RA:dOst
Regional Adaptation Strategies for the German Baltic Sea Coast

WETLANDS FOR CLEAR WATER
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Reducing nutrient loads of Baltic Sea tributaries
through restoration, creation and management of wetlands
-
24 - 25 March 2011 in Greifswald, Germany
Greifswald University

Eutrophication management in a Baltic estuarine system

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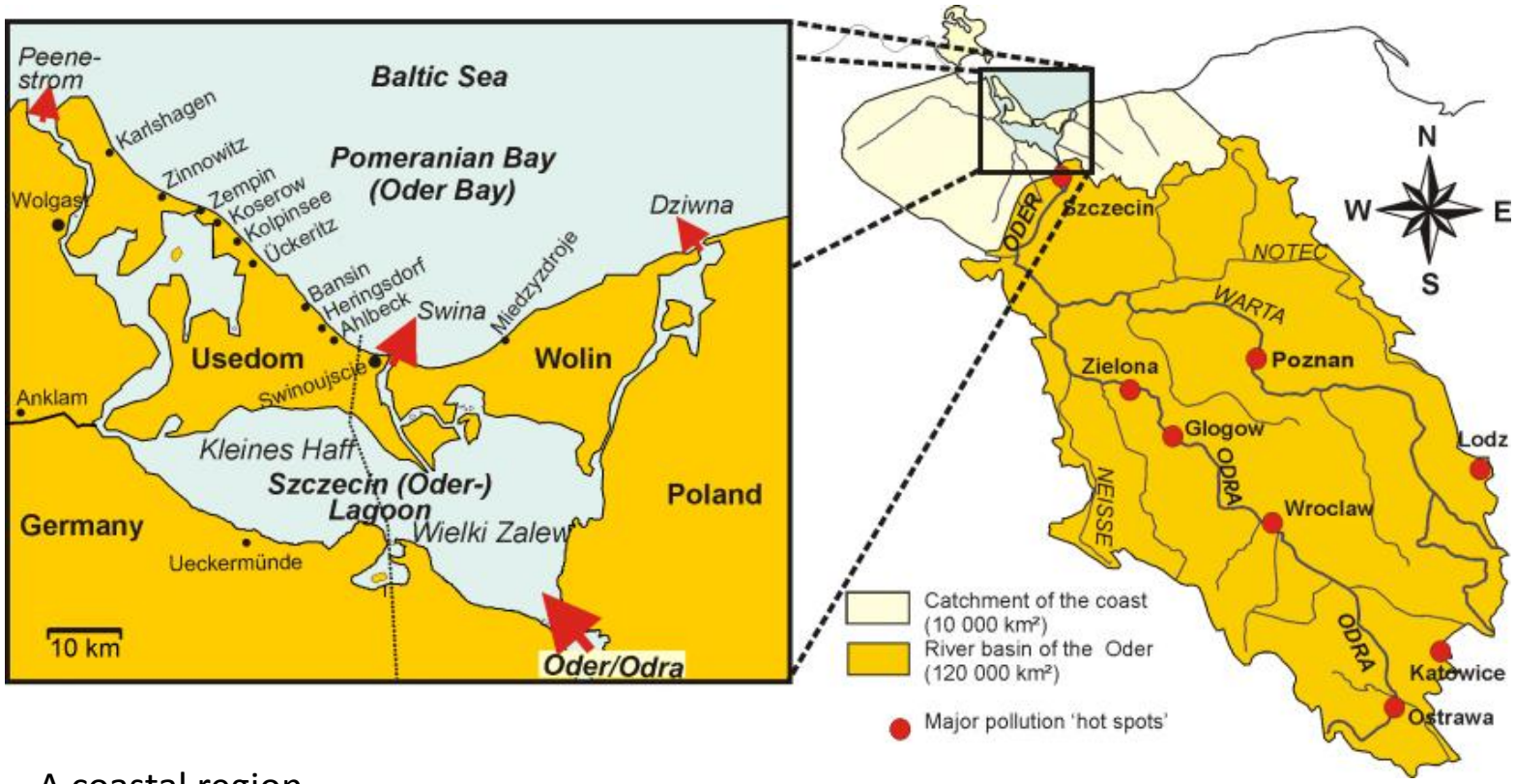
[2]Institut für ökologische Wirtschaftsforschung, Berlin

Destruction of the natural heritage:
Eutrophication

Pictures: Schernewski 2000

The Oder/Odra estuary case study



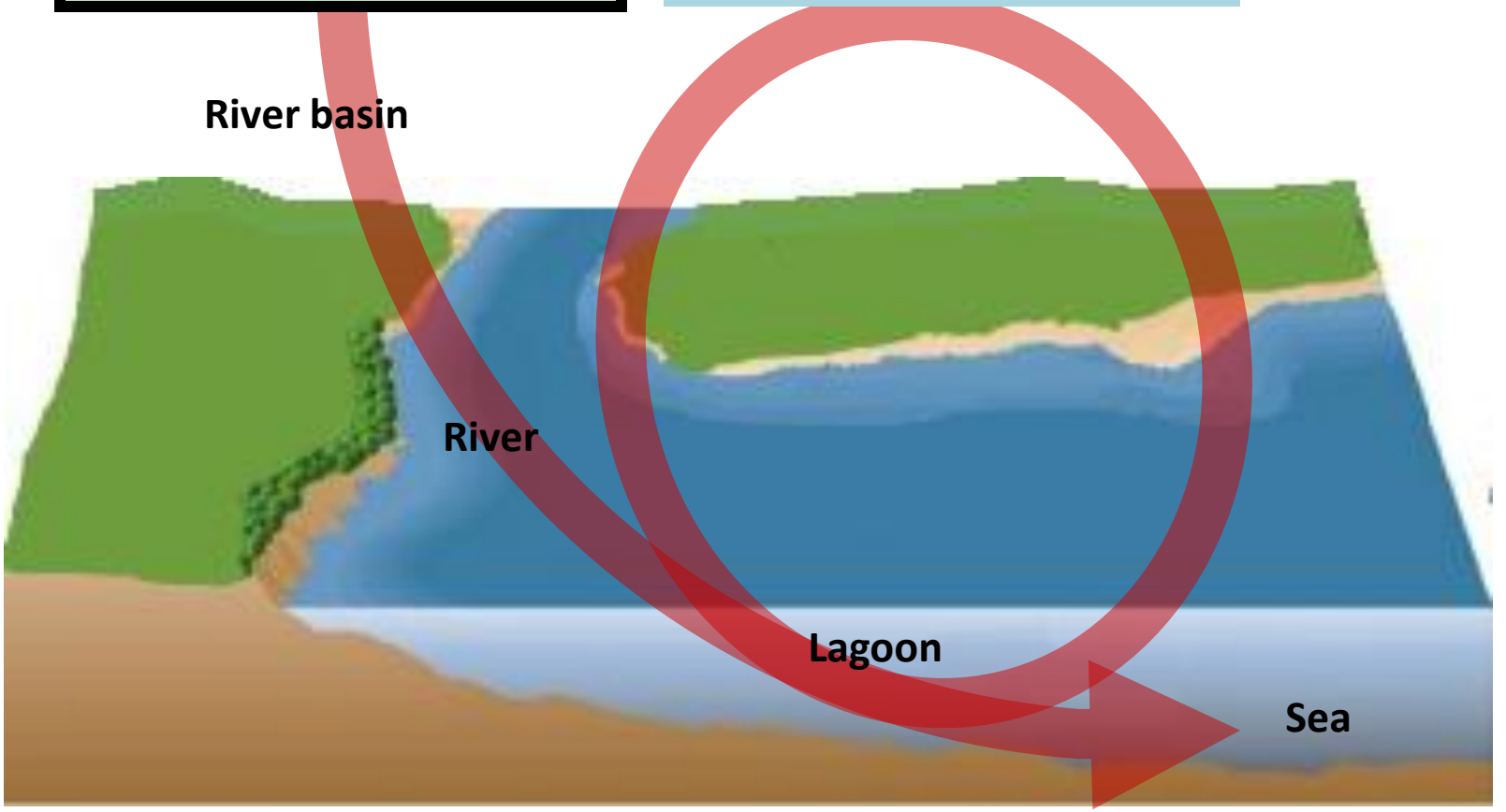
A coastal region

- characterized by a complex pattern of land, lagoons and sea
- divided between Germany and Poland and
- dominated by the Oder/Odra river basin

