Baltic Sea – Coastal Water Restoration

Gerald Schernewski

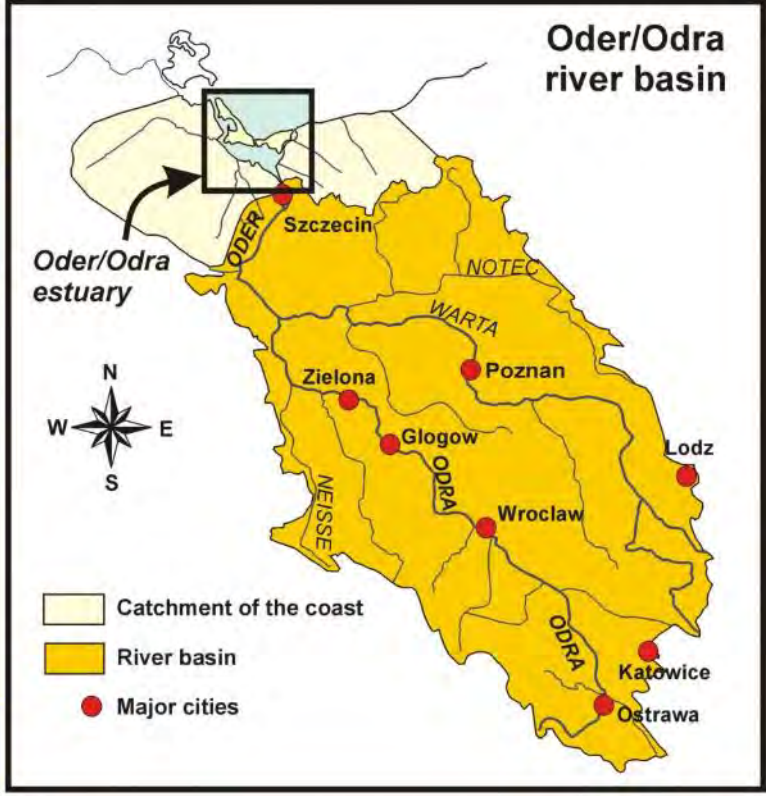
Leibniz-Institute for Baltic Sea Research, Warnemünde, Germany
Klaipeda University, Lithuania

Overview

1. Background – The Oder Lagoon
2. Eutrophication problems
3. Measures to combat eutrophication
4. Mussel farming – a cost-effective measure?
5. Mussel farming – as specific local measure?
6. Summary

1. The Oder/Szczecin Lagoon

A small coastal lagoon/estuary area is dominated by a large river basin.



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

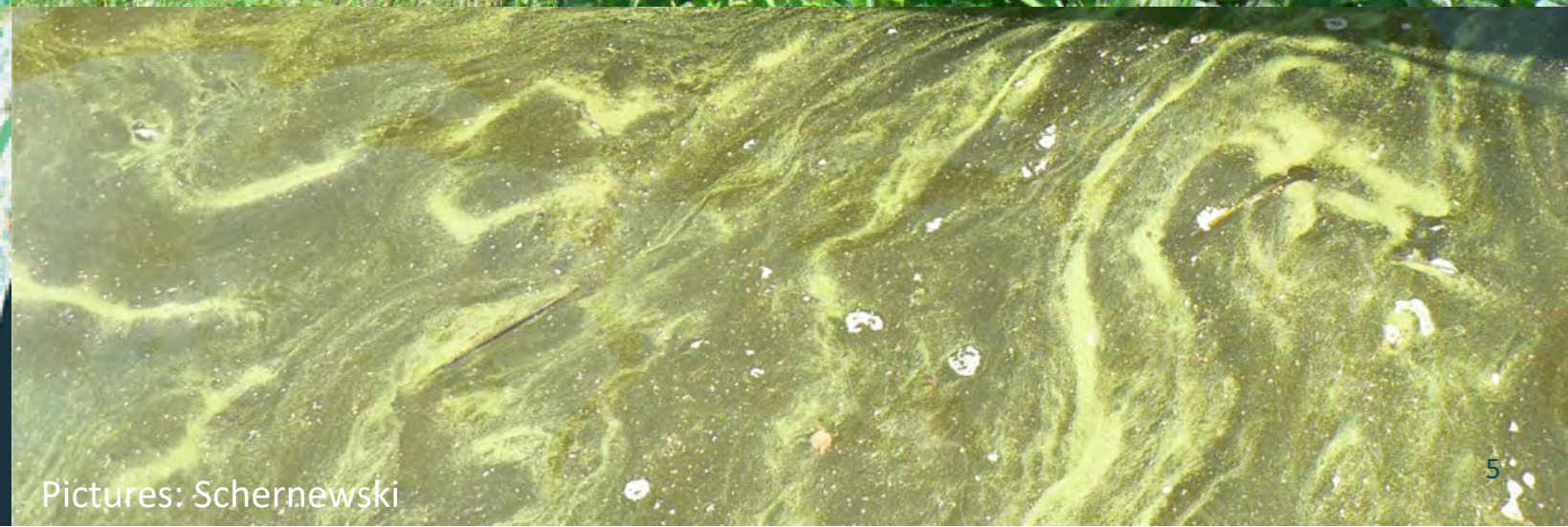
Schernewski et al. (2012)

