BaltCoast

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Leibniz Institute for Baltic Sea Research Warnemünde
IOW

Zebra mussel farming in a Baltic lagoon

Towards an ICZM Systems Approach Framework

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BONUS
Science for a better future of the Baltic Sea region

BONUS 2010-2017: The joint Baltic Sea research and development programme
Call 2014: Sustainable ecosystem services

Project acronym: BaltCoast

Project full title: **A Systems Approach Framework for Coastal Research and Management in the Baltic**

Key theme addressed:
2.3. Integrated approaches to coastal management

Duration: **3 years, April 2015 – March 2018**
Total budget: **3 million Euro**

Starting point

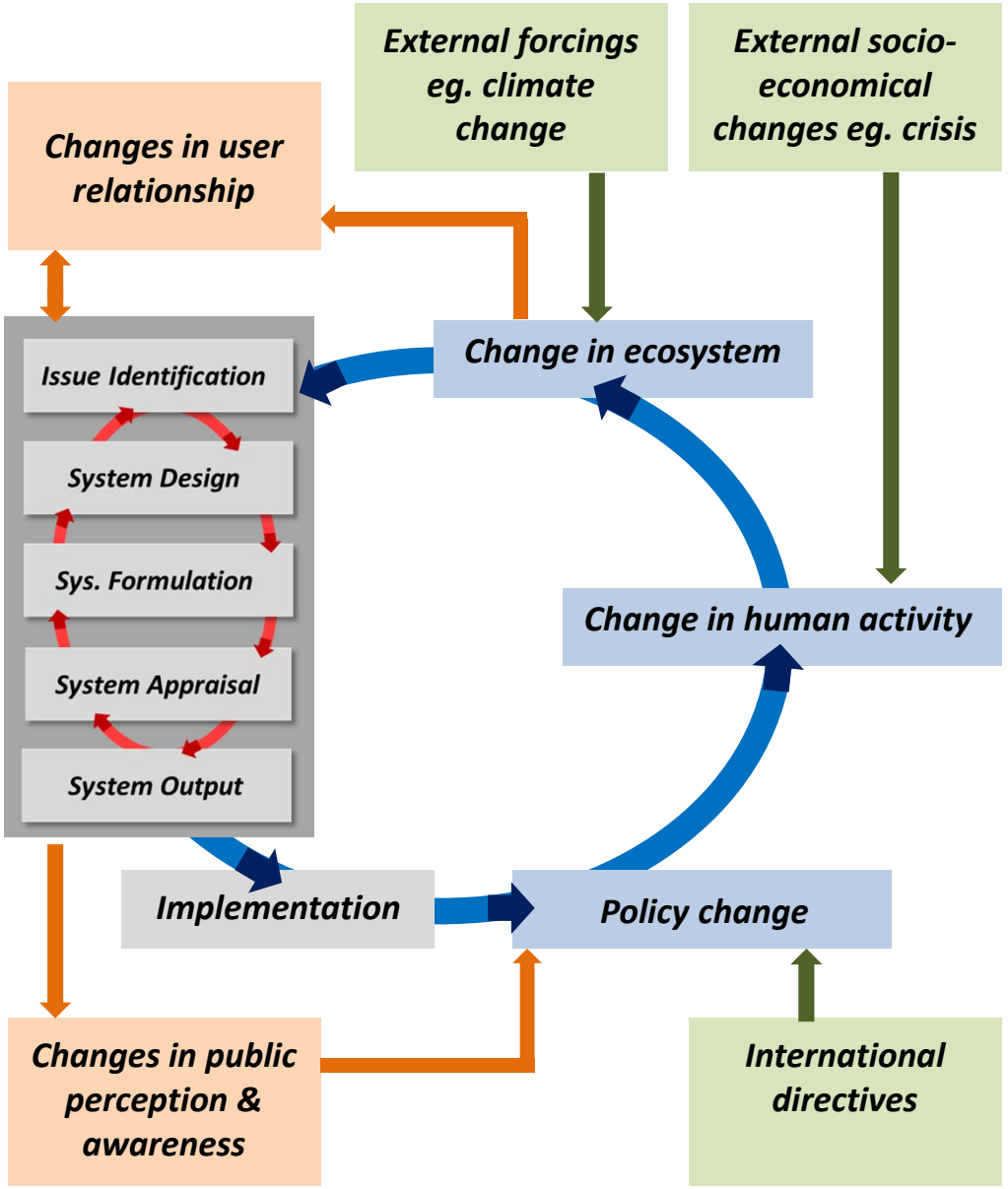
- **Repetition of scientific themes in 10-15 year cycles with little progress**
- **Insuffient transfer of scientific results/knowledge into practice**
- **Failure of the implementation of environmental measures/new approaches…**

Further development/adaptation of a Systems Approach Framework (for coastal systems) that serves as a systematic approach to integrate different disciplines, practitioners and end-users as well as to integrate natural, social and economic sciences…

….it builds upon previous results (SPICOSA, OURCOAST, SUSTAIN)

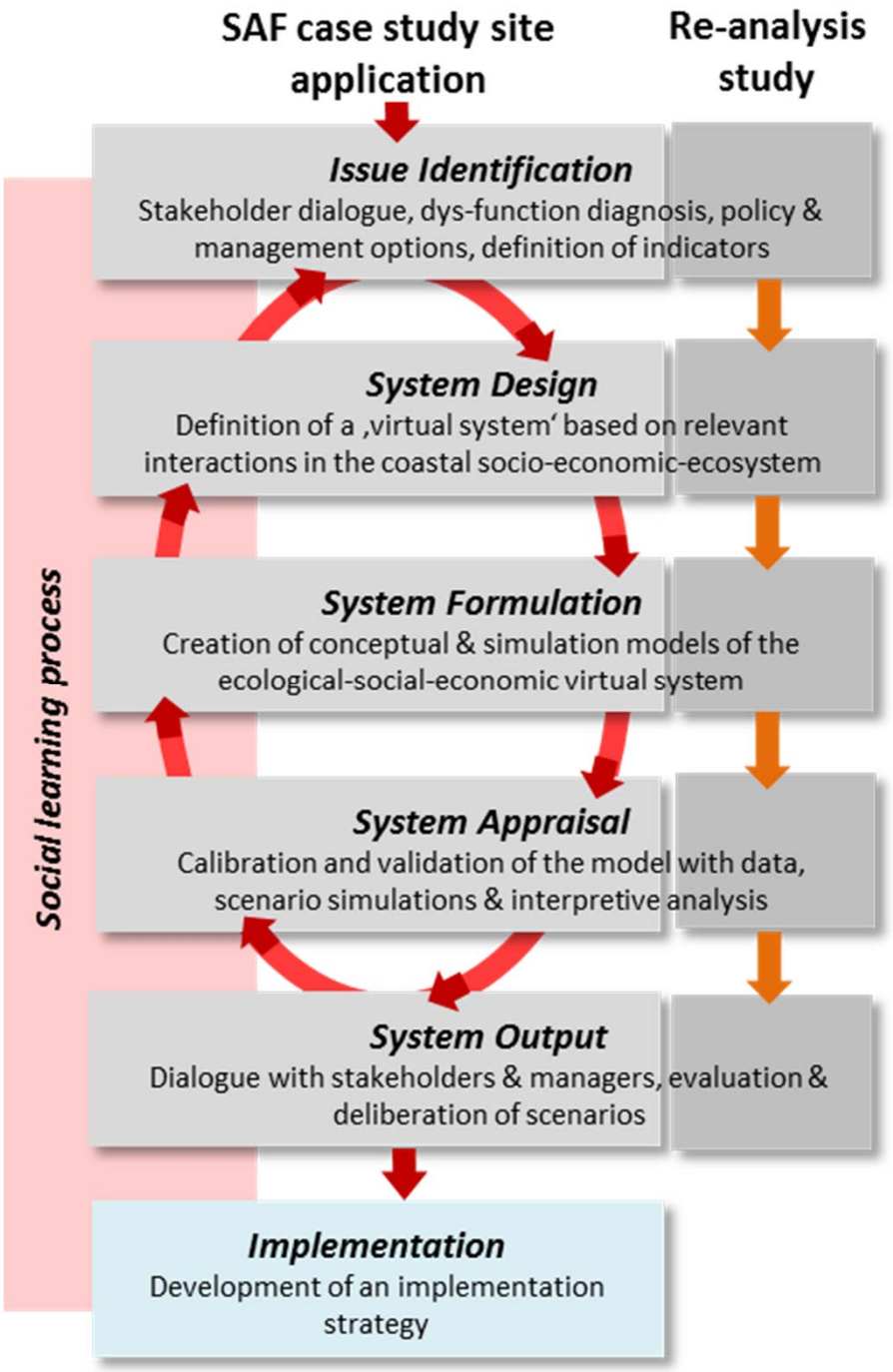
Systems Approach Framework (SAF)