Managing eutrophication: Approaches

a) External river basin management to reduce nutrient loads

b) Internal lagoon management in a socio-economic framework



Managing eutrophication

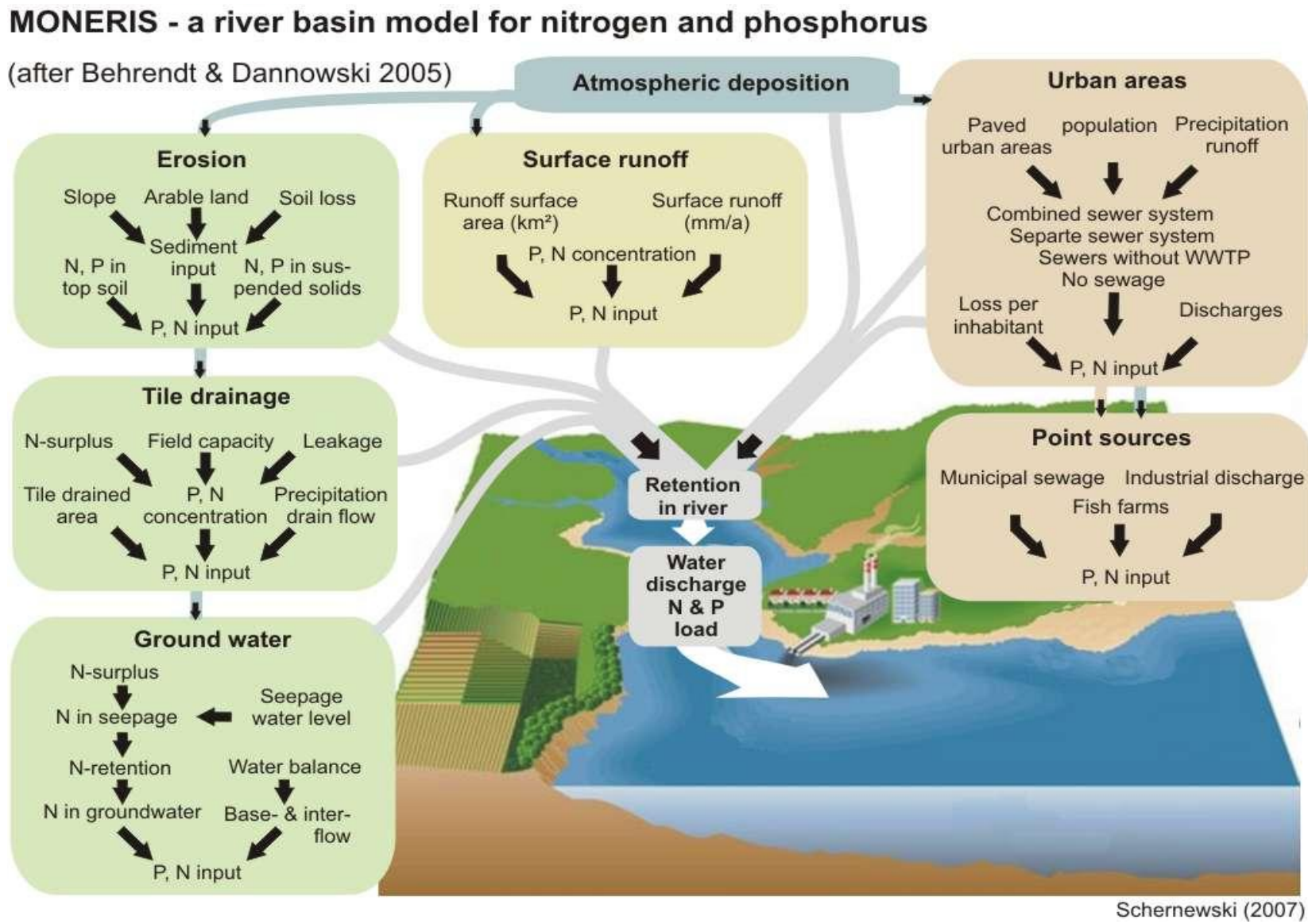
Questions

- To what extent can the nutrient load in the Oder River be reduced?
- Can we reach a good water quality status according to the Water Framework Directive via a river basin management? If not, what are realistic objectives?
- Should a nutrient load reduction and management efforts focus on nitrogen or on phosphorus?

Tasks

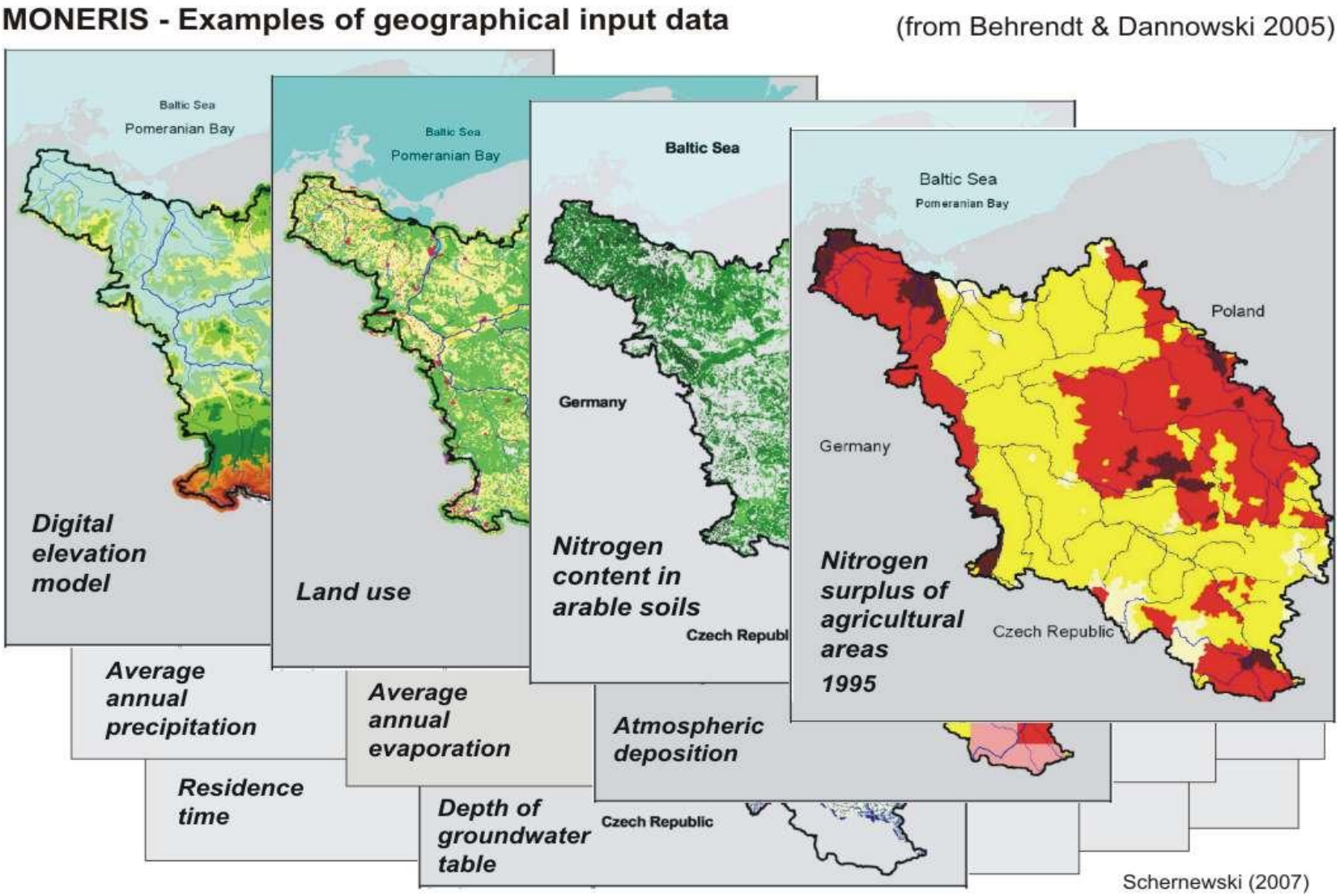
- To explain the long-term eutrophication history in the river and in the estuary and their causes;
- to assess the relationship between external loads and the water quality status, nutrient availability, limitation and algal biomass and
- to improve our understanding about sources, pathways and spatial origin of nutrient loads.