1. The Oder/Szczecin Lagoon - an EU Natura 2000 site

Schernewski (2008)

2. Eutrophication – blue algae blooms

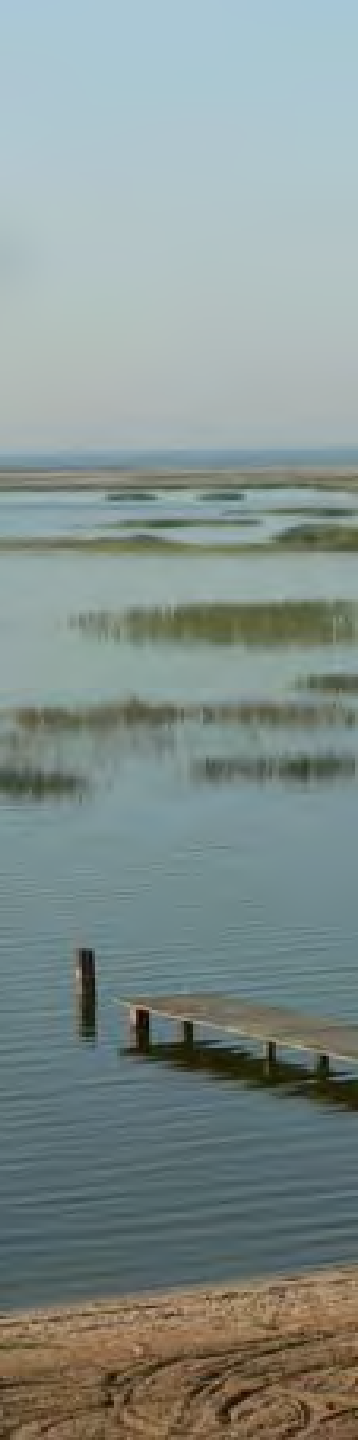
Satellite image: Siegel et al. 2000



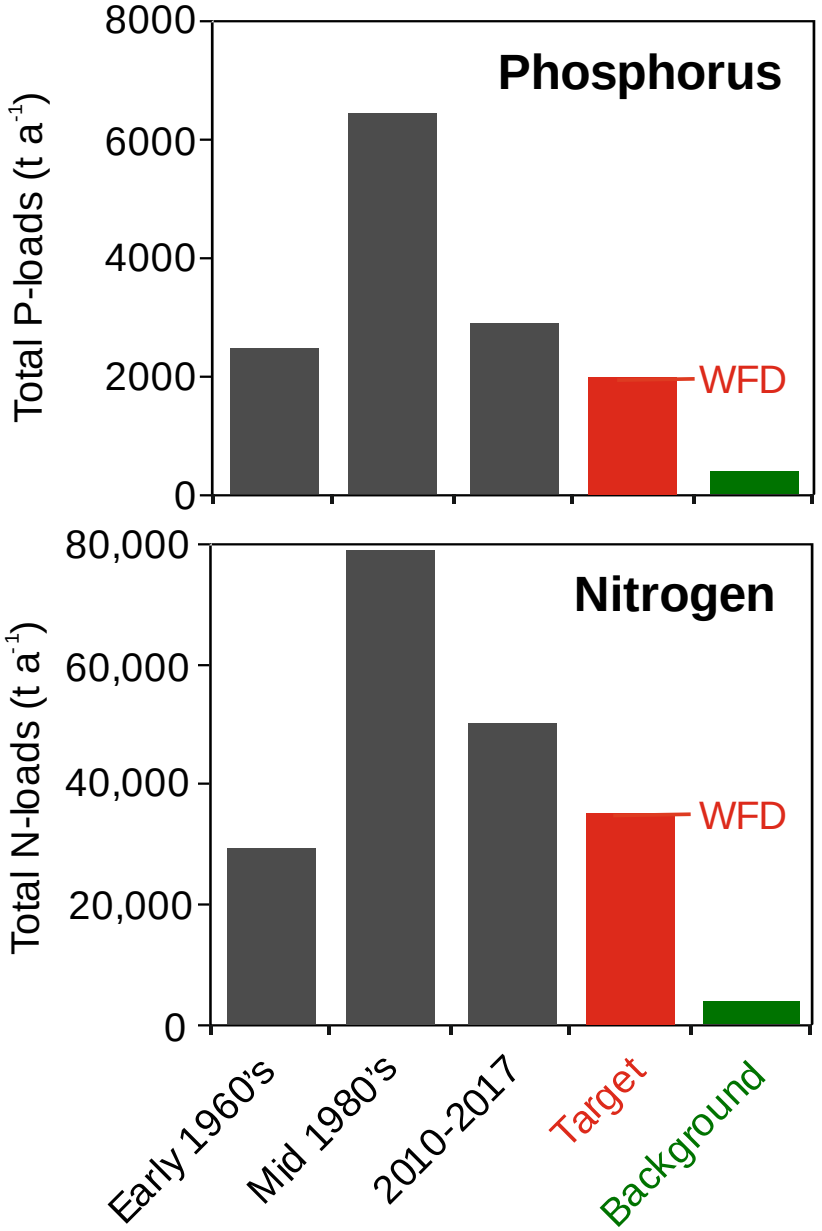
Pictures: Schernewski

2. Eutrophication - hypoxia

Pictures: Schernewski



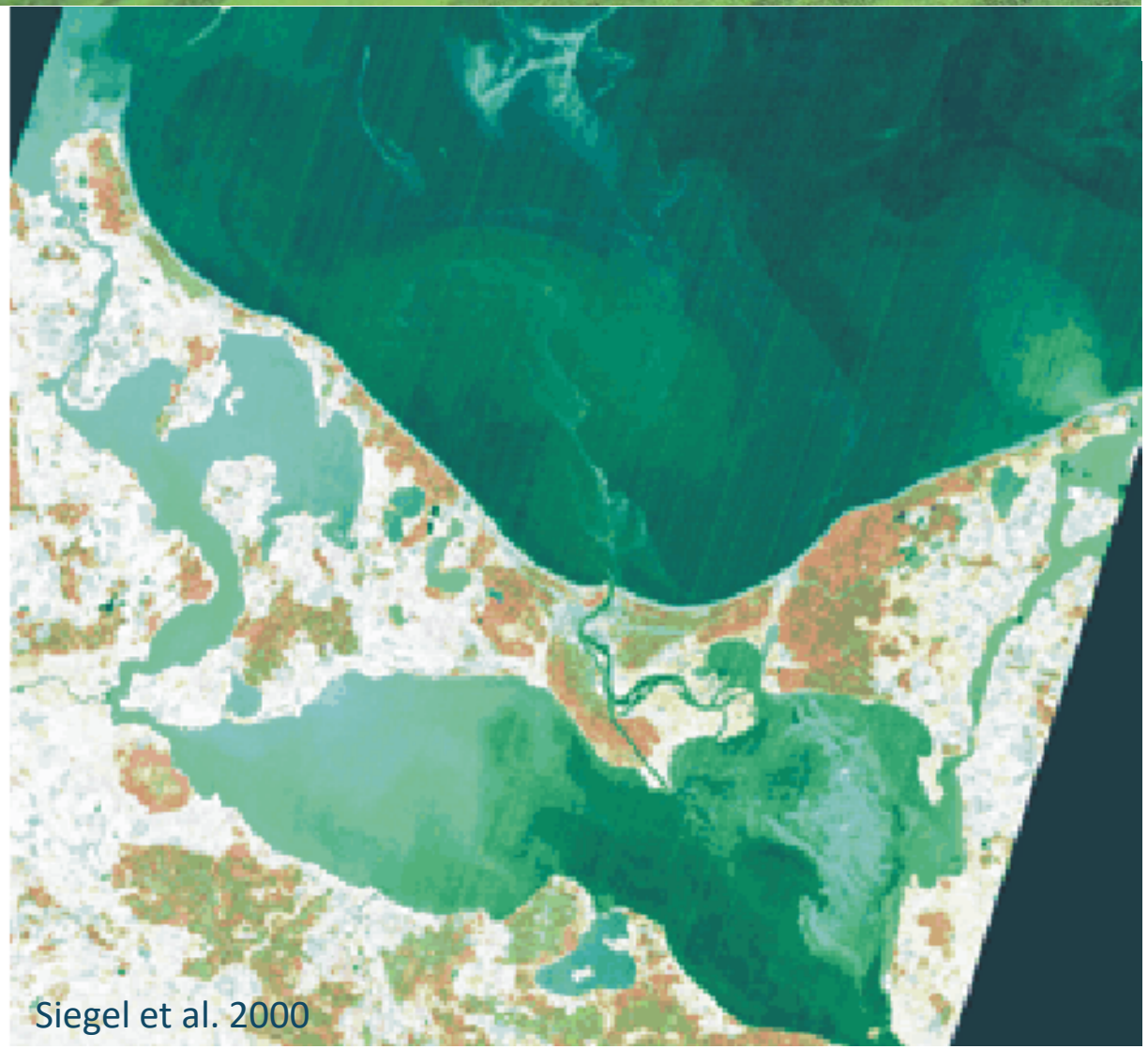
2. Eutrophication – perspectives for the Oder/Odra River



- Additional load reductions are necessary to reach acceptable loads and a good status in the river.
  (according to the Water Framework Directive (2.6 mg N/l N, 0.1 mg P/l) as well as the Baltic Sea Action Plan)
- Potentially a good water quality in the river could be reached, but this would not cause a good status in the Oder Lagoon.
- Taking into account the present economic development and intensified agriculture it seems not realistic that a good status in the river will be reached.

