



# **The costs of reducing eutrophication of the Baltic Sea – a review of the literature**

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# Overview of the presentation

- Background
- Cost-effective reduction of nutrient loads:
  - Comparison of models
  - Factors that affect results
  - Applications to international agreements
- Research needs

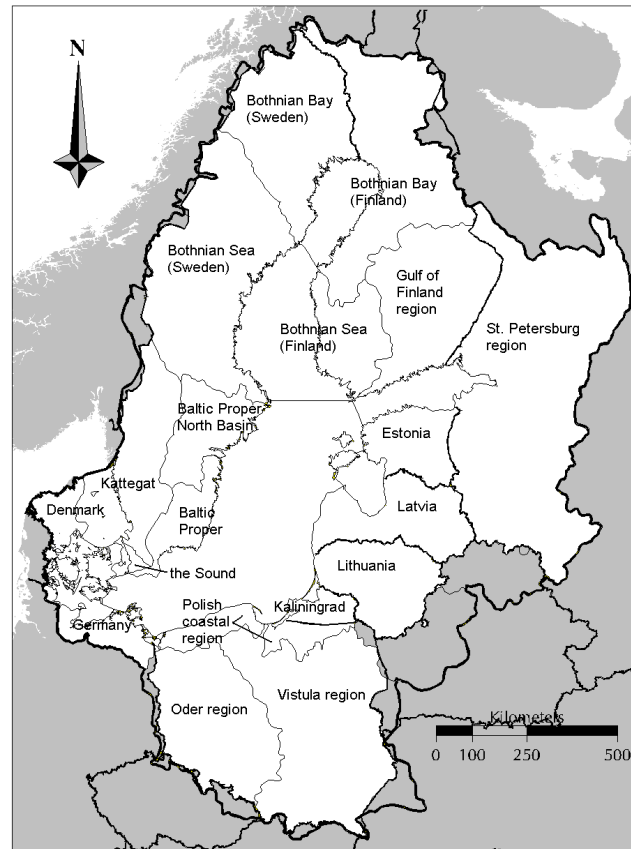
# Background I:

## Necessary components in cost-effectiveness analysis

- Interpret the politically determined environmental target into a measurable target indicator
- Cost-effective reductions to the Baltic Sea – a comparison of models
- Quantify the impact of measures at the target
- (Identify the potential of each measure)

# Background II: Eutrophication of the Baltic Sea

- Eutrophication has become a major problem in the Baltic Sea.
- 75% of the nitrogen load and 95% of the phosphorus load enter the Baltic Sea via the rivers. 25% of the nitrogen load is due to atmospheric deposition



# Background III:

## Cost-effectiveness and eutrophication

- Operative targets differently defined than stated ecological objectives → targets vary across studies
- Costs must be identified for measures in multiple sectors: agriculture, WWTP, transport, energy and ecological engineering
- Multiple nutrient pathways: through soil, waters, air