Managing eutrophication: Models



•Behrendt, H. [Hrsg.] ; Dannowski, R. [Hrsg.]: Nutrients and Heavy Metals in the Odra River System : Emissions from Point and Diffuse Sources, their Loads, and Scenario Calculations on Possible Changes; Weissensee Verlag Berlin

Managing eutrophication: Models



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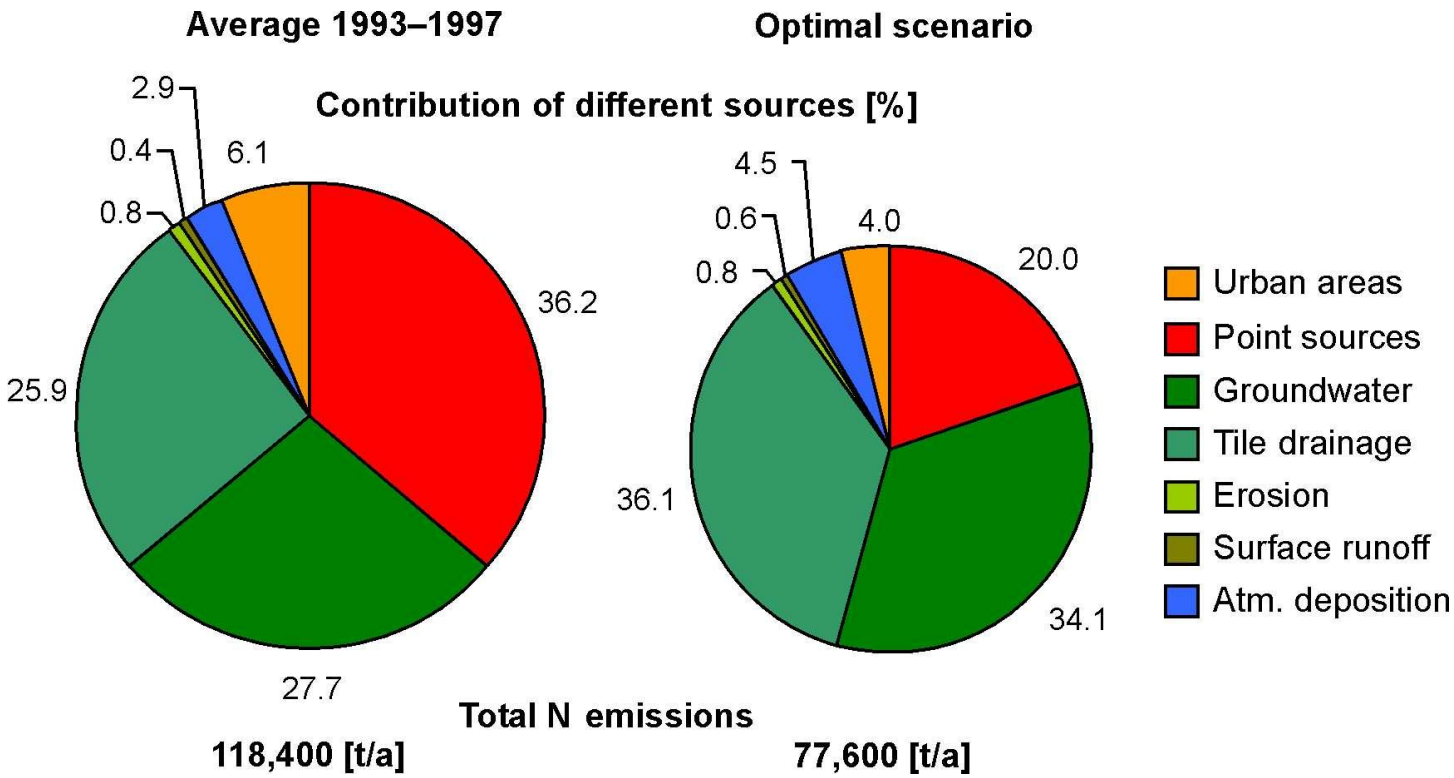
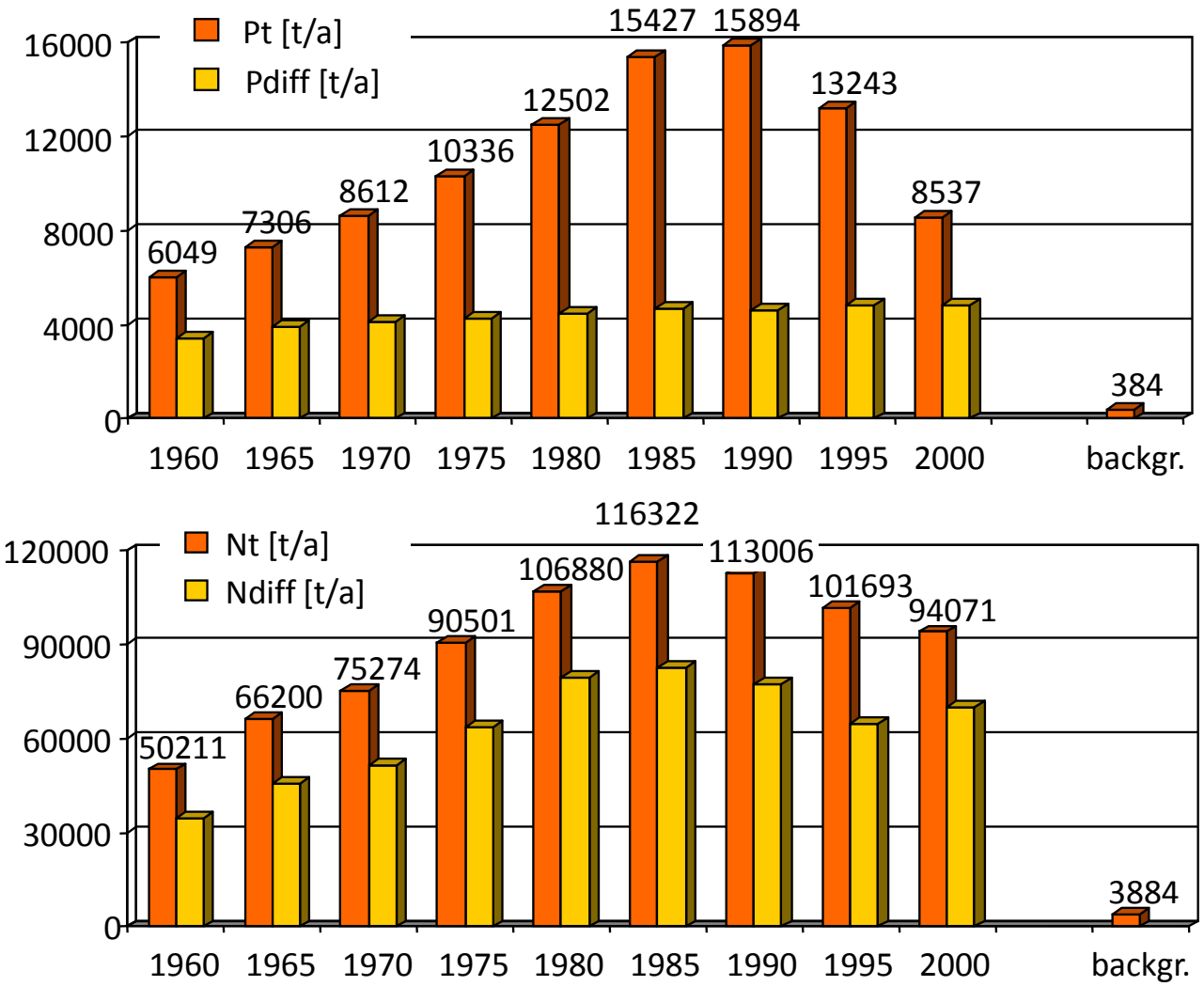
River basin management: N-Scenario



- The optimal load reduction szenario shows loads like in the late 1960‘s

Schernewski G. & H. Behrendt & T. Neumann (2008): An integrated river basin-coast-sea modelling scenario for nitrogen management in coastal waters. J Coastal Conservation

