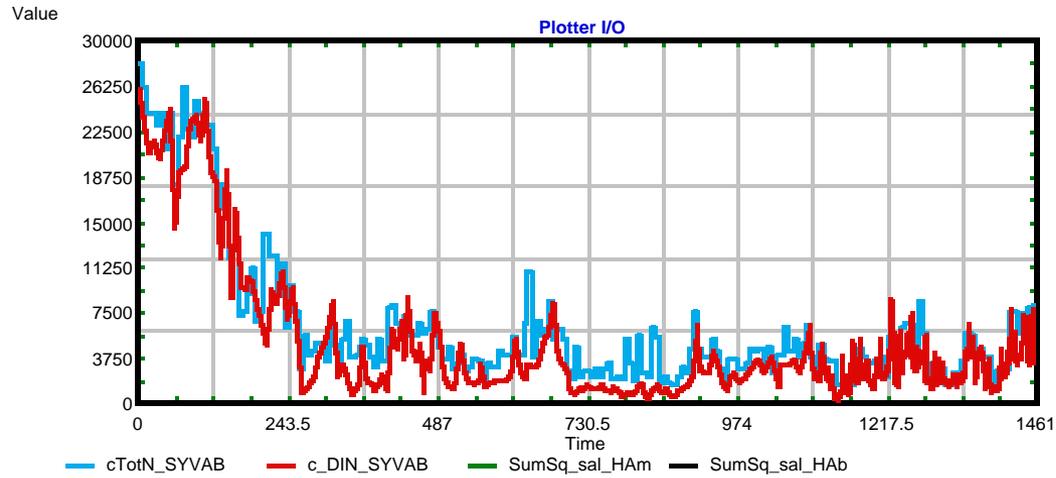
Nitrogen release from sediments accumulated in deep water



Thank you!



Concentration of tot-N (blue) and DIN (red) in SYVAB effluent 1997-2000



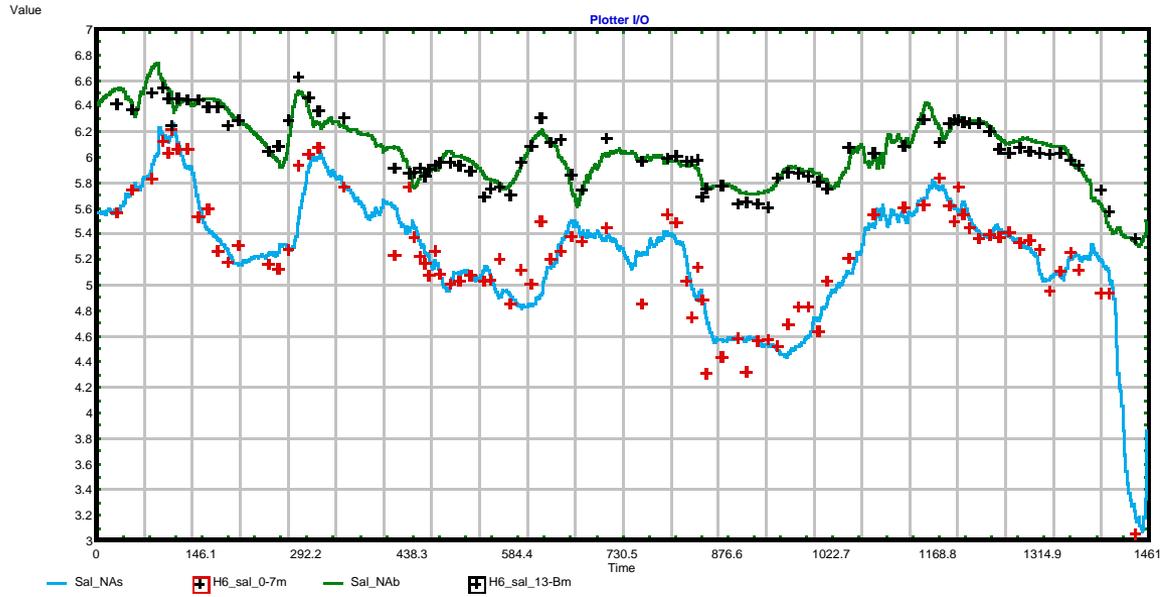
Improvements of water exchange model

- Inward transport in estuary restricted by sills between the basins – water from intermediate depths flow into inner basins
- Monthly data on local runoff distributed as daily flow using daily flow measurements from one brook (Kagghamraån)
- Actual salinity differences between surface and bottom layers used to calculate flows of estuarine circulation
- Time delay used to calculate flows (it takes some time before inflow of saline deep water affect the salinity of outflowing water)
- Wind mixing based on data on wind speed, wind direction and wind fetch (determined by basin size and orientation)
- Calibration data for each box more accurately volume-weighted
- Improvement of model layout. Use of database for constants

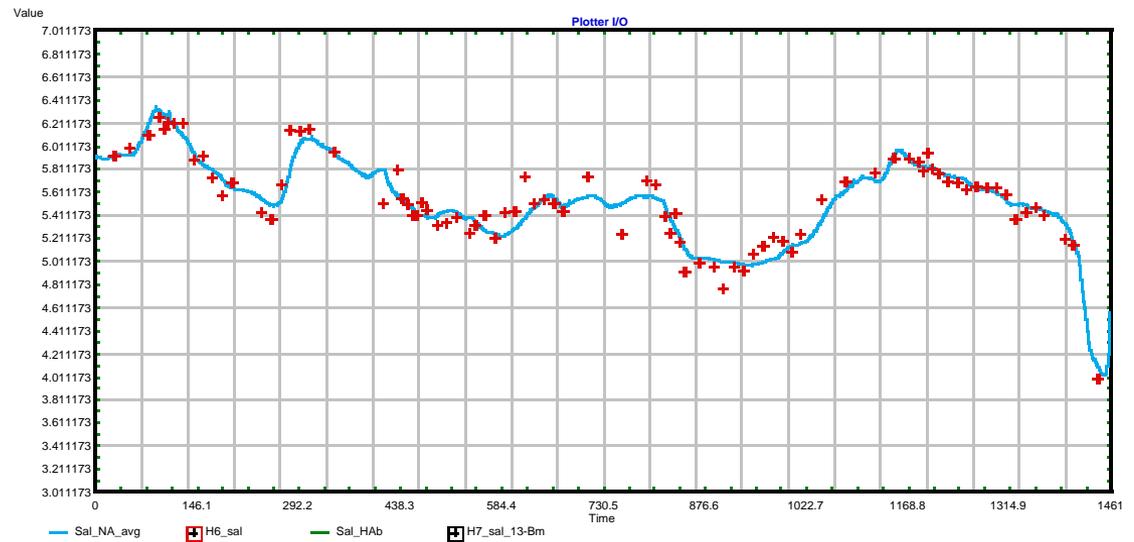
- According to PLC5-data, area specific tot-N load is 26% higher to Hallsfjärden than Näslandsfjärden (calc. for Moraån)
- Kagghamraån tot-N load is comparable to Moraån. Fitunaån is ca 50% higher

Näslandsfjärden

bottom 13m-
surface 0-7m

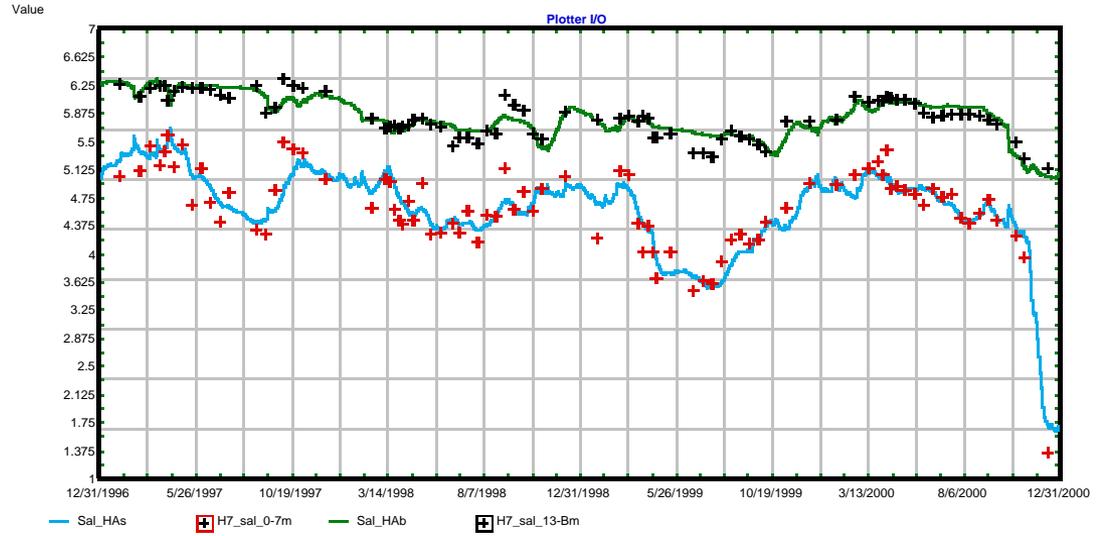


All layers



Hallsfjärden

bottom 13m-
surface 0-7m



All layers