Systems Theory is about understanding complex and large-scale interactions based on our perceptions of the world. It requires broad multi-disciplinary experience as is represents a mixture of scientific knowledge and intuition needed to understand the behaviour of complex systems (Hopkins et al. 2011).



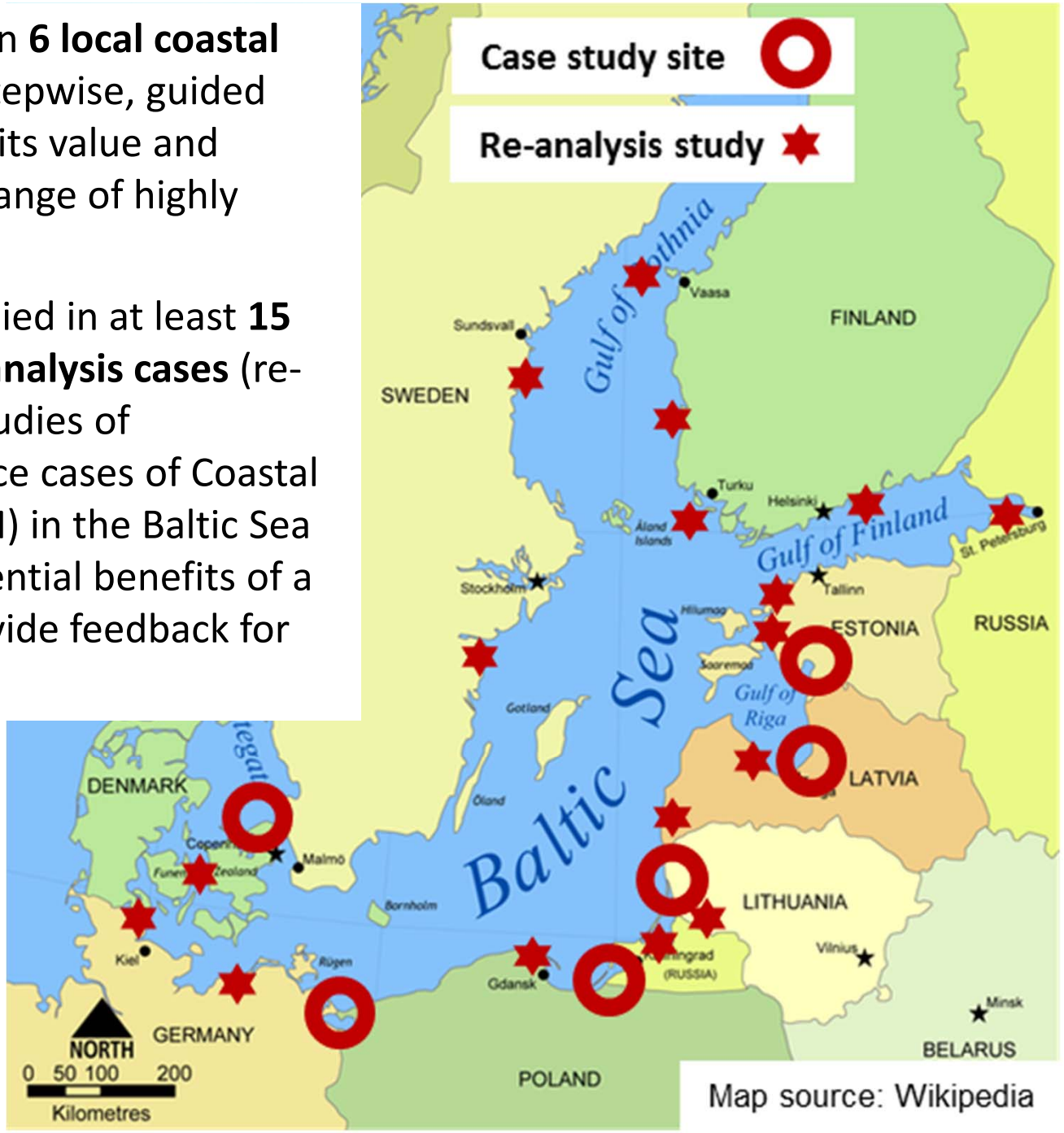
Ecological-Social-Ecomomic Assessment

within the Systems Approach Framework (SAF)



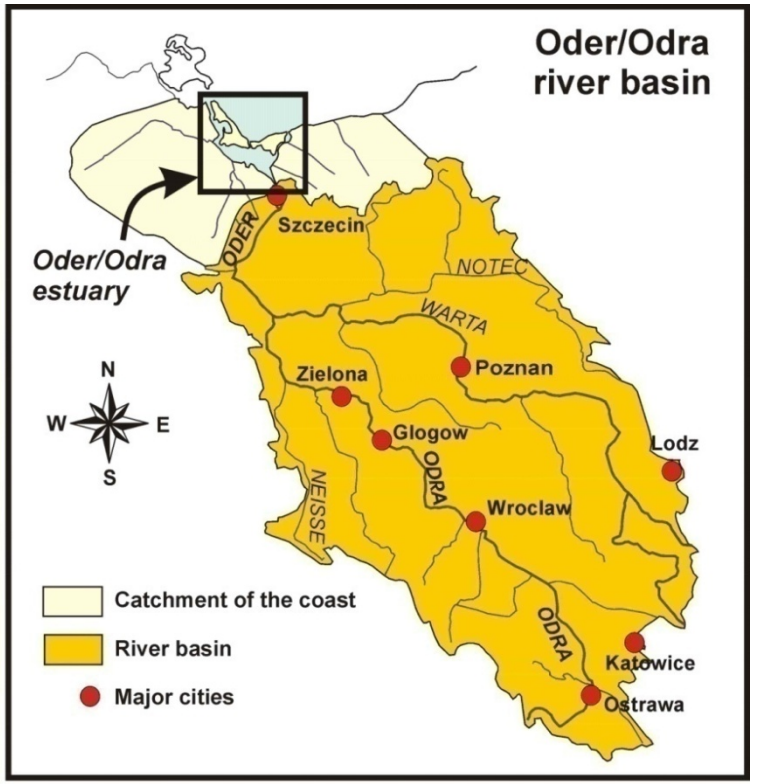
The SAF will be applied in **6 local coastal case studies (CSS)** in a stepwise, guided process to demonstrate its value and applicability for a wide range of highly relevant

The SAF will also be applied in at least **15 in-depth retrospective analysis cases** (re-analyses). Re-analysis studies of documented best practice cases of Coastal Zone Management (CZM) in the Baltic Sea region highlight the potential benefits of a SAF application and provide feedback for SAF improvement.



Map source: Wikipedia

The Oder (Szczecin) Lagoon



Oder/Odra river basin

Length (km):	854
Catchment (km²):	118,000
Discharge (m³/s):	530 (average)
Population (Mio):	15.4

Oder/Odra estuary

Catchment (km²):	8000
Lagoon area (km²):	687
Lagoon depth (m):	3.7 (average)

Coastal climate:

Temperature (°C):	8.7 (average)
Precipiation (mm):	550

Eutrophication – the major problem

- Poor transparency
- Frequent algal blooms
- Temporal hypoxia

Pictures: Schernewski 2000

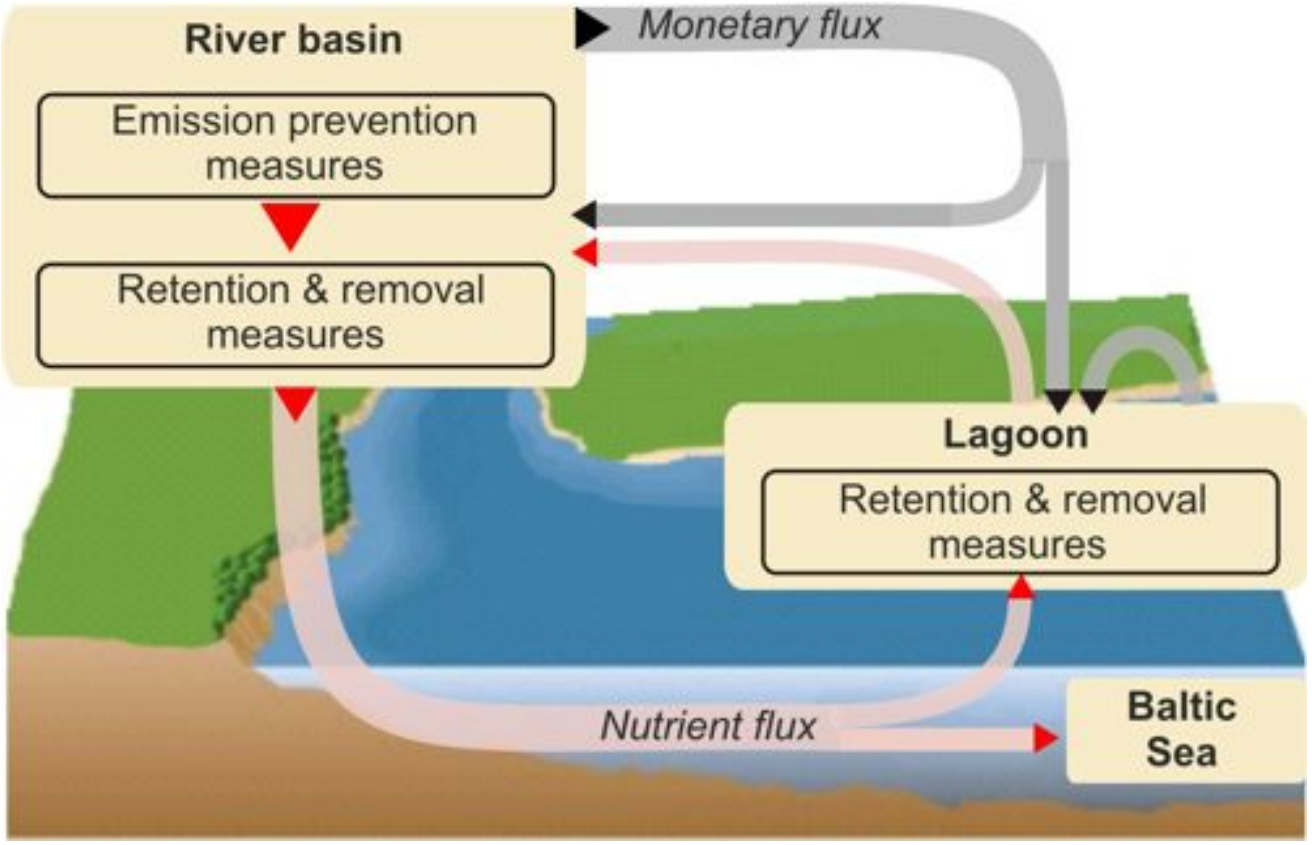
Lessons learnt and starting point in the Oder lagoon

Integrated river basin-coast-sea modeling and management approaches for German Baltic waters revealed that

- water quality (chl.a-concentrations) in lagoons and coastal bays (very likely) would strongly benefit from a nutrient (especially nitrogen) load reduction, much more than the open Baltic Sea;
- the present focus on phosphorus load reductions in the Baltic Sea Action Plan neglects our lagoons and bays;
- nutrient load reductions beyond the present state are very hard to implement and
- reliable and differentiated water quality objectives are of outstanding importance for the implementation of WDF and improved water quality. Lagoons and bays are individuals and each system requires specific water quality objectives (on water body level not WFD-type specific);

Are load reductions measures in the river basin still the only solution?

No ! We need to consider supportive nutrient retention measures in coastal waters!



And we should consider internal measures that have a direct effect on coastal ecosystem quality!

Internal measures to improve water quality

What is new with respect to mussel farming and why now?

- Enlargement of natural mussel beds
- Bio-manipulation (selective fisheries)
- Macro algae cultivation
- Enlargement and management of macrophyte areas

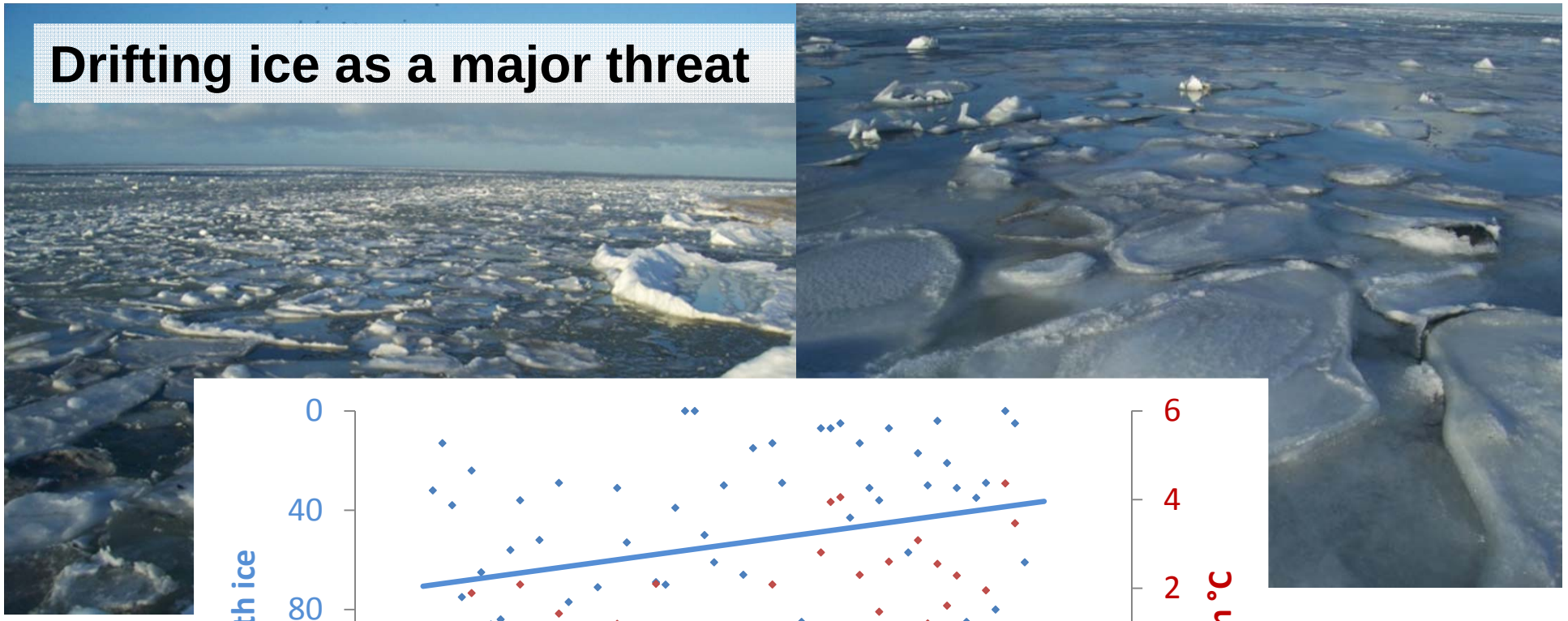
Mechanical:

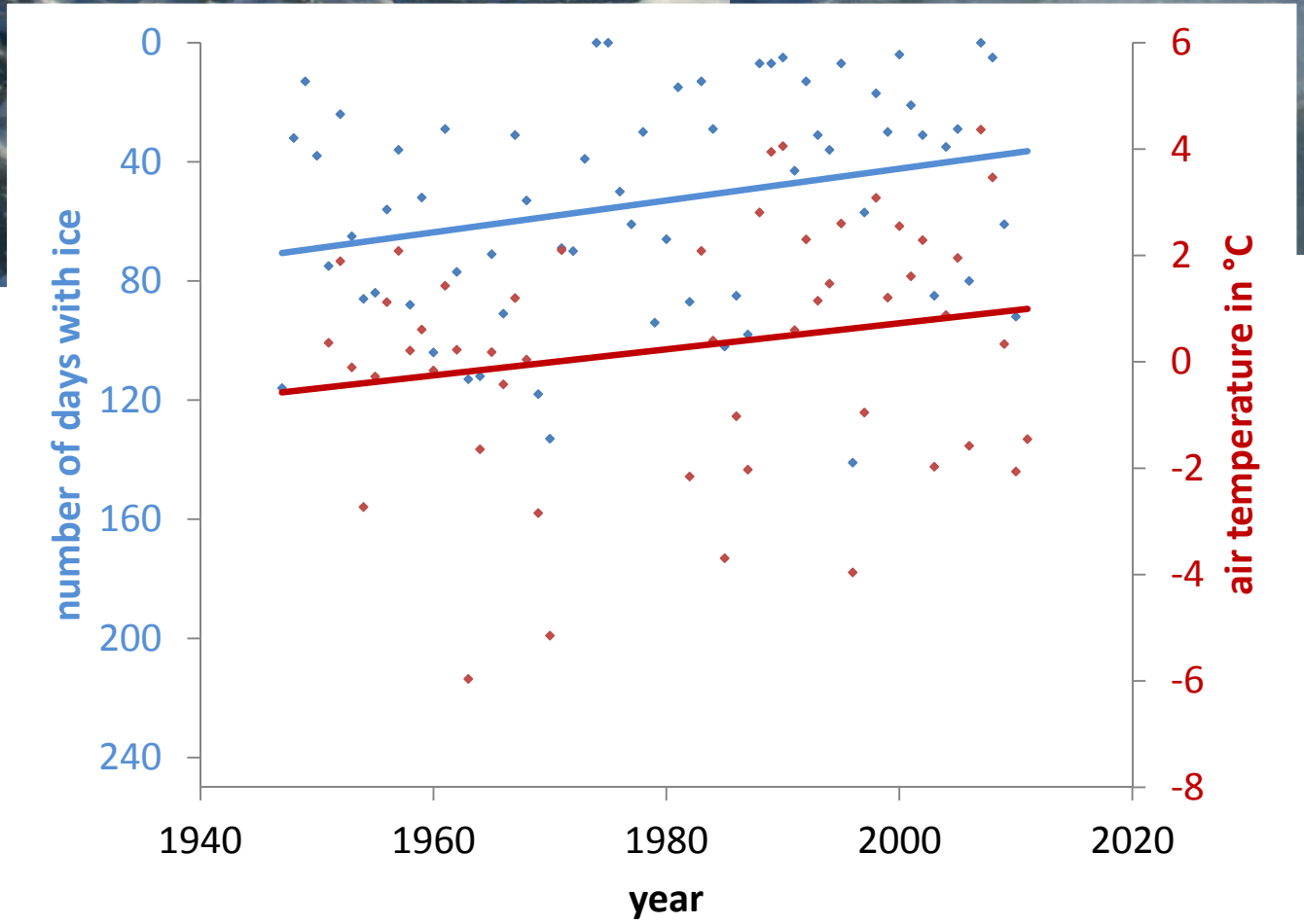
- Groin rows to support sedimentation
- Dredging of sediment and dumping on land
- Sediment capping to prohibit nutrient release from sediments

Chemical:

- Precipitation of nutrients

Drifting ice as a major threat

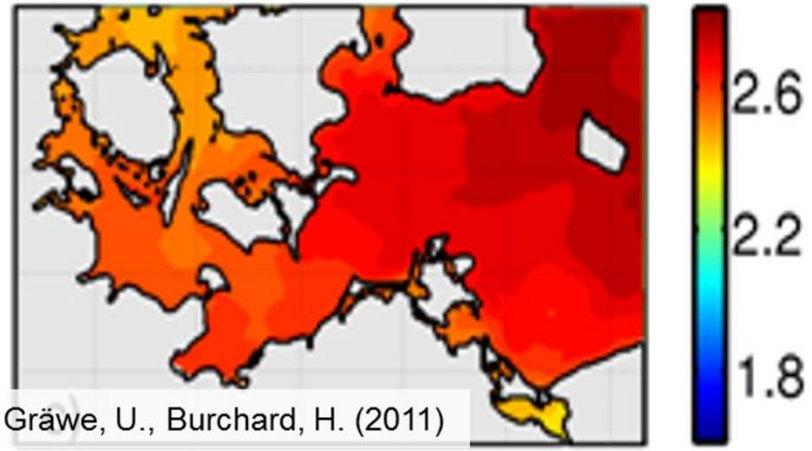




Impact of Climate Change on the Baltic Sea: Increasing temperatures and less ice-cover

According to szenario A1B, the Baltic Sea **surface temperatur** will

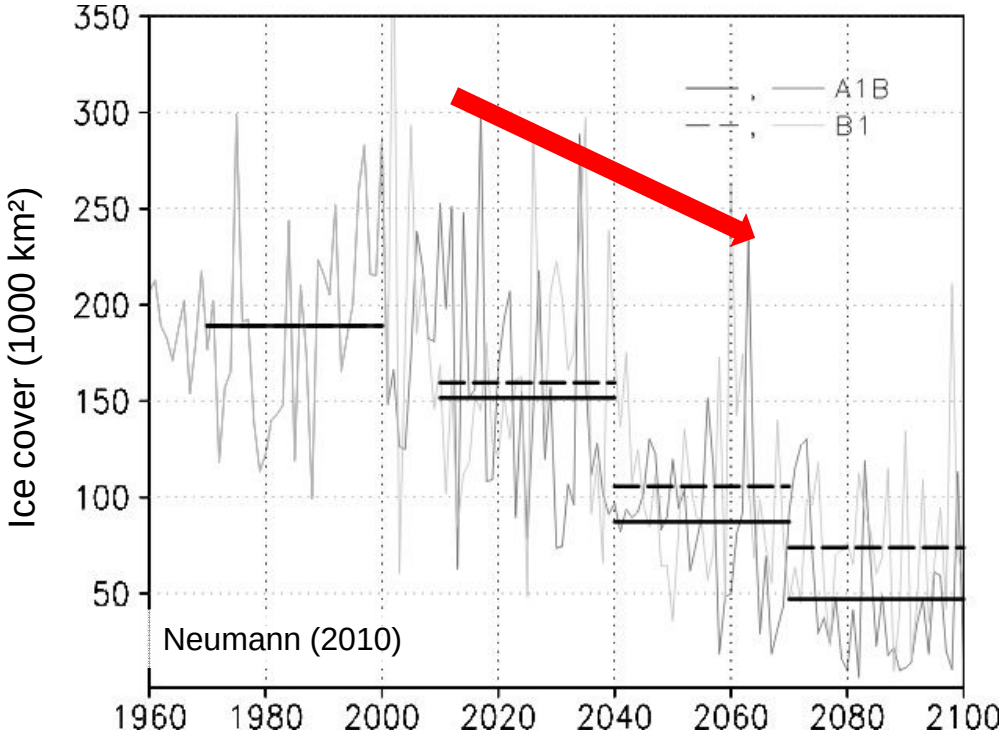
- increase by about 0,9°C (2,5°C) in the period 2020-2050 (2070-2100) similiar to the air temperature and
- extent the growing season for mussels



Gräwe, U., Burchard, H. (2011)

At the end of this century winterly ice cover will be

- restricted to northern Scandinavia and
- ice along the German Baltic coast will become the exception.



Blue-mussel farming near Kiel

Smaller mussels with higher meat contents – but the tradition in the Baltic is lacking!

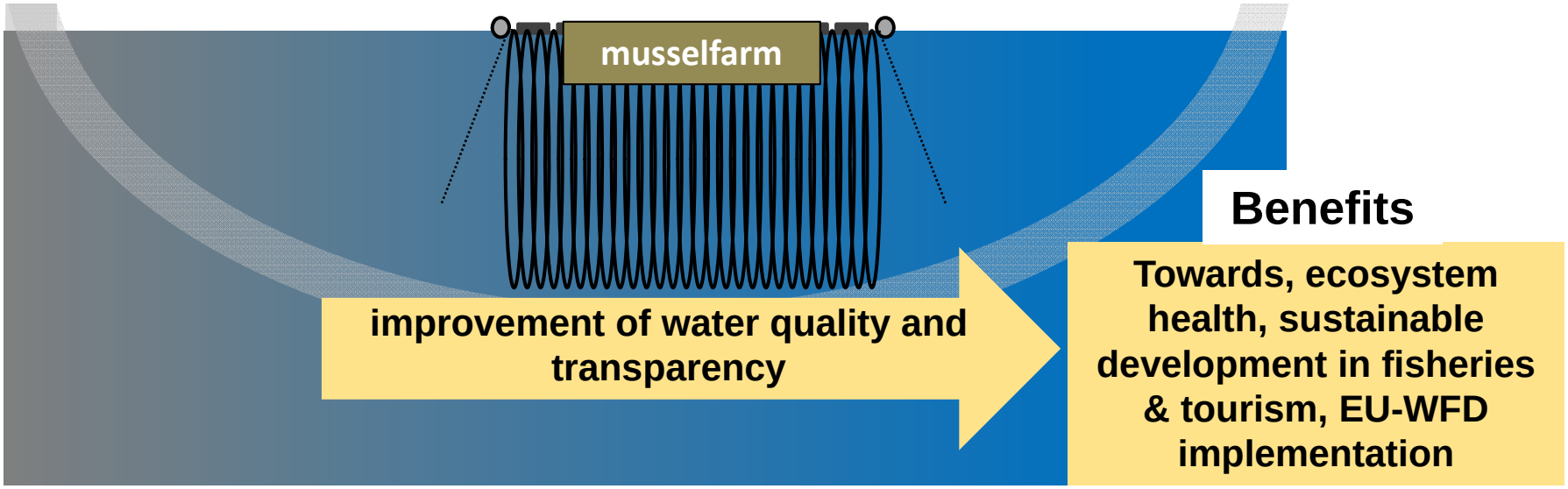
Mussel farming: The basic concept for Baltic lagoons

Objectives:

- **Sustainable production of feed (aquaculture, pic & poultry farming)**
- **Removal of nutrients via harvest**
- **Improvement of water transparency (regime-shift)**

Challenges

- **Shallow waters**
- **Low salinity requires other species (Dreissena)**



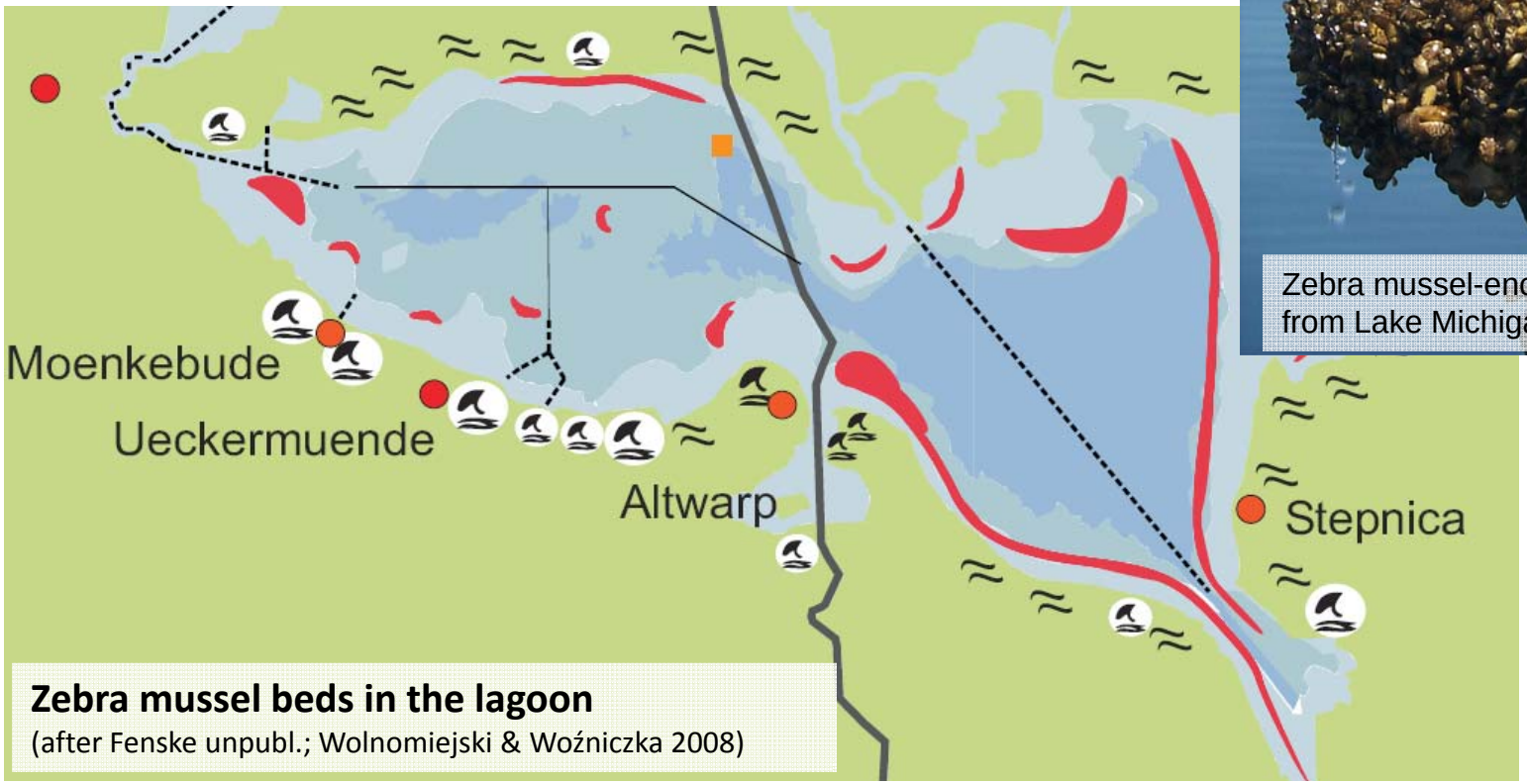
Adapted after Odd Lindahl

Zebra mussels in the Oder/Szczecin Lagoon

- Total biomass: ca. 68.000 t (about 8.000 t in the German part)
- Mussel beds in the German part: 6,56 km² or 2,4%
- Limitations for natural settling and spreading: missing hard substrate and anoxia

(Data after Radziejewska et al. (2009); Wolnomiejski & Woźniczka 2008)

Zebra mussel-encrusted current meter from Lake Michigan (Wikipedia)



Zebra mussel beds in the lagoon
(after Fenske unpubl.; Wolnomiejski & Woźniczka 2008)

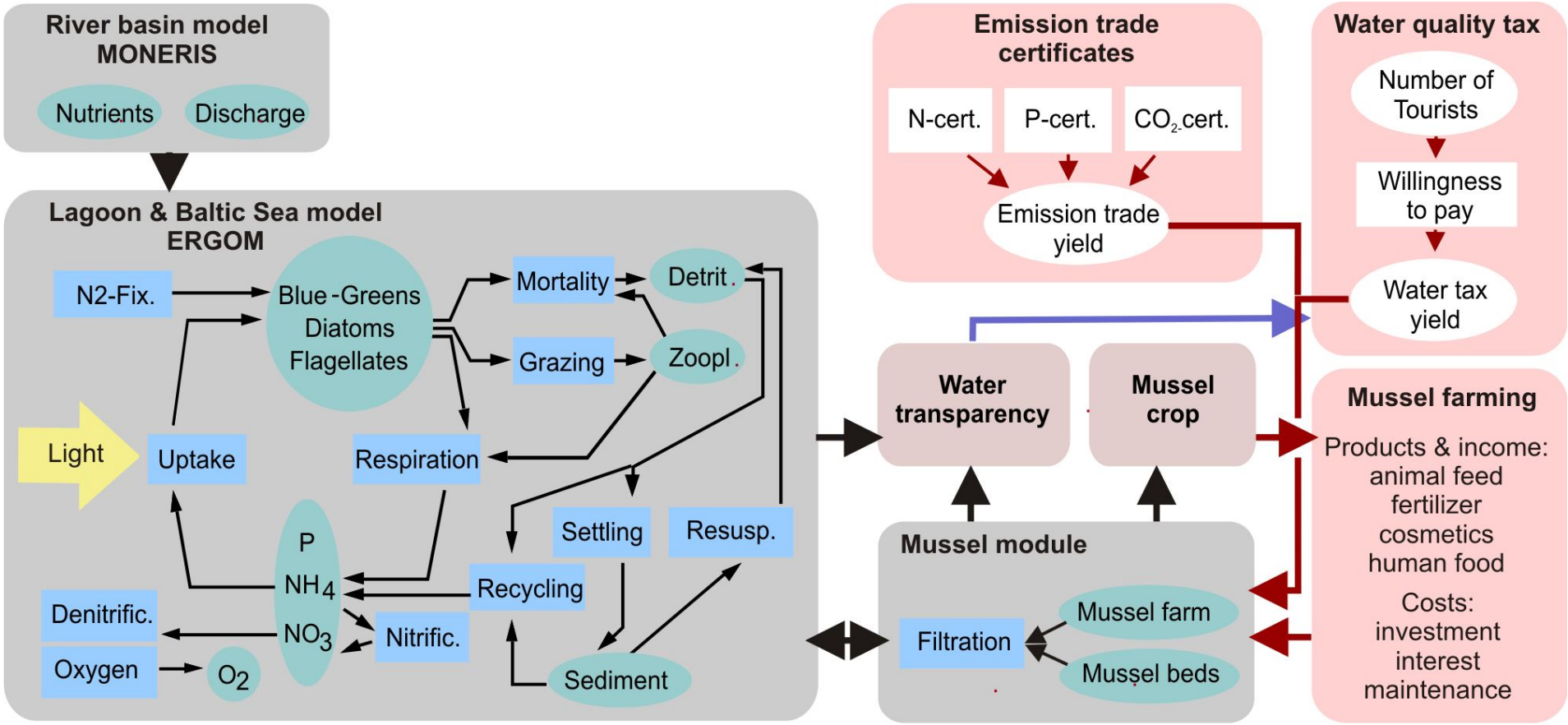
Zebra mussel cultivation in Oder/Odra Lagoon:

Experiments by Sven Dahlke

(Pictures: Klamt 2011)

Modelling – present state

- Extension of an ecological model by a mussel module
- Development of an economic model
- Linking both models via water transparency and mussel yield
- Scenario simulations with the model system

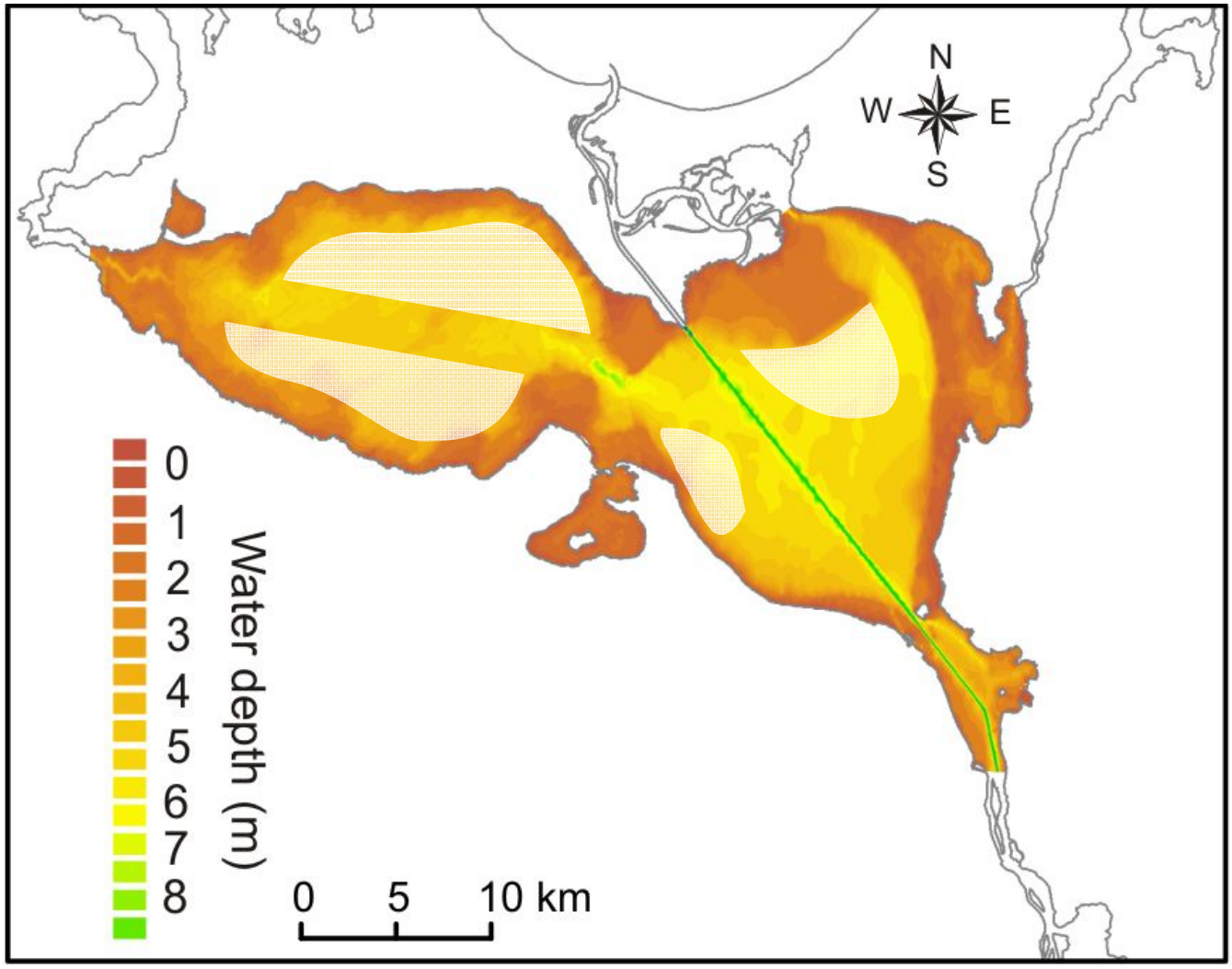


Schernewski et al. 2012: Ecology and Society

Zebra mussel farming: Carrying capacity

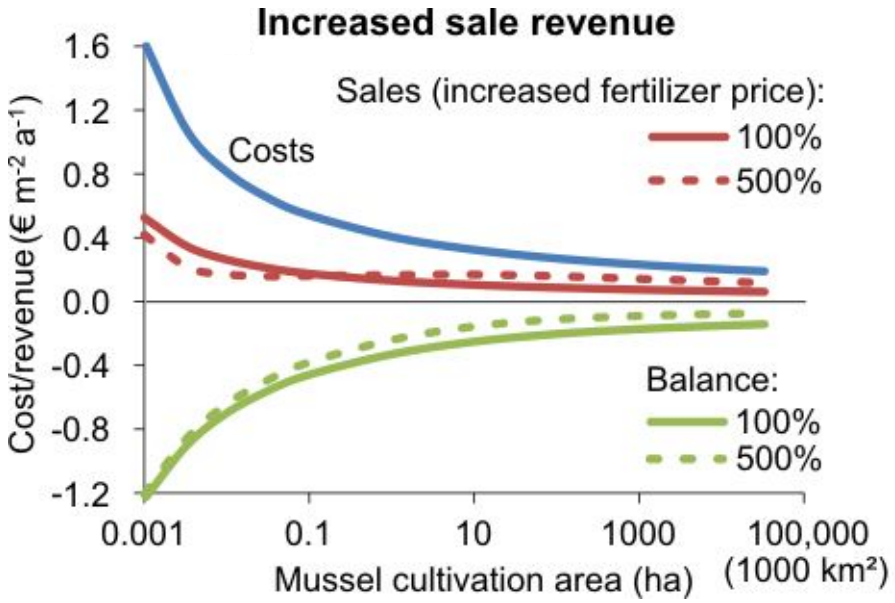
- Theoretical farming area (2 and 5 m water depth): 335 km²
- Max. realistic farming area: 134 km² (20% of the lagoon surface)

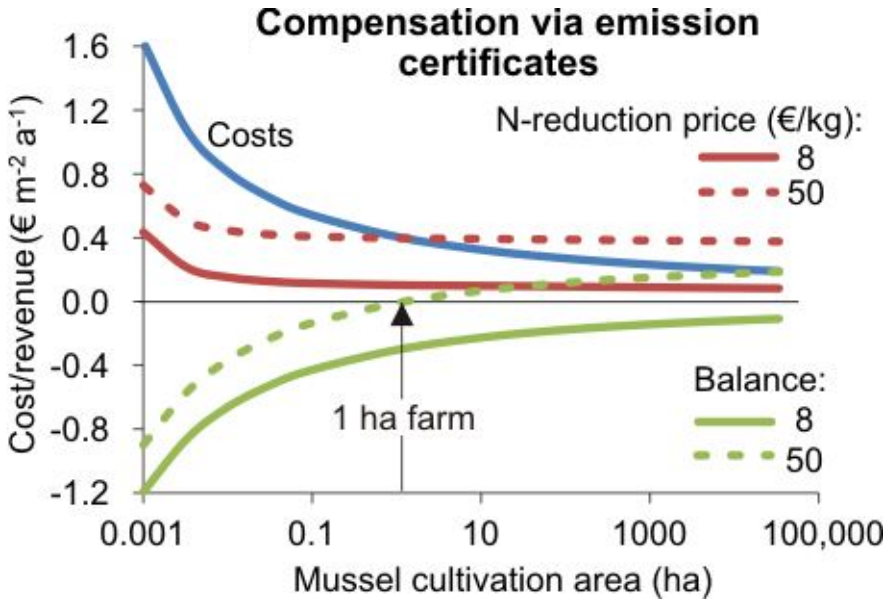
Derived from Thau Lagoon data; Dupuy et al. 2000; Gangnery et al. 2001



Zebra mussel farming:
Future scenarios

- impact of increased fertilizer/animal feed market prices on the profitability of mussel cultivation in the lagoon
- effect of additional income from nitrogen emission certificates (financial compensation/subsidy for removing nitrogen from surface waters) on profitability

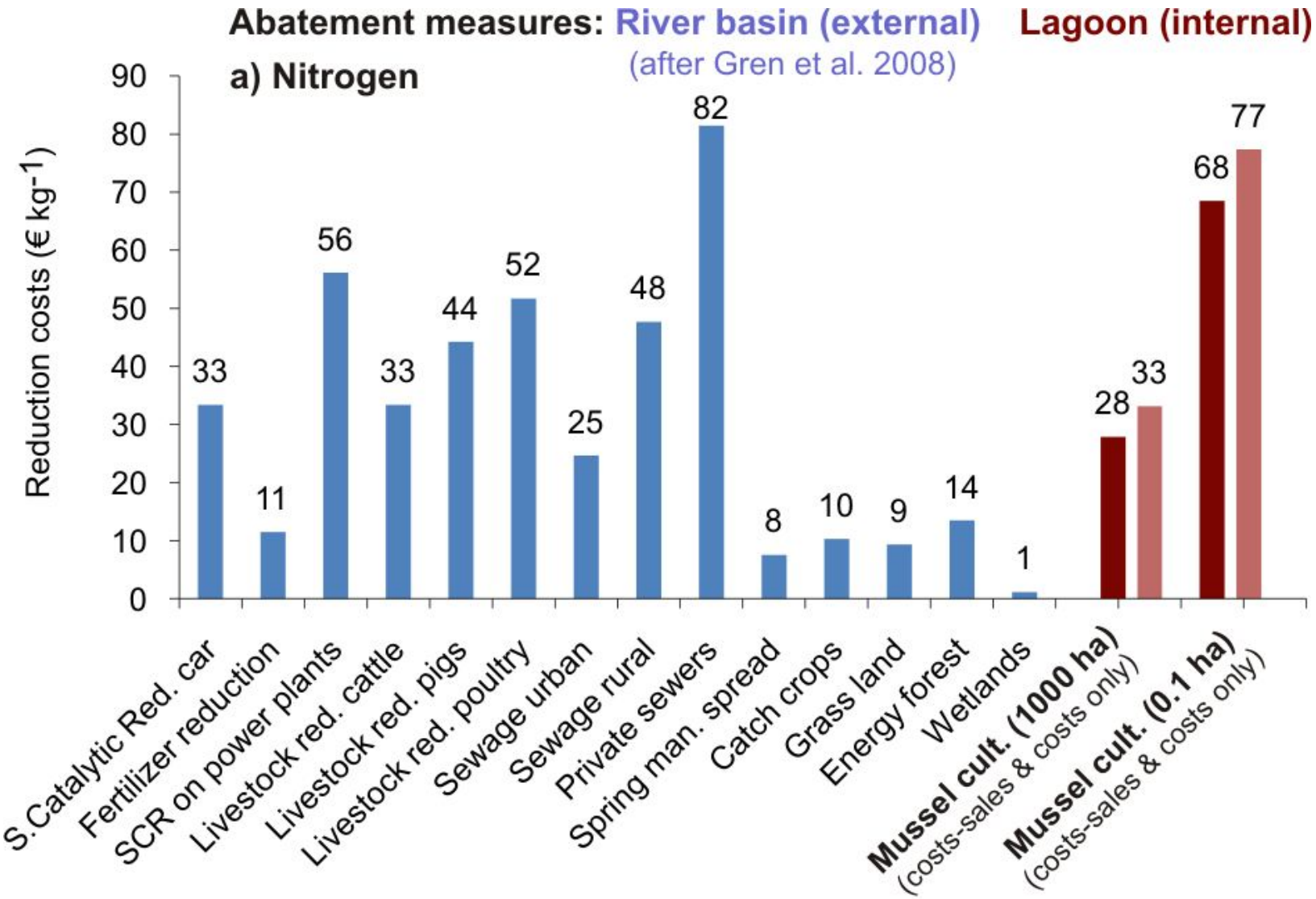




Schernewski et al (2012): Ecology and Society

Zebra mussel farming

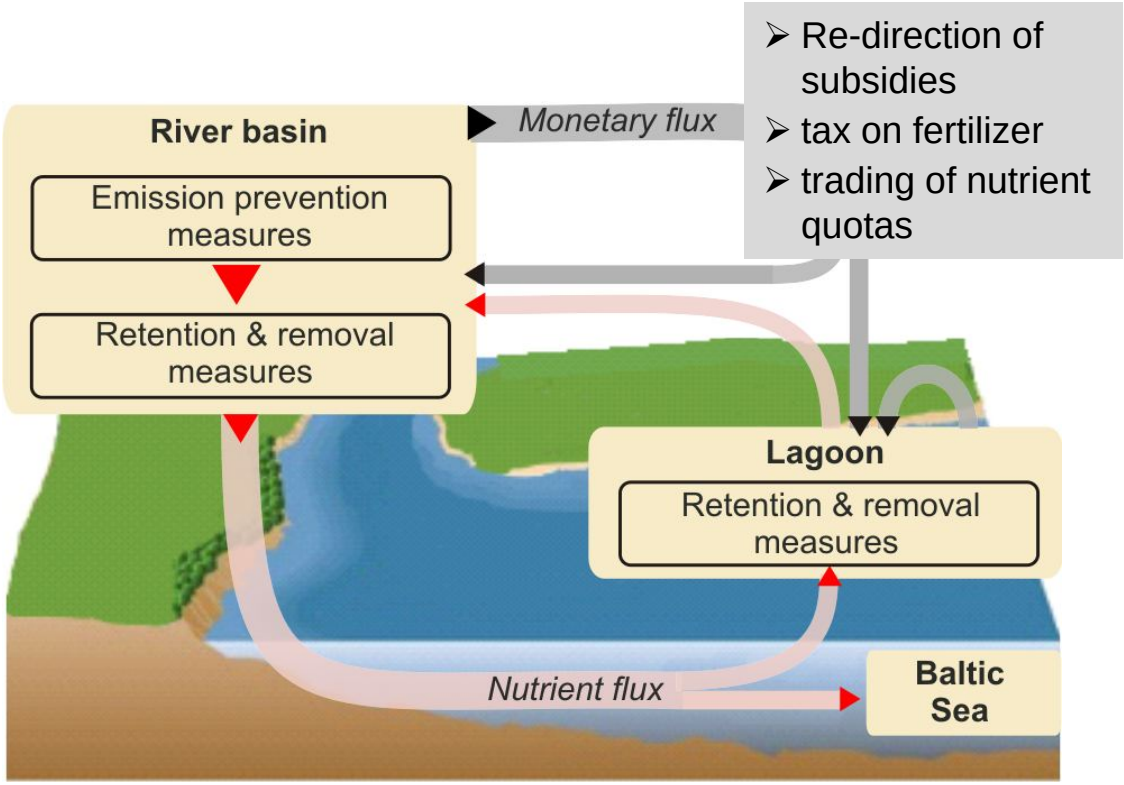
Costs of measures in the Oder/Odra river basin to reduce 1 kg of nitrogen



Schernewski et al.(2012) Ecology and Society

Summary

- Zebra mussel farming is a **suitable supportive measure to remove nutrients** and to protect the Baltic Sea. In the Oder/Odra mussel farming potentially could remove nearly 1000 t N per year or 2 % of the annual Oder N-loads. Its potential is limited in the Oder Lagoon, but this is different for other systems.
- Zebra mussel farming is **not a cost-effective measure** to remove nutrients today. At a N-load reduction target of 50% and more, mussel farming would become cost-efficient and has the additional benefit of improving water transparency.
- Zebra mussel farms in the lagoon are **not profitable** and would require additional subsidies.
- Zebra mussel farming can be regarded as **environmental friendly** as long as the carrying capacity and specific max. density are not exceeded.
- Mussel farming will not allow an ecosystem **regime shift** in the lagoon.



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Thank you for your attention !!

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Tasks within BaltCoast

- Assessment of alternative methods to support water quality improvement like extension of macrophyte belts and supporting pile rows.
- Further development of these methods (mussel beds, mussel farming, macrophyte belts and pile rows) into single and combined measures that support the implementation of Water Framework, Marine Strategy Framework, Habitats and Bathing Water Quality Directives. Change of focus from nutrients towards water transparency.
- Implementation of a mussel model into the full 3D- ecosystem model with a high spatial resolution, that allows scenario simulations, the analysis of spatial (and seasonal) environmental effects and supports concrete measure planning.
- Development of integrated ecological, social and economic scenarios for the implementation of small mussel farms to support local bathing tourism, nature protection and policy implementation (partly by supporting macrophyte growth).
- Implementation of a test mussel farm with accompanying ecological and economical studies.