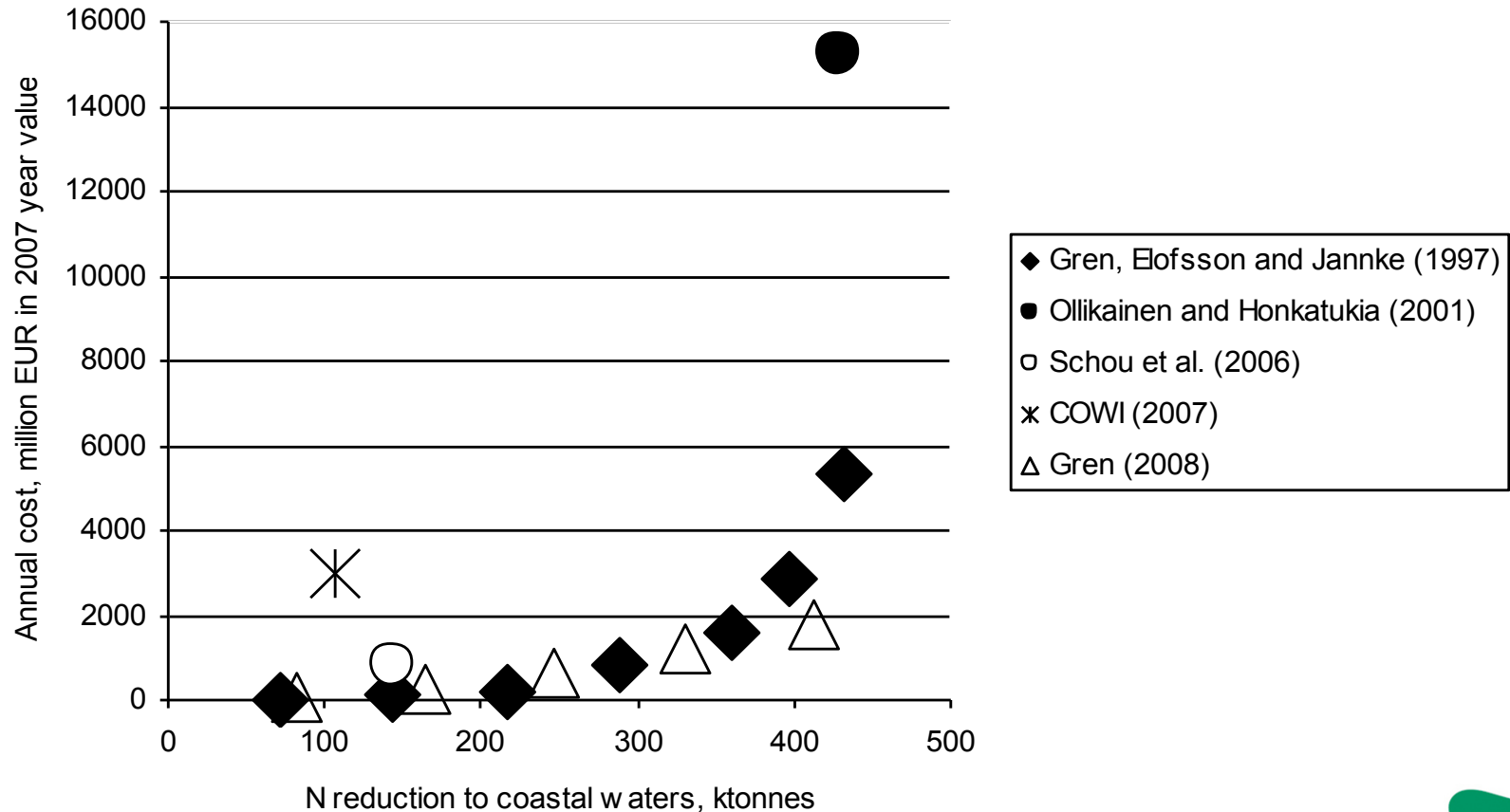
# Cost-effectiveness models: reductions in nutrient loads to the Baltic Sea

- Baltic-wide studies of the costs of reducing nutrient loads to the Baltic Sea have been carried out by
  - Gren, Elofsson and Jannke (1997)
  - Ollikainen and Honkatukia (2001)
  - Schou et al. (2006)
  - COWI (2007)
  - Gren (2008)
- Can these studies be compared?
- What determines results?

# Comparison of model input

	Gren, Elofsson and Jannke (1997)	Ollikainen and Honkatukia (2001)	Schou et al. (2006)	COWI (2007)	Gren (2008)
<b>Number of measures included<sup>1</sup></b>	15	Measures included in HELCOM reports	10	16	14 for nitrogen and 7 for phosphorus
<b>Sectors covered</b>	Agriculture Wetlands Wastewater treatment Energy Transport	Measures included in HELCOM reports	Agriculture Wetlands Wastewater treatment Energy Transport	Agriculture Wetlands Wastewater treatment Phosphate free detergents Rural households Energy Transport	Agriculture Wetlands Wastewater treatment Phosphate free detergents Rural households Energy Transport
<b>Nutrient transports from sources to sea</b>	Interdependencies between measures	Not included	No interdependencies	No interdependencies	Interdependencies between measures
<b>N target, red in total load to coastal waters</b>	0-60 %	50 %	20 %	12 %	0-50 %
<b>P target, red in total load to coastal waters</b>	0-60 %	50 %	n.a.	33 %	0-60 %

# Comparison of results: Total cost





# Comparison of results: cheap and expensive measures

	Gren, Elofsson and Jannke (1997)	Ollikainen and Honkatukia (2001)	Schou et al. (2006)	COWI (2007)	Gren (2008)
<b>Cheap N measures</b>	Wetlands Agricultural measures Wastewater treatment	n.a.	NOx-reductions in energy sector Reduced fertilizer use Wetlands Catchcrops	NOx-red from shipping WWTPs in coastal urban areas Catchcrops, Reduced fertilizer use Manure-storage facilities	NOx-red from shipping Fertilizer reductions Wetlands
<b>Expensive N measures</b>	n.a.	n.a.	Livestock reductions	NOx-red in energy sector if only purpose is eutrophication target	NOx-red in energy and transport sector Private sewers
<b>Cheap P measures</b>	Wastewater treatment, Wetlands Agriculture	n.a.	n.a.	Wastewater treatment in coastal urban areas Phosphate-free detergents	Phosphate-free detergents Fertilizer reductions Wetlands
<b>Expensive P measures</b>	n.a.	n.a.	n.a.	n.a.	n.a.

# Factors that affect 'accuracy' of results

## *I. Factors in the above Baltic-wide studies:*

- Number and type of measures included
- Geographical coverage
- Cost estimation methods
- Assumed lifelength of investment and chosen discount rate
- Assumptions about capacity of different measures
- Environmental target formulation and stringency
- Nutrient transport model

## II. *Factors that have been shown in other studies to be of importance for results:*

- *Uncertainty about nutrient transports*  
Increases the costs of load reduction if damage function is convex (Elofsson, 2003; Byström, Andersson and Gren, 2000).
- *If marine nutrient transports are accounted for*  
Total costs might be higher or lower. The relative costs of reductions in different countries are altered (Gren and Wulff, 2004).
- *If N and P interaction is accounted for*  
This affect relative costs of the two nutrient w.r.t. the targets (Elofsson, 2006).

- *Time lags*  
Affect the choice between downstream and upstream abatement over time (Hart, 2003) and the choice of whether to make large investments (Laukkanen and Huhtala, 2008)
- *Agricultural policy*  
Changes both the need for nutrient reductions and the relative costs of different measures (Brady, 2003) and decoupling reforms may have a different impact on emissions in different regions (Lethonen et al., 2007).
- *Climate and energy policy*  
Changes both the need for nutrient reductions and the relative costs of different measures (Östblom 2007; Östblom and Hammar, 2007).
- *Secondary benefits from nutrient reductions*  
Affect the costs of measures (Samakovlis et al., 2005; Krupnick et al., 1998)

## Application: prospects for international agreements.

### Losers (X- marked) under a cost-effective or cooperative solution

	Nitrogen			Phosphorus		N and P
	Gren, Elofsson and Jannke (1997)	Ollikainen and Honkatukia (2001)	Gren (2001)	Gren, Elofsson and Jannke (1997)	Ollikainen and Honkatukia (2001)	Gren (2008)
Sweden						
Denmark		X		X	X	
Germany				X		
Poland	X	X	X	X	X	X
Estonia	X		X			
Latvia	X	X	X	X		X
Lithuania	X	X	X	X	X	X
Russia	X		X	X	X	
Finland						

# Research needs

- Robustness of conclusions on cost-effective policies
- Cost uncertainty
- Policy instrument to implement cost-effective policies
- Incentives for participation in international agreements
- The medium and long term role of agricultural policy and agricultural markets for eutrophication and abatement
- The role of climate change and climate policy
- Time dynamics