

Nutrient reductions through engineering approaches

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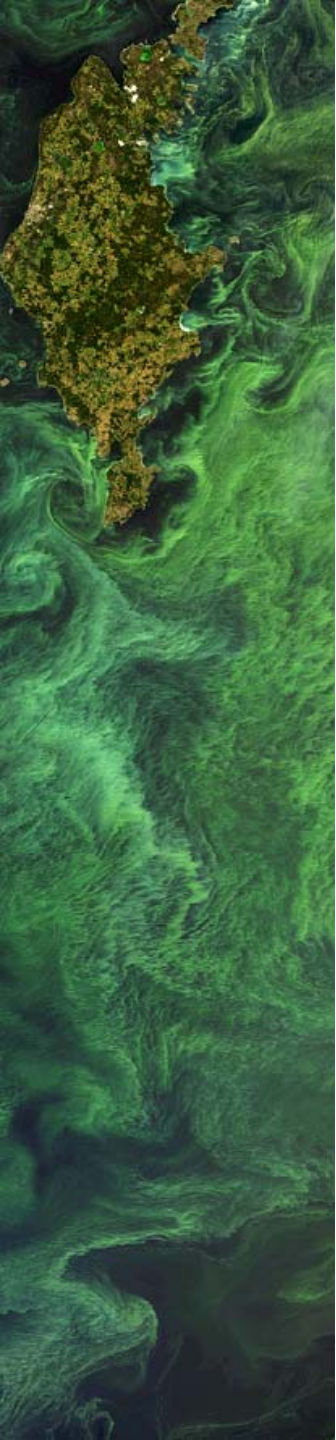
The Baltic Sea suffers from all the classic signs of eutrophication



Pathway to a healthier marine ecosystem based on

- Basic knowledge
- Monitoring & Assessment
- Governance & Management
- Action





The response of the Baltic Sea to *nutrient reductions* will take time

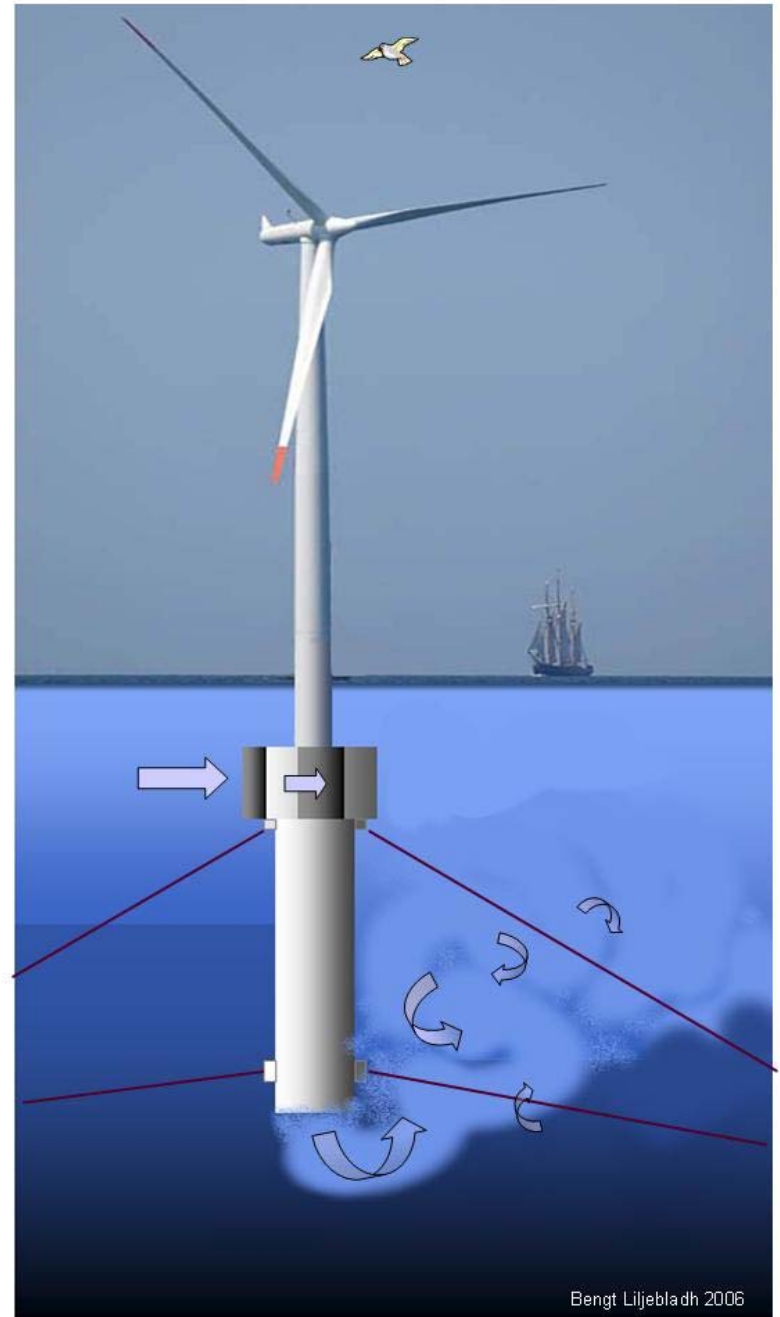
Are there technical solutions available?

Engineering approaches to save the Baltic

2006 - BalticSea2020 65 million €

2006 - Finnish foundation (BSAG)
60 million € to reduce P inputs

2008 - Swedish government 5
million € for pilot projects, but funds
other projects on nutrient reduction



Can we add oxygen to the Baltic?

(Conley et al. 2009, *ES&T*)

The hypoxic area (oxygen < 2 mg/l) averages 49,000 km²

Would require 2-6 million tons oxygen to be added each year



20,000-60,000 railway cars of liquid oxygen each year to keep bottom waters oxic



Can we change the saltwater inflow?

Increase the salinity - deepen the Drogden Sill

More saltwater inflow creates more stratification
and more hypoxia

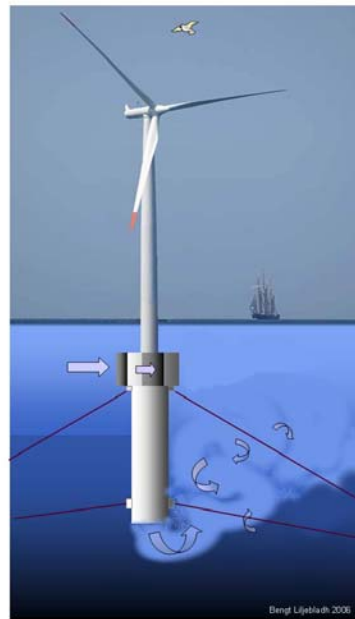
Make the Baltic fresher - close the Drogden Sill

Short term increase in hypoxia (10-15 years), but
improved oxygen conditions after 30 years
Change the species composition

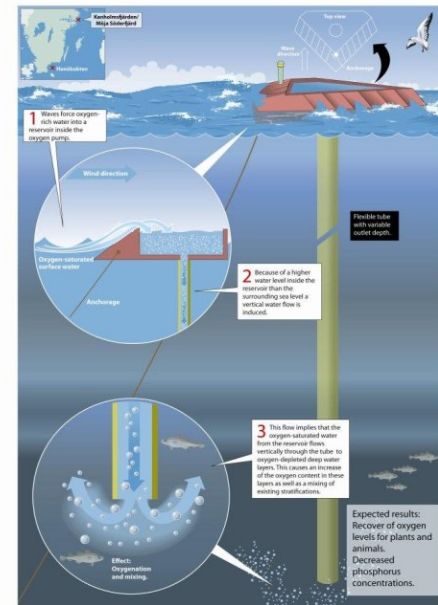
Ventilate the bottom waters by mixing?

Halocline ventilation by mid-water mixing (50 m to 125 m)

Effect on circulation, cod reproduction, nutrient cycling
and not the least shipping



BOX and PROPPEN
Projects



WEBAP Project



Phosphorus Sequestration

Can we enhance the permanent burial of phosphorus in sediments by precipitation with aluminum or other compounds?

Is phosphorus sequestration possible in brackish waters?

Energy and CO₂ considerations

Ethical (reversibility)

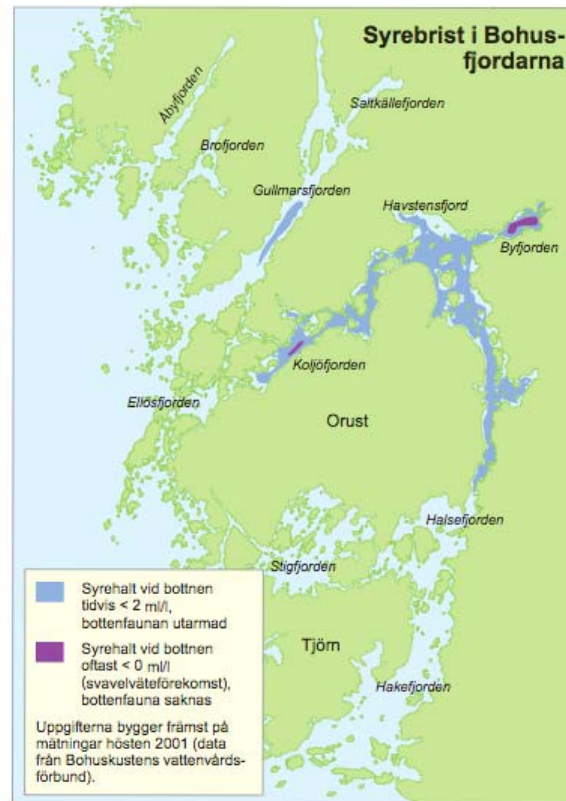
Legal considerations (London Convention)

Re-establish the functioning of the coastal filter

However, we have a limited understanding of:

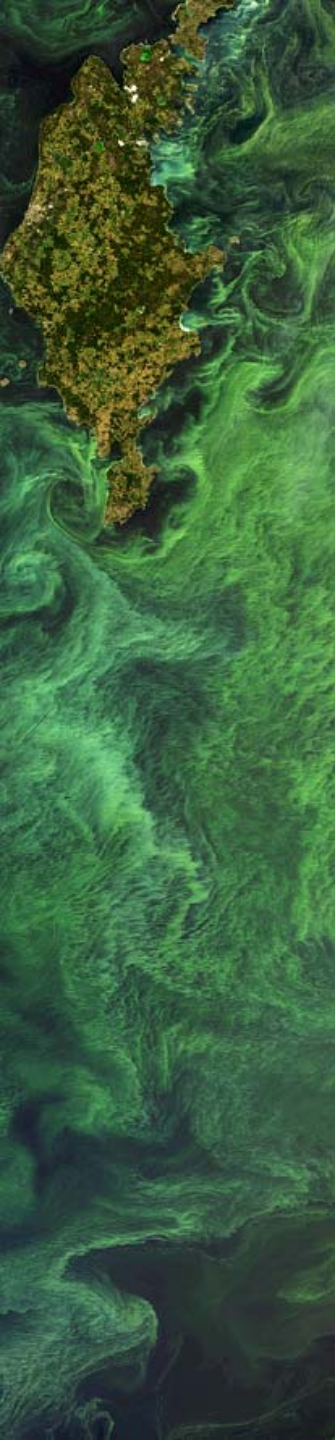
The spatial and temporal extent of hypoxia.

The role of the coastal filter in nutrient removal.



Från Förändringar under ytan (Monitor 19).





Mussels



PEW FELLOWS PROGRAM
IN MARINE CONSERVATION

Use mussels to take nutrients out.



Limited amounts taken up by mussels relative to total
Nutrient release from sediment can offset nutrient uptake
Can interfere with recreational activities
Expensive relative to land-based reductions

Can not recommend mussels for nutrient removal

We must focus our efforts on nutrient reductions



An aerial photograph of a coastline, likely the Baltic Sea region, showing a large landmass on the left and swirling green water on the right, indicating a significant environmental issue like algal bloom.

Recommendations

There is no “silver bullet.”

Large-scale solutions for the Baltic Sea are probably not possible or feasible. *Ginormous* problem.

Solutions might be appropriate for the coastal zone.

Science in the support of management.

New funding should include solutions to reduce nutrient loading *to* the Baltic Sea, not in the Baltic!