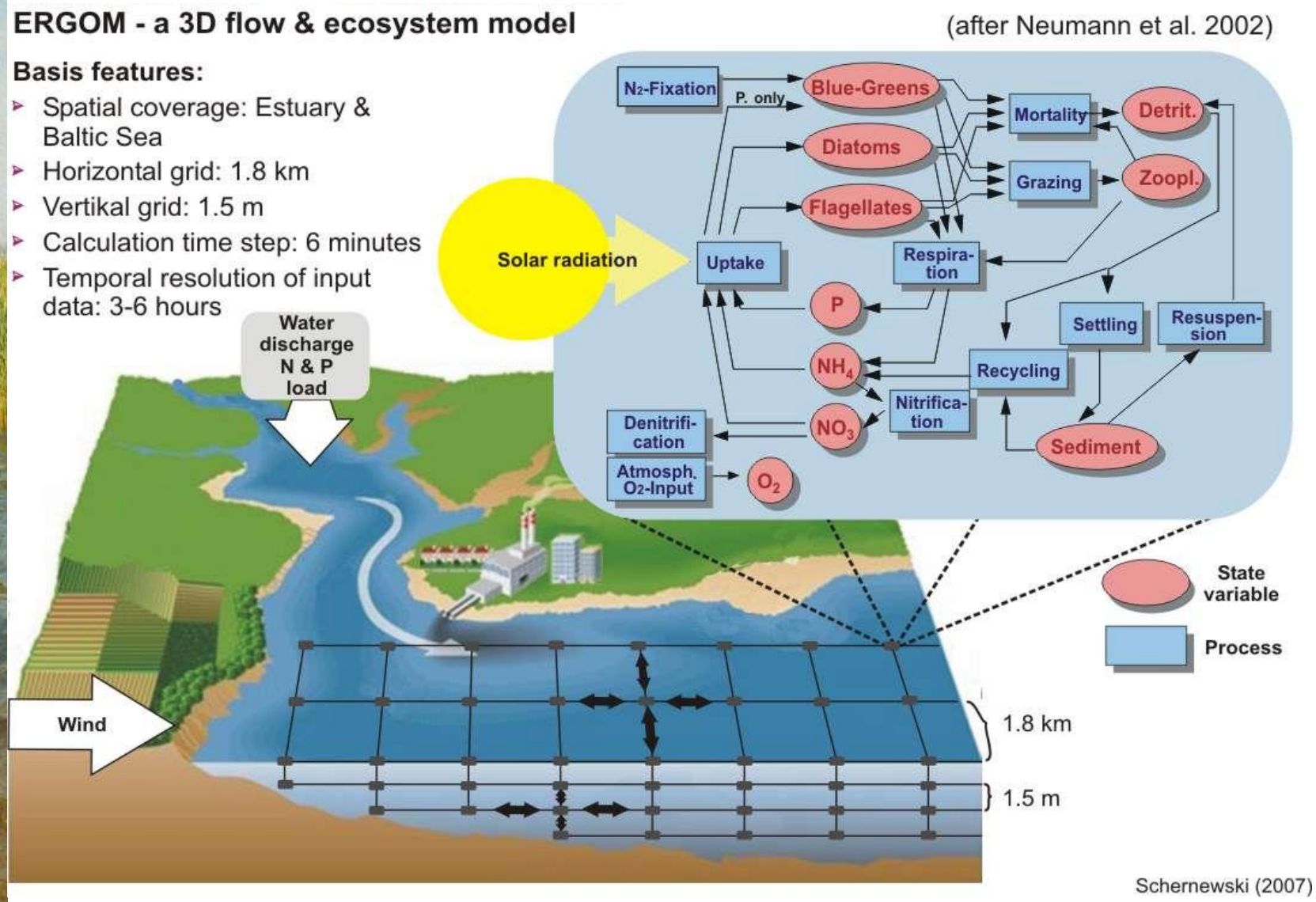
Eutrophication history: Long-term model simulations



Behrendt H, Dannowski R (eds) (2005) Nutrients and heavy metals in the Odra river system. Weißensee Verlag, Berlin

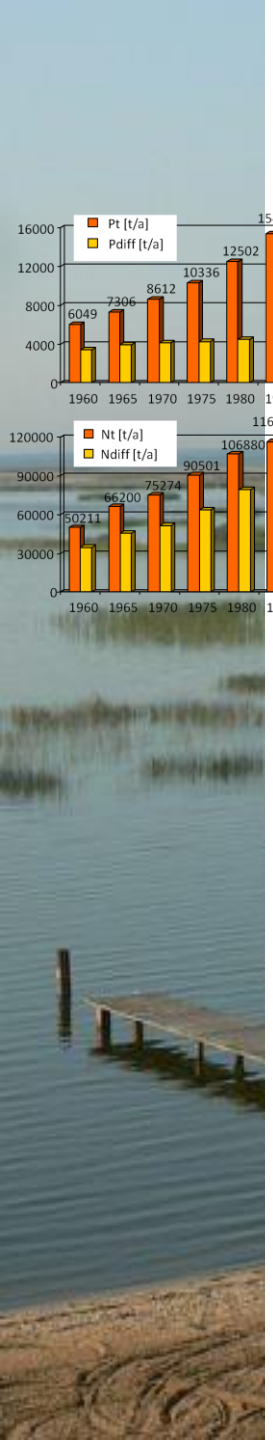
Behrendt et al. (2005)

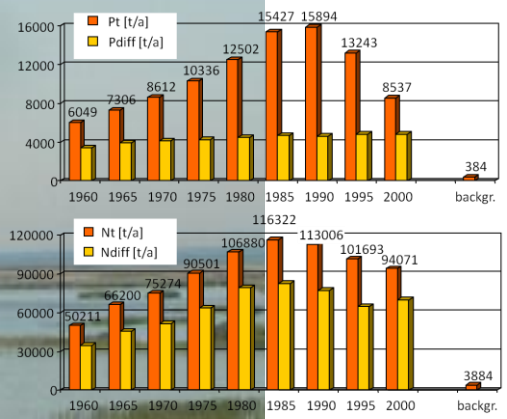
Managing eutrophication: Models

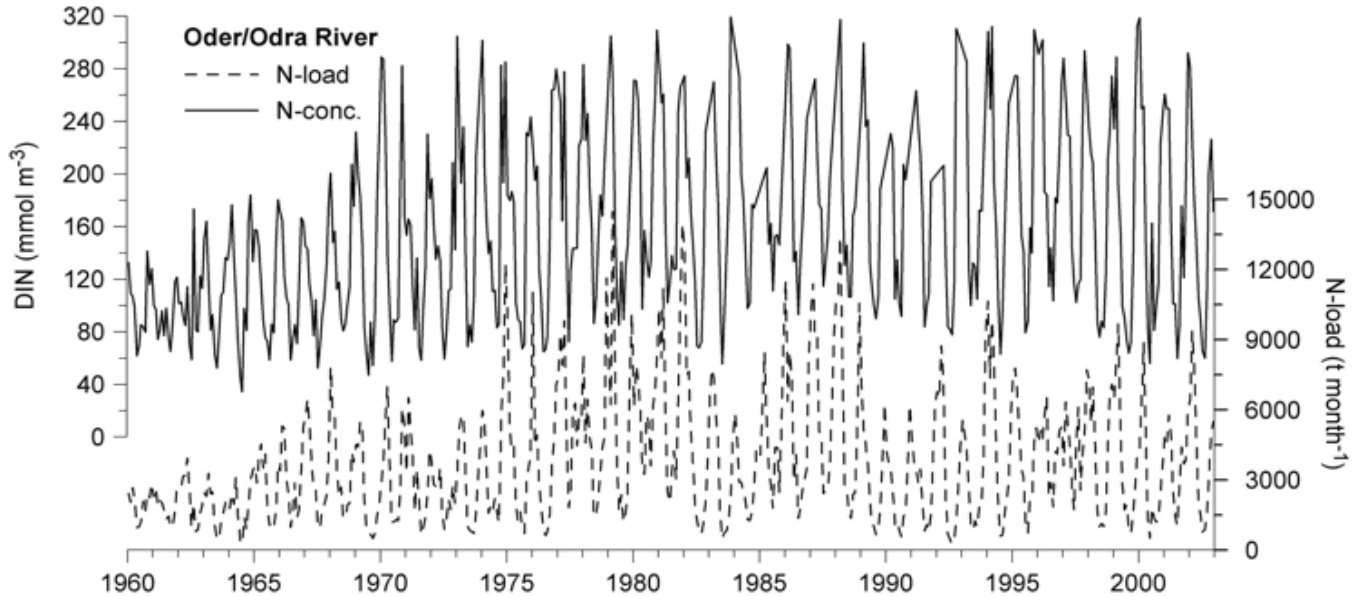


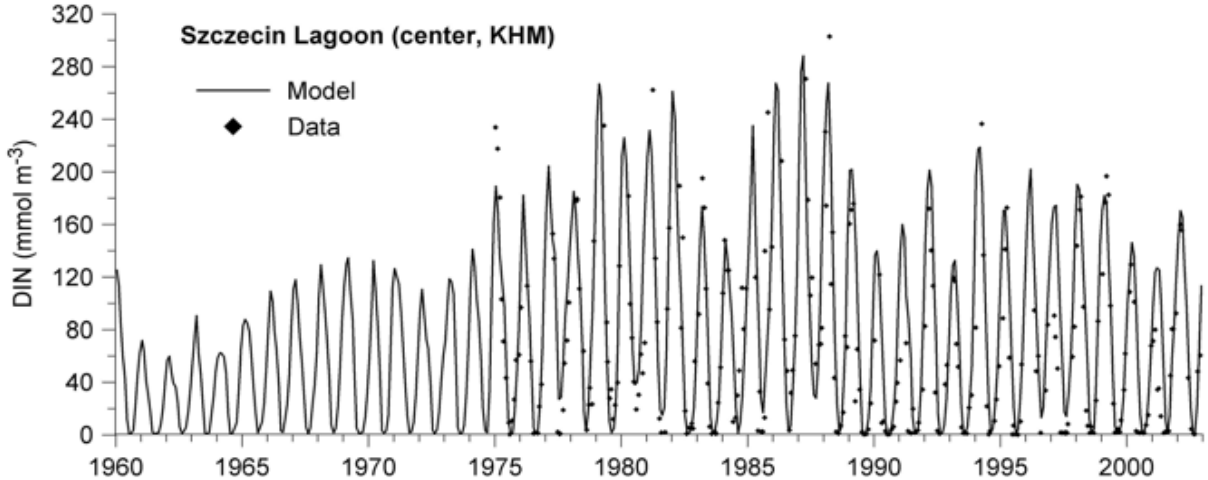
Neumann T, Fennel W, Kremp C (2002) Experimental simulations with an ecosystem model of the Baltic Sea: a nutrient load reduction experiment, Global Biogeochem. Cycles 16(7-1):7–19

Eutrophication history: Long-term model simulations









Schernewski, Neumann, Opitz & Venohr (submitted): Long-term eutrophication history and functional changes in a large Baltic river basin - estuarine system. Estuaries and Coasts

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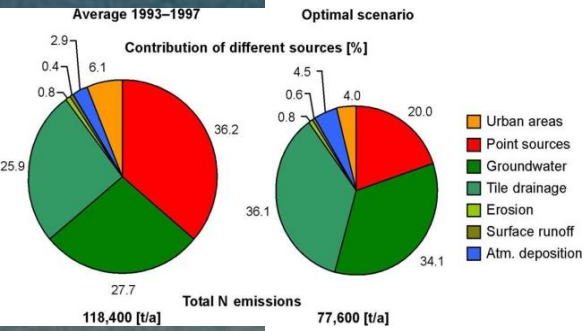

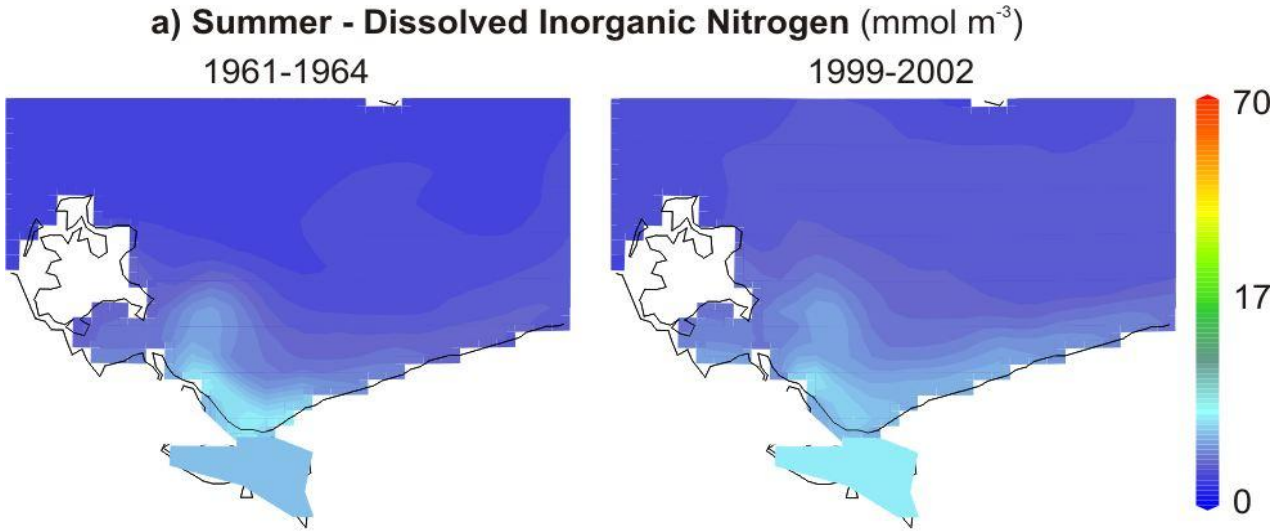

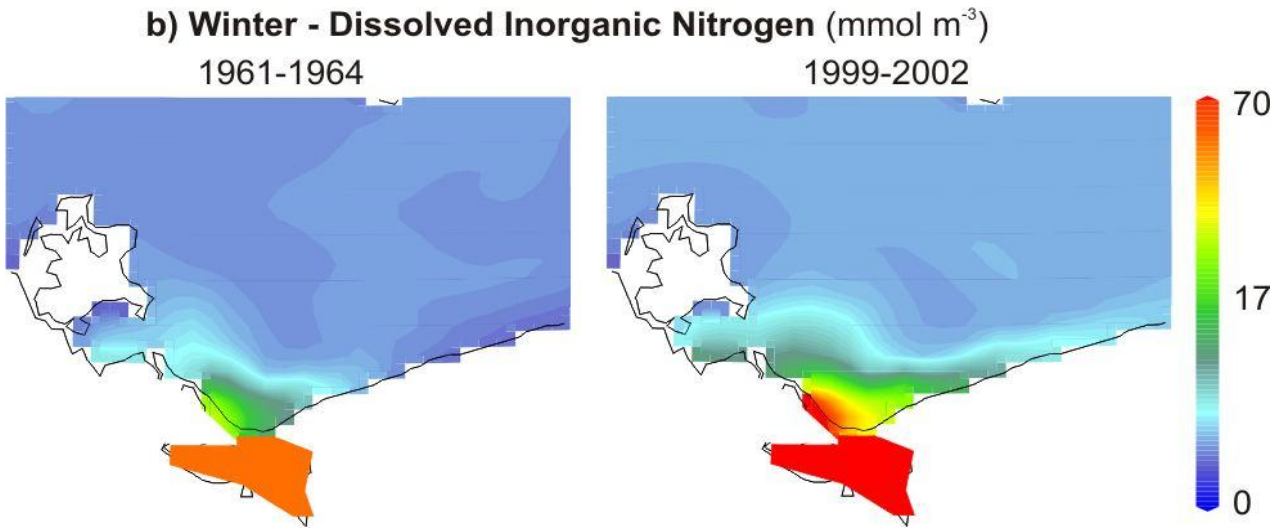

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2. Water quality objectives & nutrient loads

Suggestions for water quality objectives for the EU-Water Framework Directive

Oder/Odra river	Total-P	PO_4-P	Total-N	NH_4-N	Total-P	Total-N
	(average)	(average)	(average)	(average)	load	load
	(mg l^{-1})	(mg l^{-1})	(mg l^{-1})	(mg l^{-1})	(t a^{-1})	(t a^{-1})
Existing	0,1	0,07		0,3		
Suggestion	0,1	0,07	1,5	0,3	1700	25000

Oder Lagoon	Total-P	PO_4-P	Total-N	DIN	NO_3-N
	(average)	(winter)	(average)	(winter)	(winter)
	(mg l^{-1})	(mg l^{-1})	(mg l^{-1})	(mg l^{-1})	(mg l^{-1})
Existing	0,016	0,006	0,21	0,15	0,11
Suggestion	0,1	0,05	1,2	0,85	0,7

Schernewski, G., N. Stybel & T. Neumann (submitted): Ecological and economic aspects of eutrophication management in the southern Baltic: Odra/Oder river basin measures versus mussel farming. Ecology and Society

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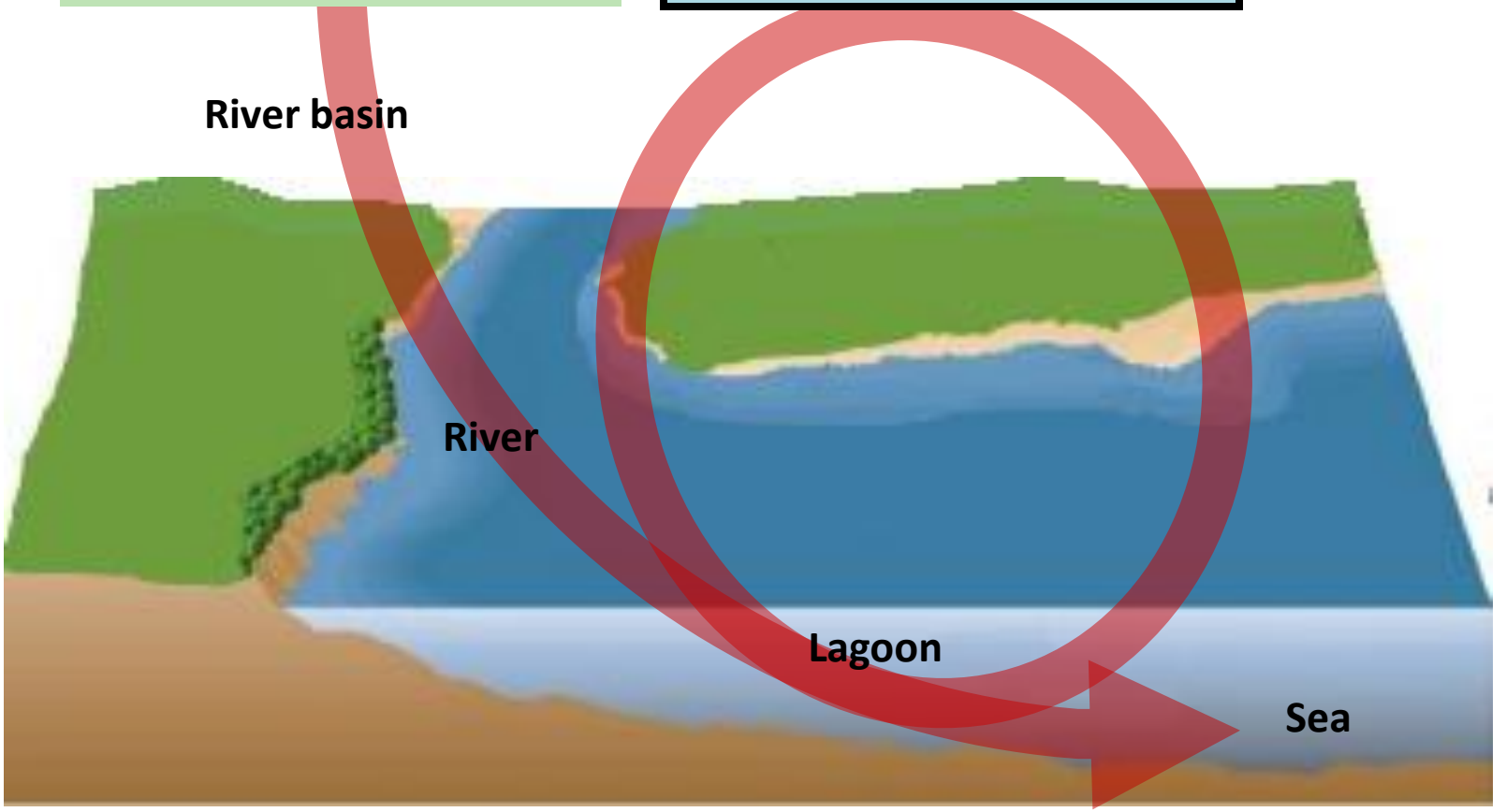
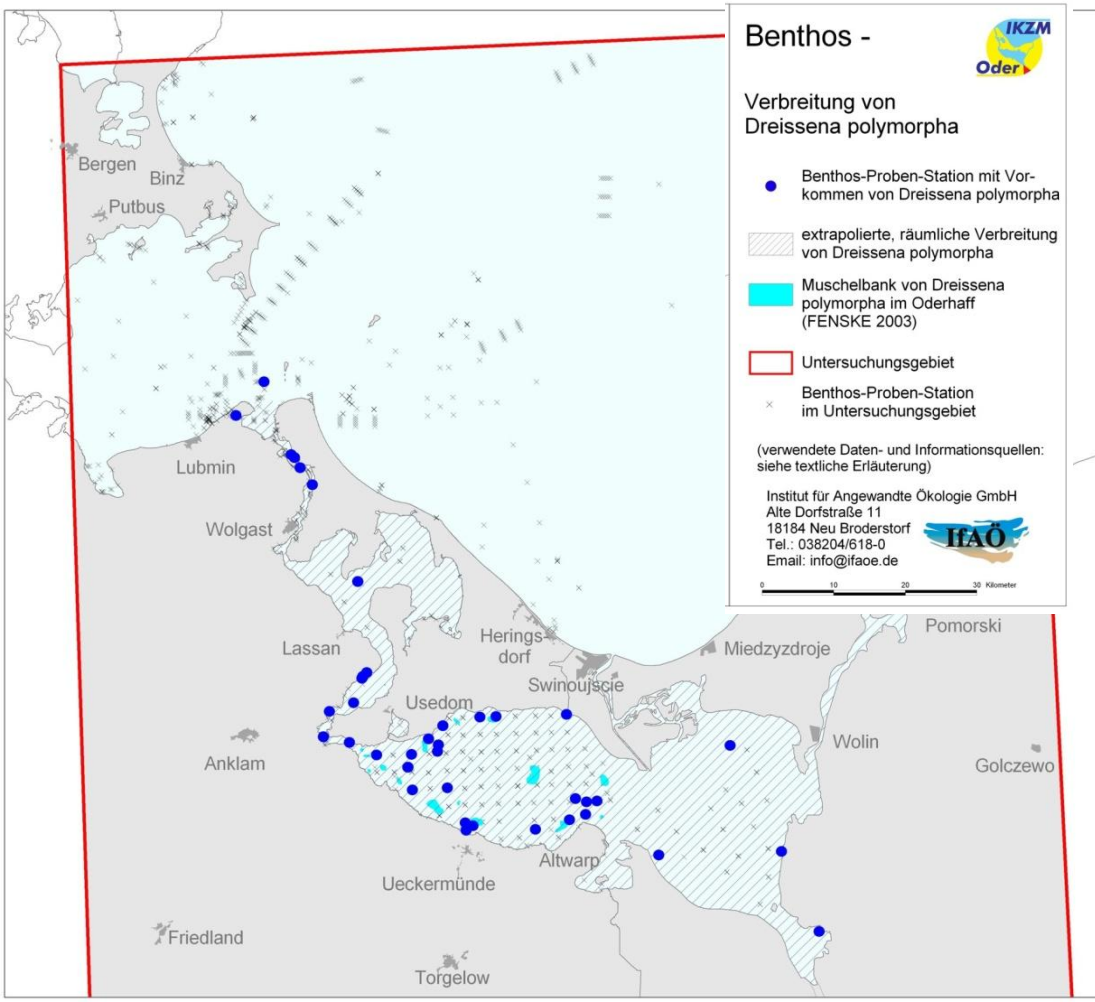


Zebra mussels in the Szczecin Lagoon

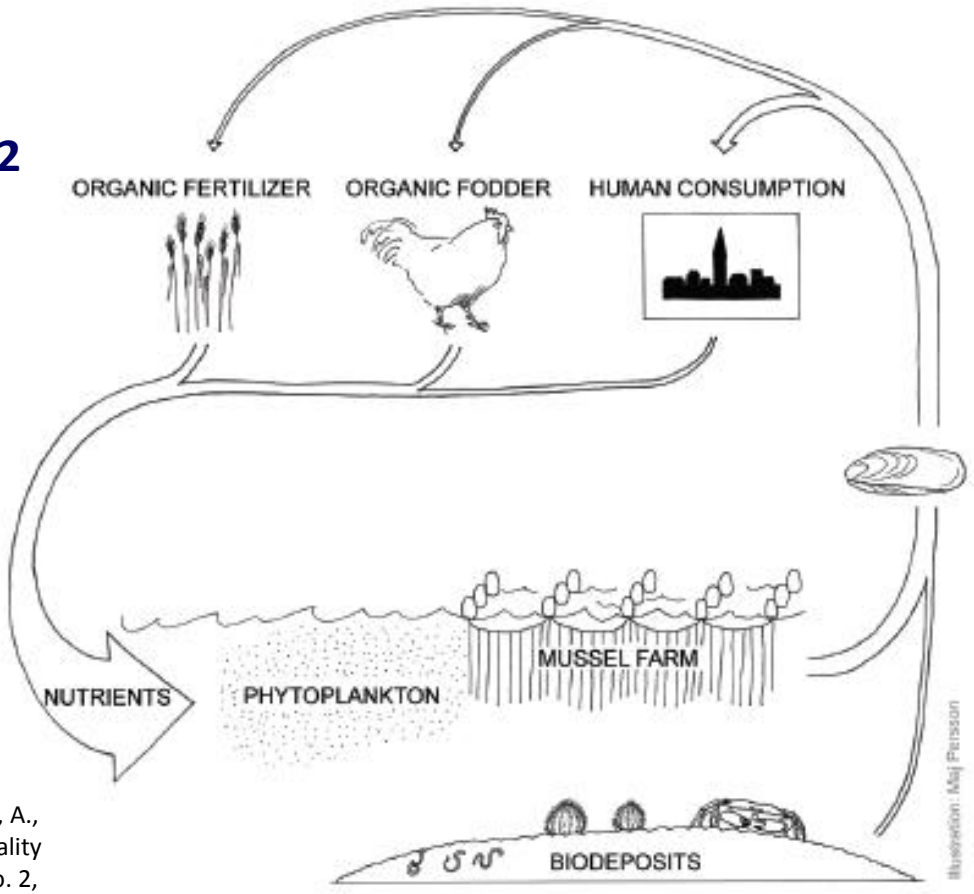


- **Biomass: 68,000 t**
- **Coverage in the German part: 2.4 %**
- **Average abundance on beds: 4000 mussels per m²**
- **Filtration rate: 1083 l m-2 d-1**
- **After 2 years**
  - size: 12-14 mm (max. 30)
  - weight: 500-1000 mg (max. 2500 mg)

(Data after Fenske, unpubl.; Woźniczka & Wolnomiejski unpubl.)

Water quality improvement by mussel cultivation

- **Enhancement of filtration capacity by cultivating on long lines or nets (increase of mussels from 4000 - 6400 per m²)**
- **Improved water transparency by higher filtration capacity**
- **Harvesting of 6.4 kg mussels per m² every 2 years**
- **Removing of 1% N per mussel (64 g N per m²)**
- **Mussels / mussel shells could be used for: human food, animal feed and fertilizer**

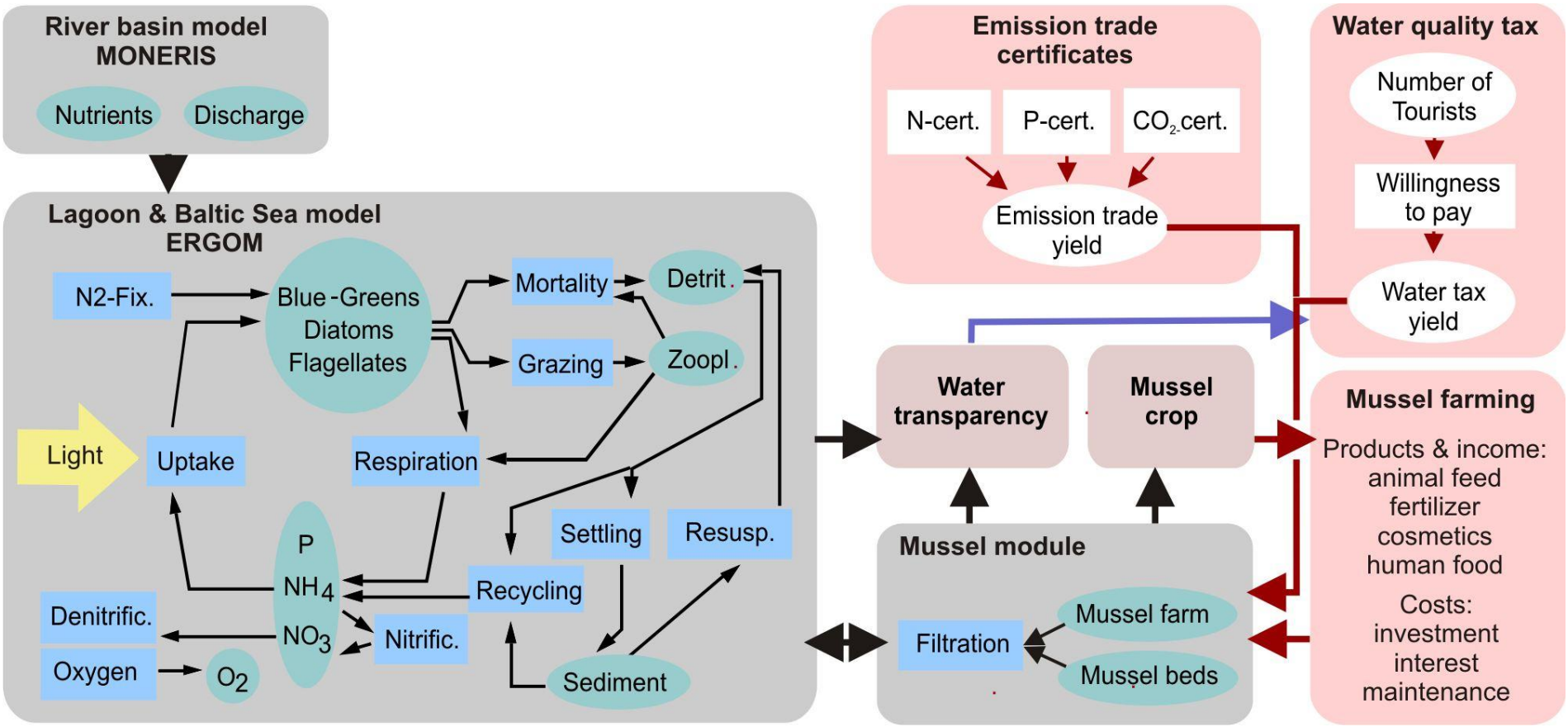


Lindahl et al. (2005)

Lindahl, O. Hart, R., Hernroth, B., Kollberg, S., Loo, L., Olrog, L., Rehnstam-Holm, A., Svensson, J., Svensson, S. and Syversen, U. (2005): Improving Marine Water Quality by Mussel Farming: A Profitable Solution for Swedish Society; Ambio Vol. 34, No. 2, pp. 131-138

4. Mussel farming – a solution?

The MONERIS- ERGOM system with extensions: Mussel module and economic model



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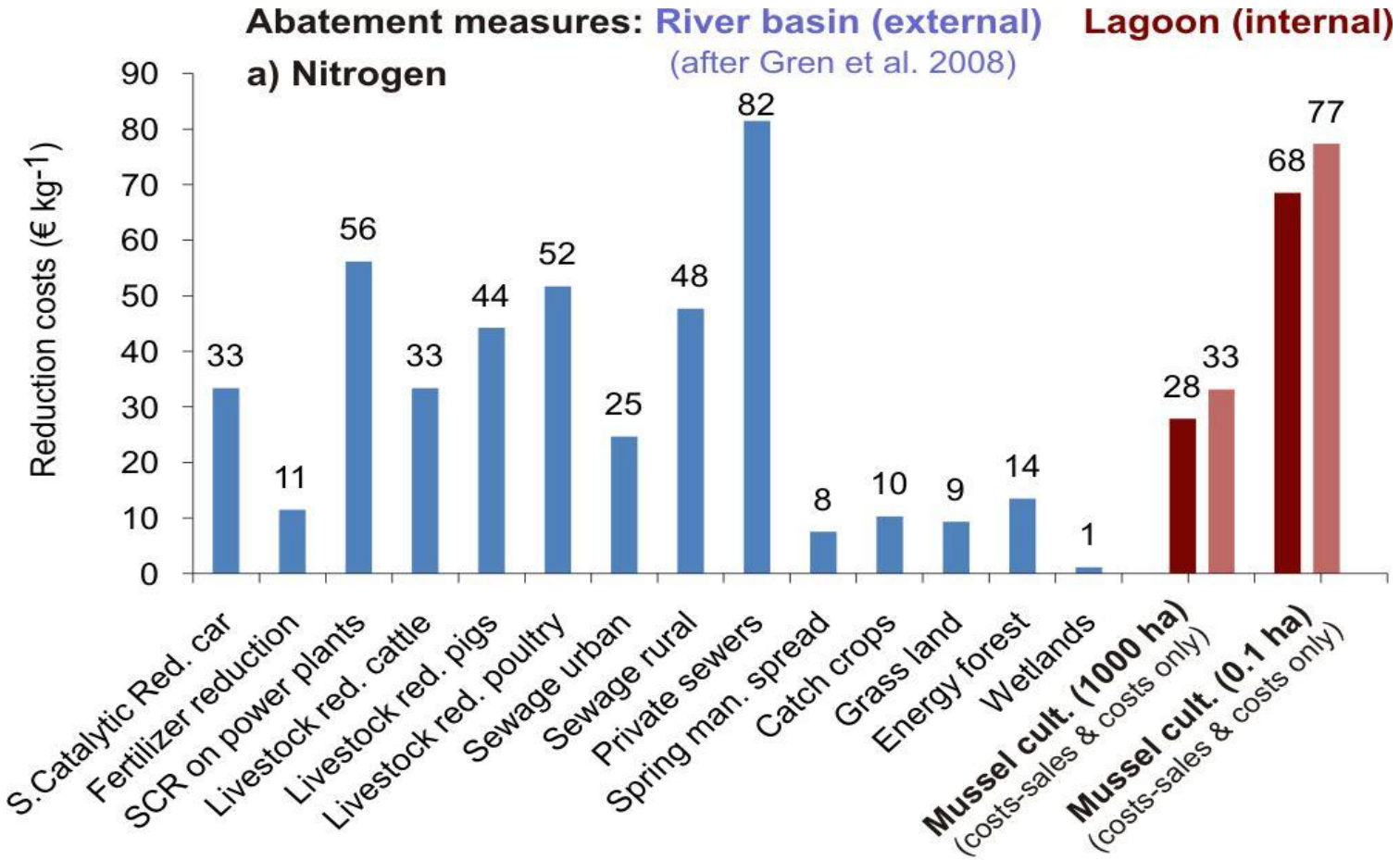
4. Mussel farming – a solution?