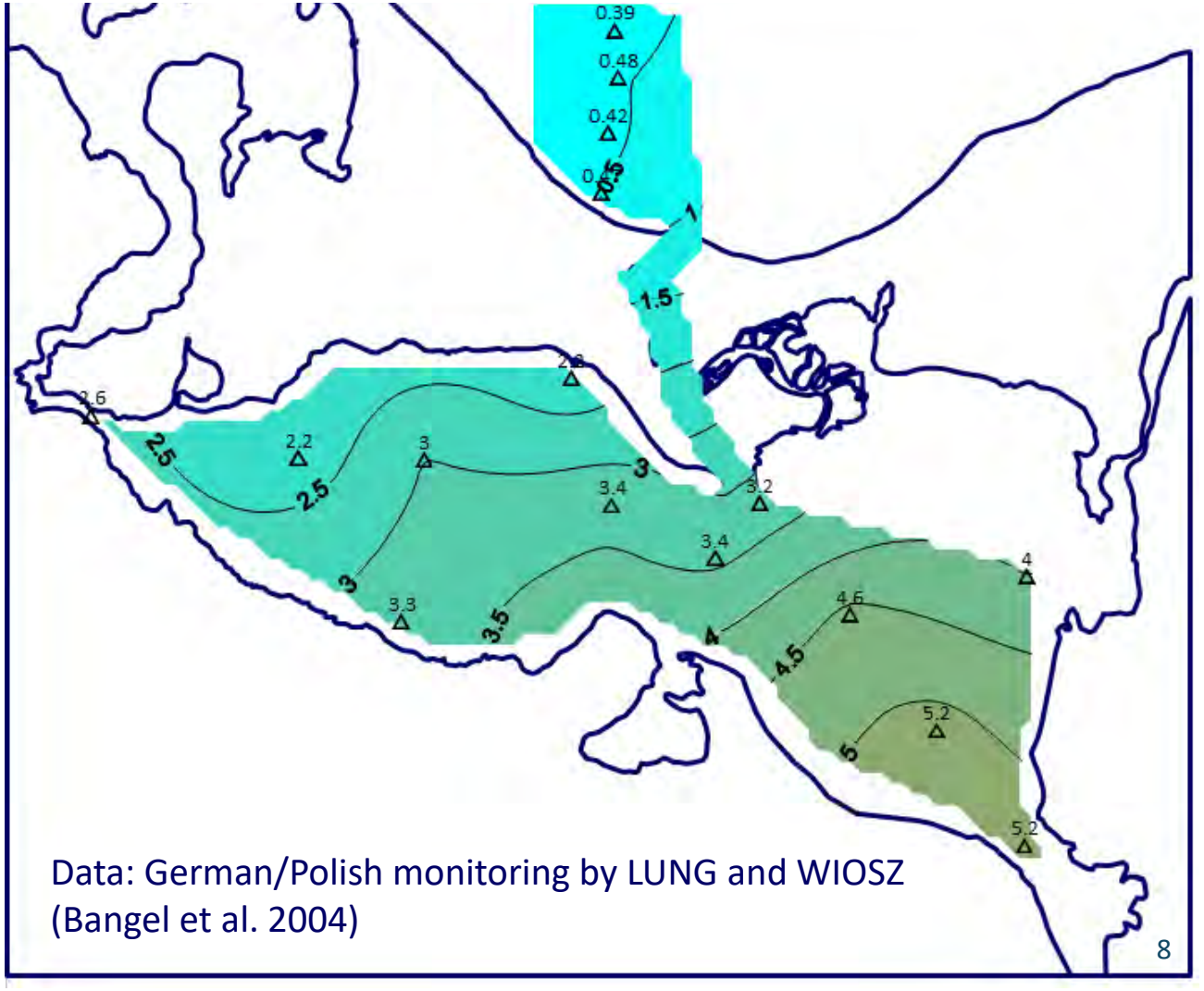
Schernewski et al. (2012): Ecology and Society (updated)

2. The Oder river plume in the lagoon



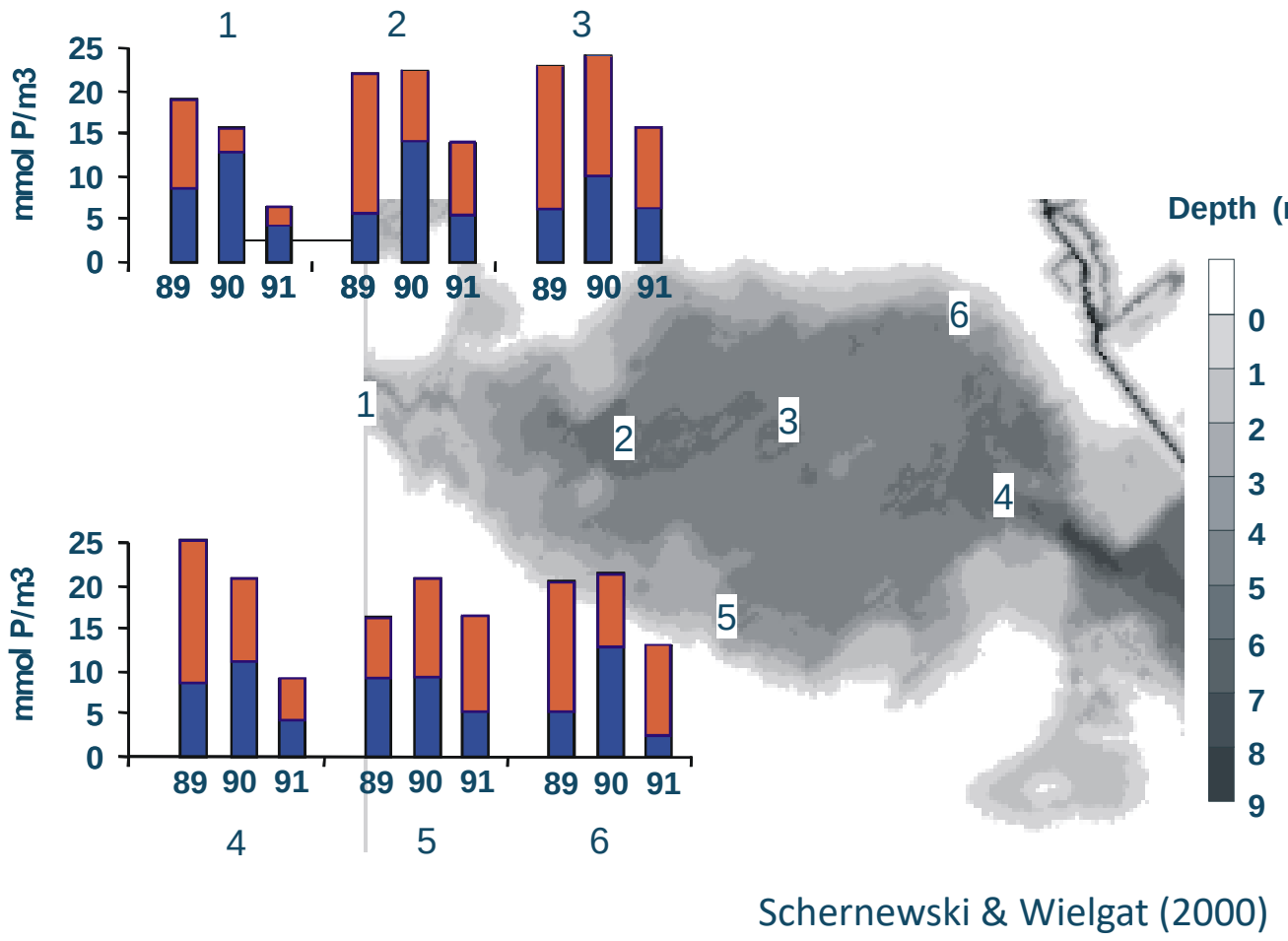
Siegel et al. 2000

Median concentrations of phosphate [µmol/l] in June (period 1980-91)

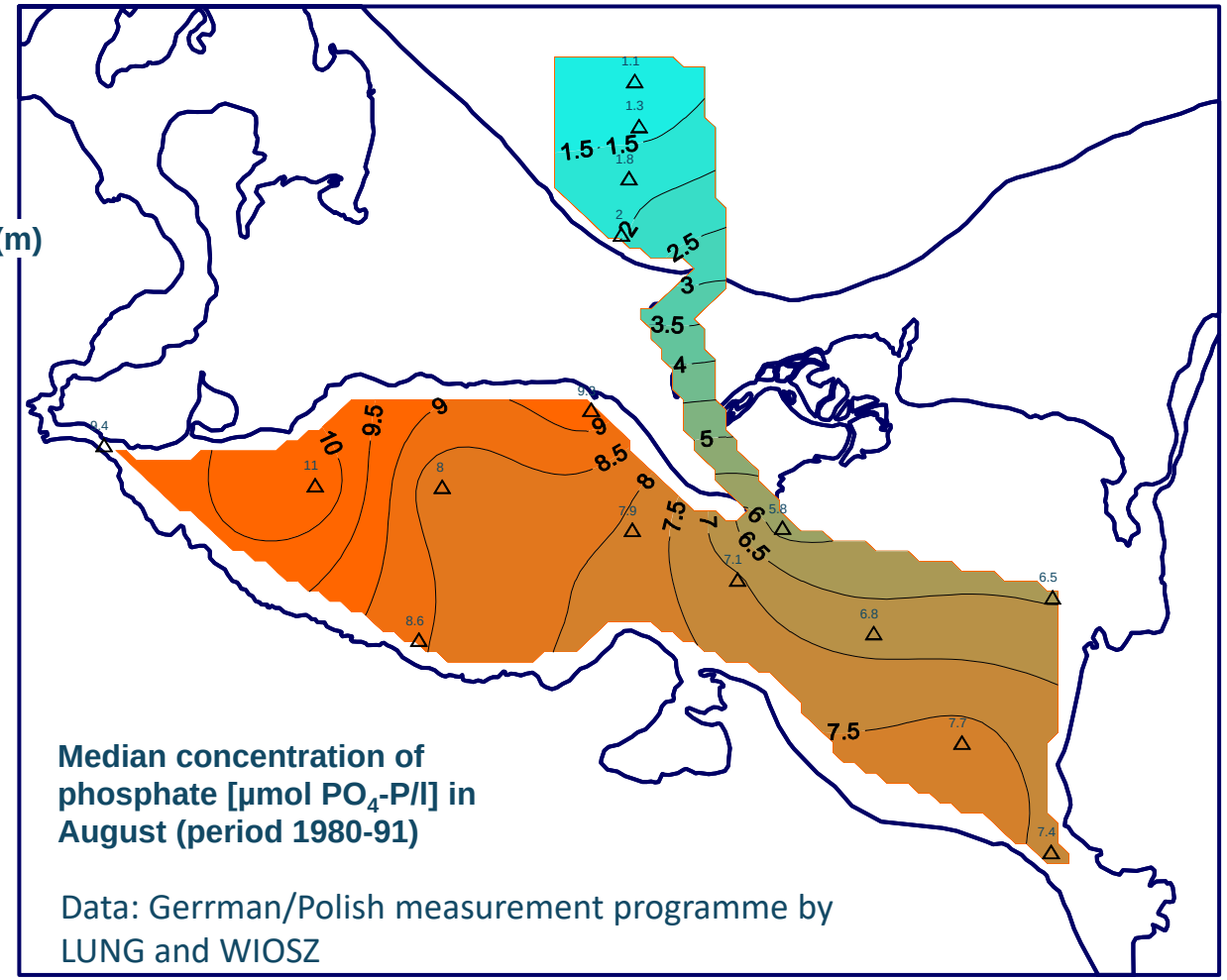


Data: German/Polish monitoring by LUNG and WIOSZ (Bangel et al. 2004)

2. Oder Lagoon: Internal eutrophication



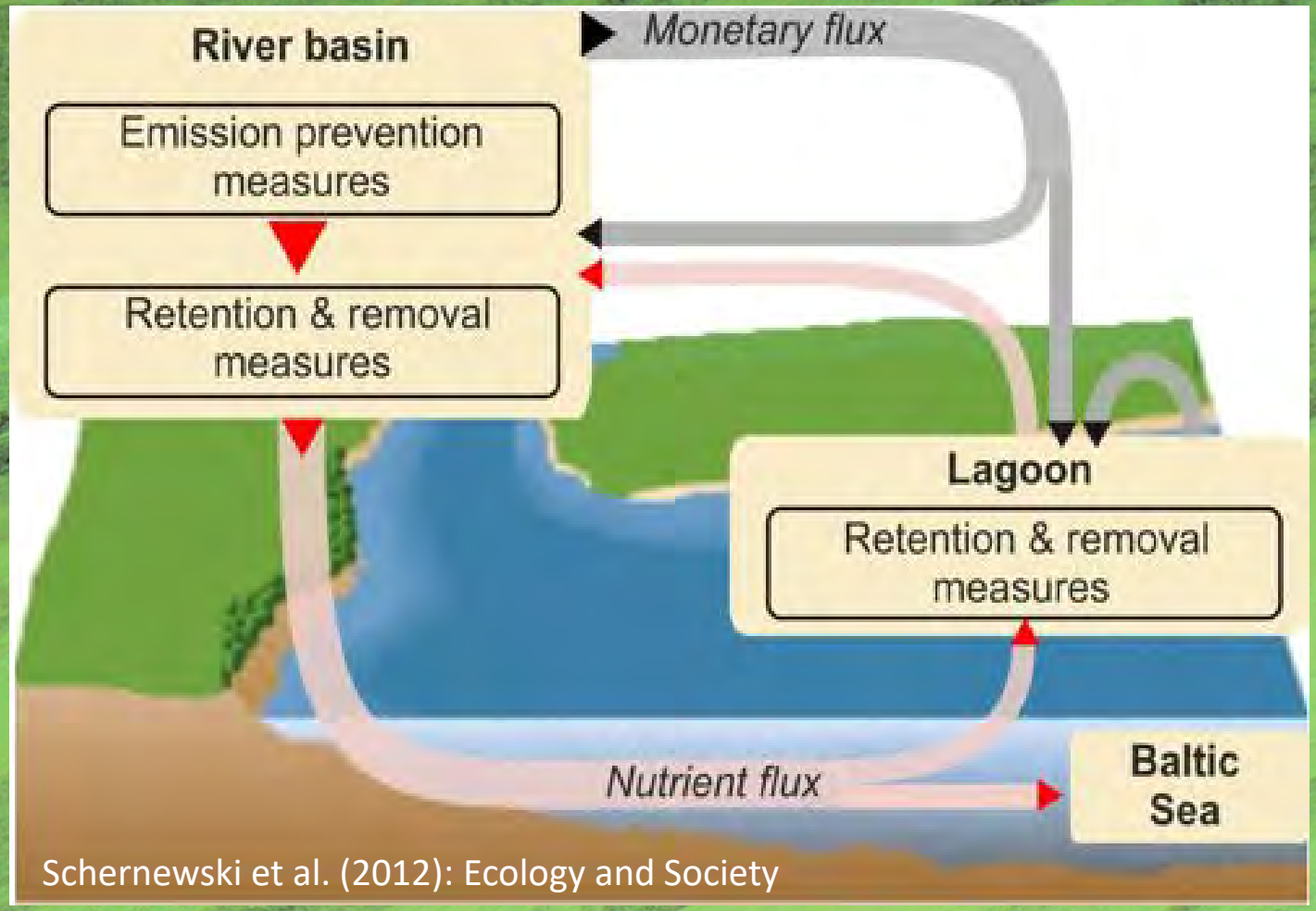
Schernewski & Wielgat (2000)



- Internal eutrophication, the P release from the sediment under hypoxic conditions, can contribute up to 400 t P/a (the Oder load of 3 month) during short periods in summer.

3. Starting point – what when river basin management fails?

- If river basin nutrient load reductions are insufficient?
- If a good water quality in the river does cause a good quality in coastal waters?
- If coastal waters are naturally eutrophied and/or internal eutrophication counteracts efforts?
- Measures in coastal water are required to improve the ecological status?



Schernewski et al. (2012): Ecology and Society

3. Internal measures to improve water quality

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

Biological:

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

Photos: Scheibe 2008; Klamt 2011

4. Mussel farming:

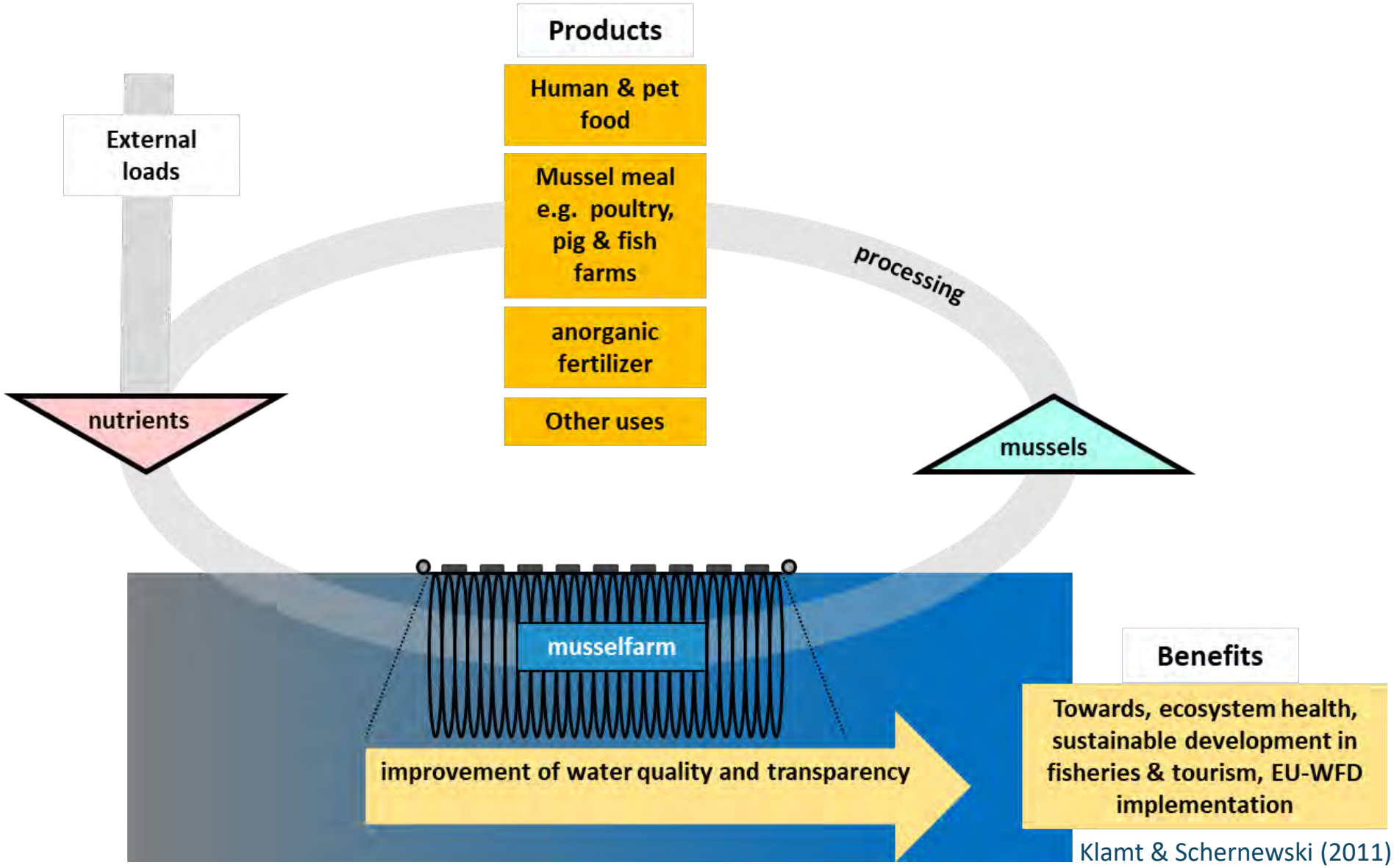
Zebra mussel (*Dreissena polymorpha*)

➡ **Waters with low salinity do not allow Blue mussel farming.**

Questions:

- Can Blue mussels farming approaches be transferred to Zebra mussels in the brackish coastal waters?
- Is mussel farming environmental friendly and sustainable?
- What is the efficiency with respect to water quality improvement (nutrients and water transparency)?
- Is mussel farming a cost-effective measure compared to measures in the river basin?
- Can mussel farming be a profitable business and support local economy?

4. Mussel farming: The basic concept for Baltic coastal waters



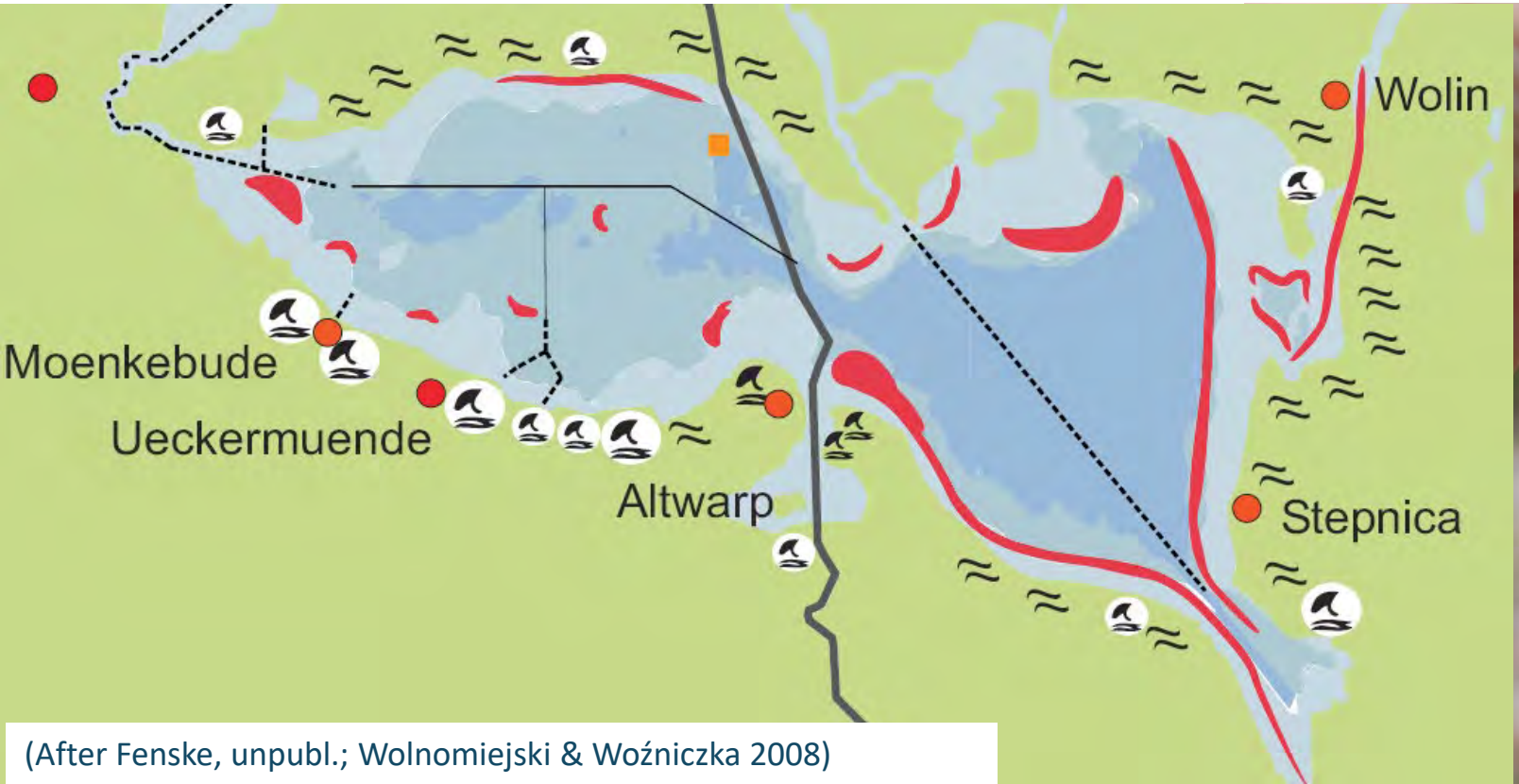
Klamt & Schernewski (2011)

4. Zebra mussels in the Oder Lagoon

- Total biomass: ca. 68.000 t
- