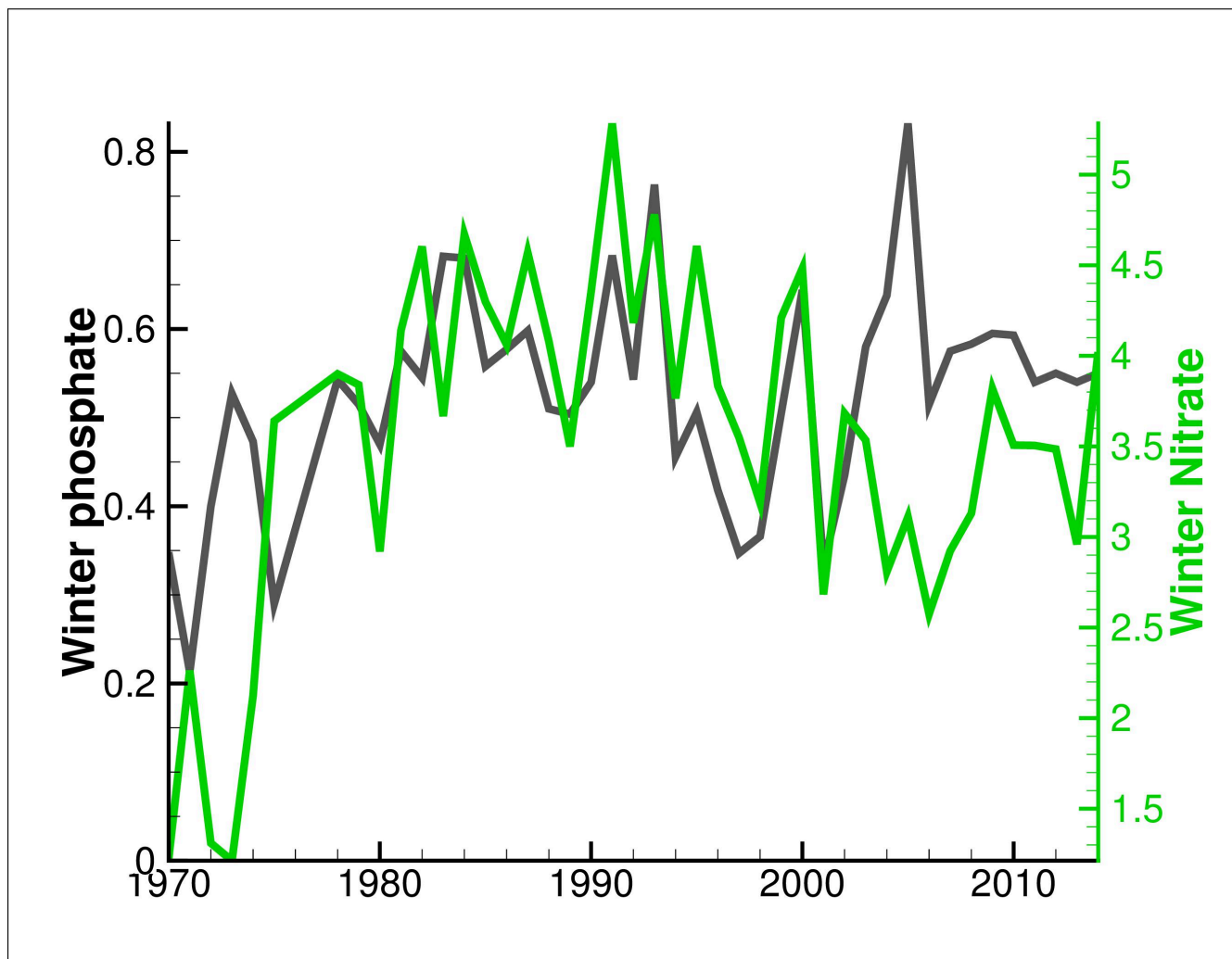


Internal load and restoration by manipulation

Bo Gustafsson

Cause for concern, but not alarm



North Sea
1960-2010

1960-2010

Land

Land
1960-2010

1960-2010

Sea

0.6 Mton P

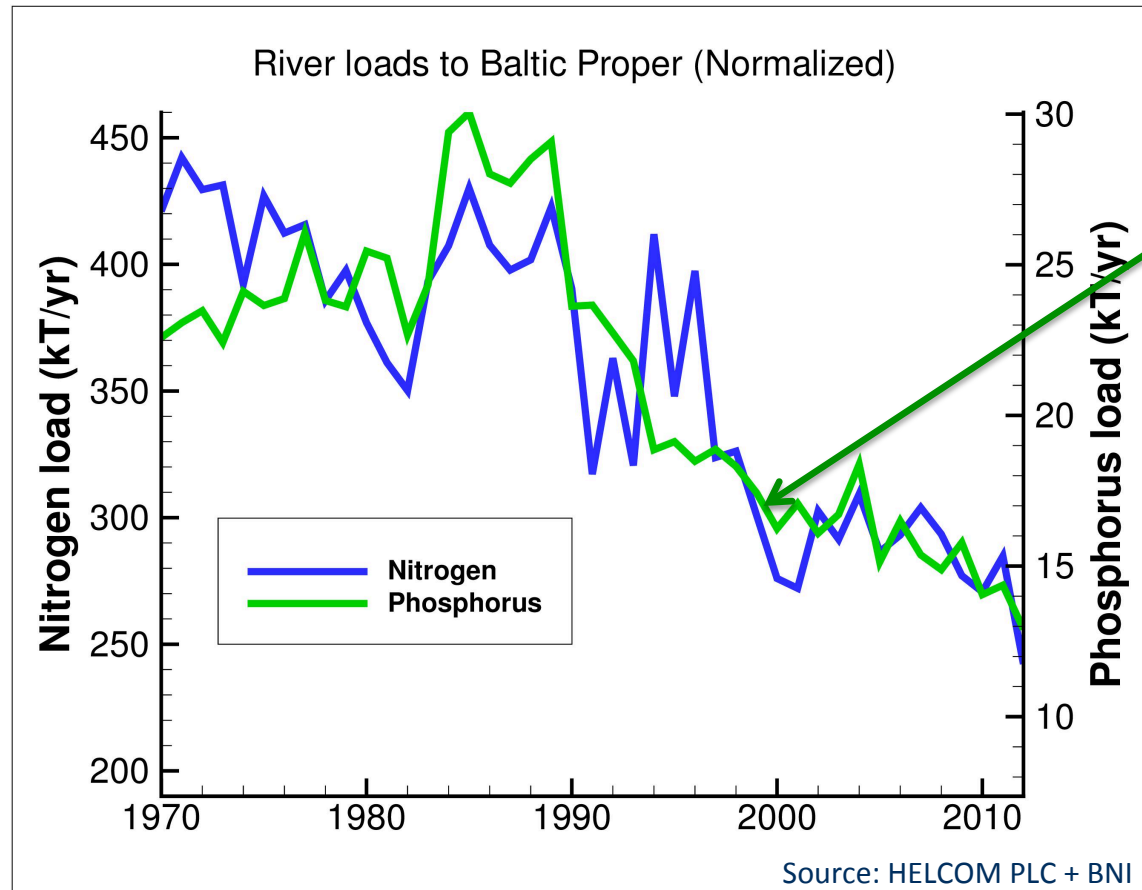
1960-2010

Top sediment

1.6 Mton P

Deep sediment

NB!
"Only" 0.3 – 0.7 Mton in
hypoxic/anoxic Baltic
proper



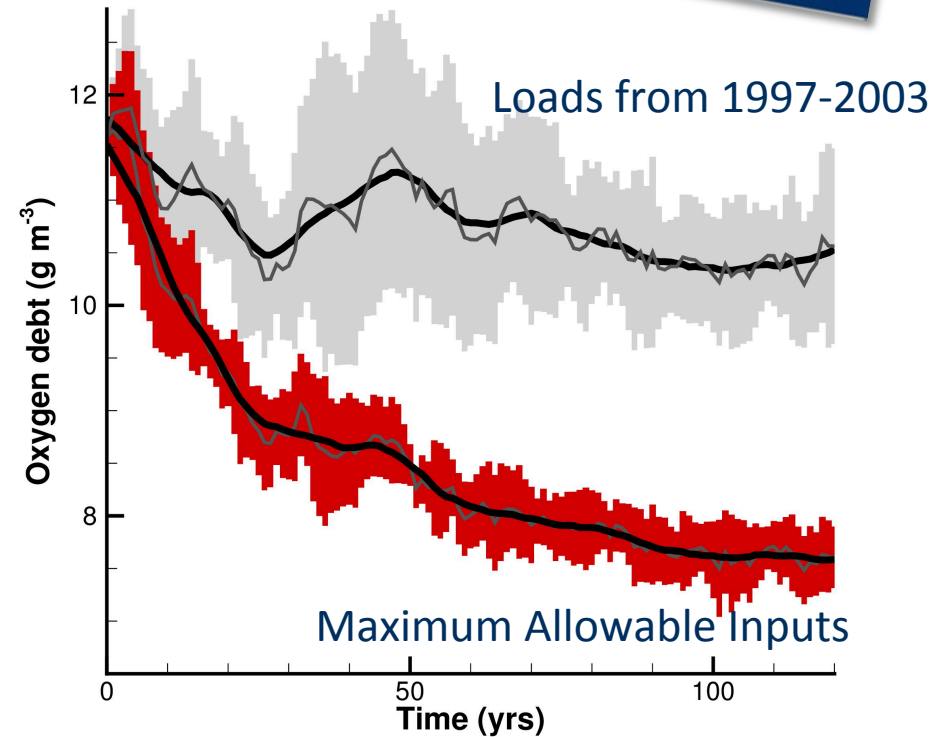
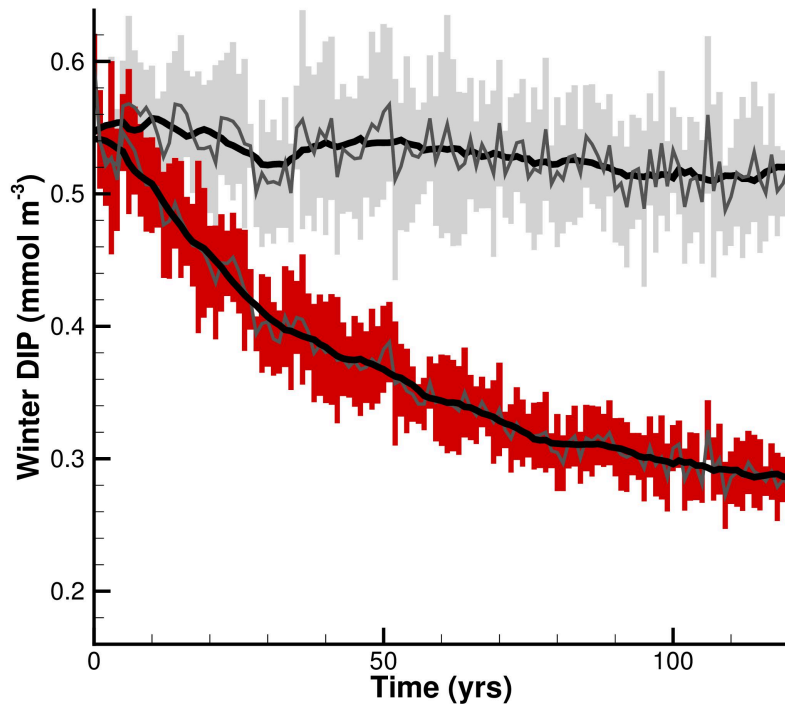
Loads in balance with burial! →
Further reductions leads to improvement

P burial (2000) in Baltic proper:
17 000 ton/yr (Mort et al., 2010, Gustafsson et al., 2012)

Internal pools (load) delays recovery



50% of DIP target achieved within about 20 years
Oxygen conditions at target at about 30-50 years



Gray and red shades indicate natural variability

Conclusions part 1

- There is a **huge pool of phosphorus** in the Baltic Sea, especially including the sediments
 - As long as the sediment pool is large, there will be leakage from the sediments (internal load)
 - The dominant part of the sediment leakage is part of a recirculation of nutrients between water and sediments
 - There is "only" 15-30% of the phosphorus pool in the hypoxic part of Baltic Sea
- These processes are well described in the BALTSEM model and were taken into account when calculating Baltic Sea Action Plan targets

Adding oxygen (by e.g. pumping water)

Examples of issues



- Will only store a proportion of the P in surface sediments → **short term effect**
- Risk of a "**P-bomb**" (stable organic P to labile metal-oxide P → all stored P will be released again if hypoxia occur,, Reed et al., 2011) (NB! Baltic Sea is naturally hypoxic)
- Denitrification will likely decrease → higher nitrogen concentrations: What happens?
- Other ecological consequences?

- That Baltic will recover from 10 years treatment is an **unproven hypothesis!**
- If loads are not reduced the effect will **not be persistent** (shown from lakes)



Dredging as restoration

- Technique is still untested on very large scale
- Effect of removing a part of the sediments in the Baltic Sea is not explored:
 - Perhaps there is “only” 300 kTons to be lifted from deep Baltic: does that really turn the system?
 - Will removal of the deep sediment disrupt the natural burial of organic P?
 - Will sedimentation really decrease if P in the water column decrease?

Conclusions

- All methods are experimental
- Efficiency and consequences are questioned by a wide community of Baltic Sea scientists
- There is **no simple restoration method!**
- **Loads are decreasing** at a steady rate
- There are still **a large potential for more cost-efficient measures** on land (waste water treatment and farming practice) in the “big” countries
- Evidence points to that **Baltic responds** to nutrient load reductions