The cost-efficiency of nitrogen retention measures in the Oder river - coastal - sea system



Gren, I., Lindahl, O., Lindqvist, M., (2009) Values of mussel farming for combating eutrophication: An application to the Baltic Sea. Ecological Engineering 35(5):935–945

2. Water quality objectives & nutrient loads

Some conclusions (based on model simulations)

- The lagoon is a natural eutrophic system and a good water quality status cannnot be reached with external load reductions alone.
- N-load reductions reduce phytoplankton concentrations. Therefore, N reduction measures make sense.
- N-Fixation does and did not play an important role in the lagoon and will not compensate riverine N-load reductions
- Between 1960 and 2000 a temporal shift and changes in the availablity of N and P took place. A real, lasting nutrient limitation is and was un-likely.
- Denitrifikation in the lagoon declined from 26 % (1960er) to15 % (1999-2002) of the riverine loads. An increase in denitrifikation in the coastal Baltic Sea is observed.

Next steps

- Increased spatial resolution of ERGOM
- Extension of the approach to the entire German catchment/Baltic Sea

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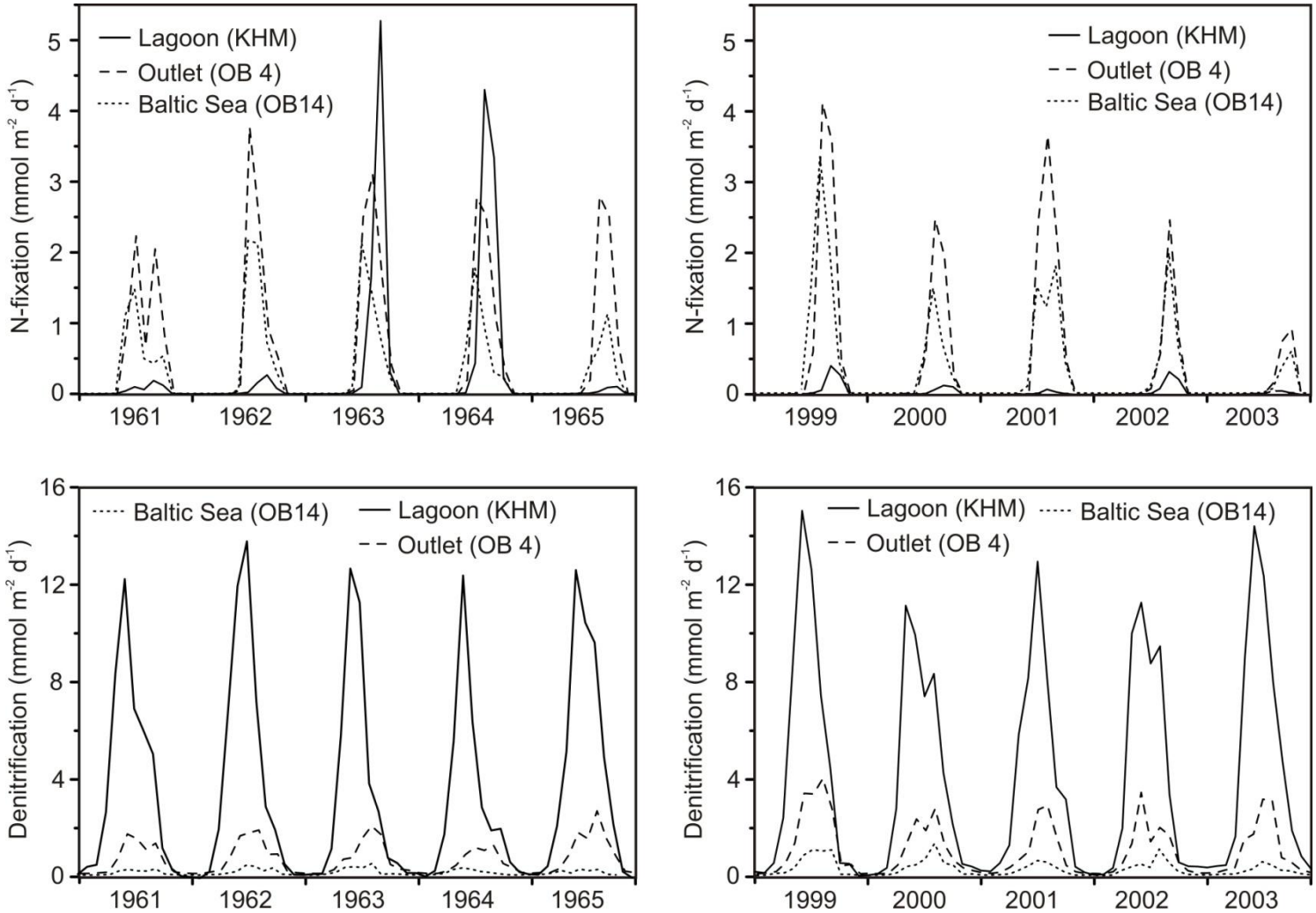
Thank you for your attention

Nitrogen fixation and denitrification in the Oder lagoon (1960-2002)



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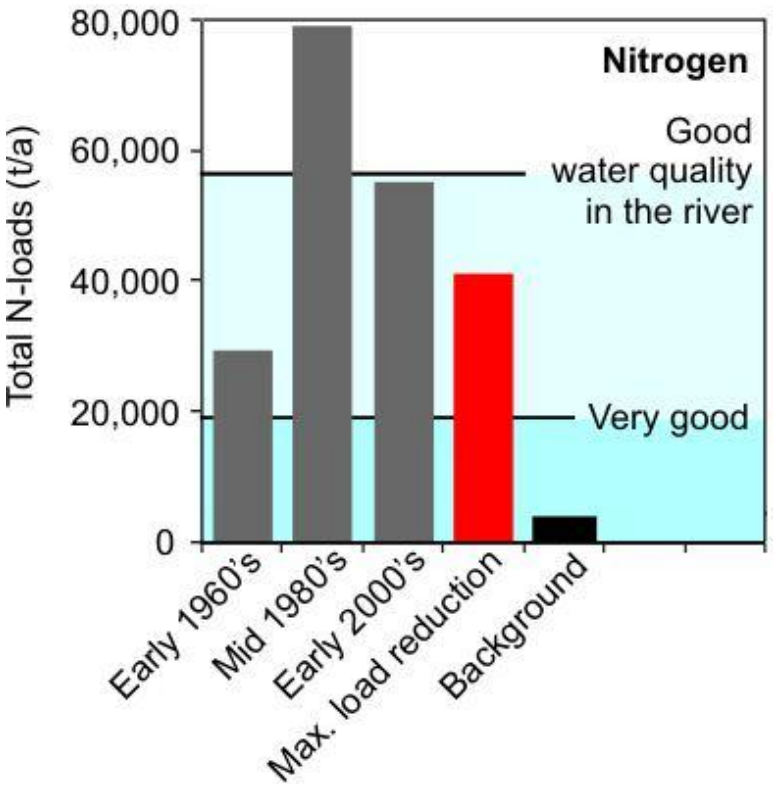
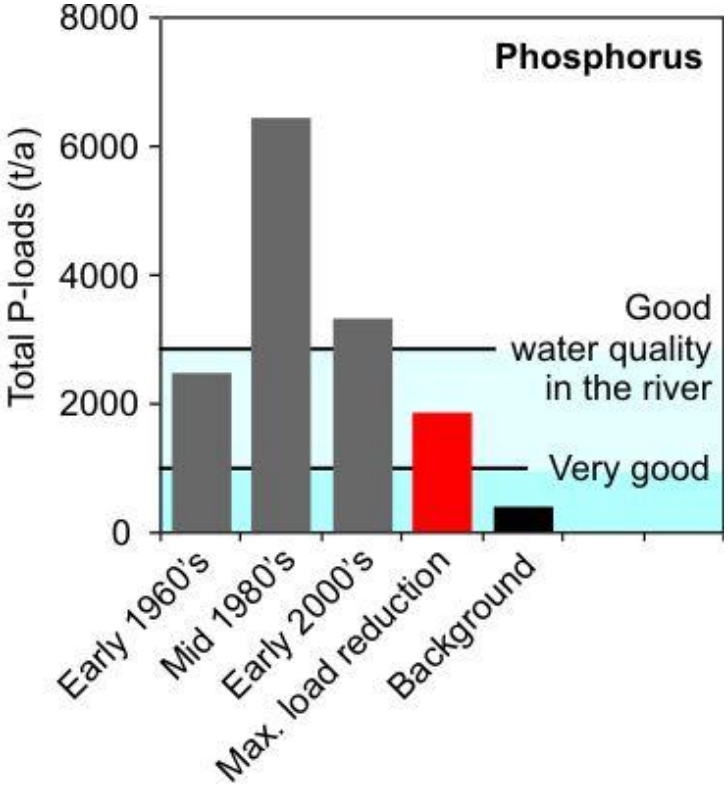
Water quality objectives in the river





- A „good water quality“ in the river is a realistic objective, but this will not cause a good status of coastal waters

Voss, Dippner, Korth, Neumann, Opitz, Schernewski, Venohr (in prep.) : History and future development of Baltic Sea eutrophication. Estuarine, Coastal and Shelf Science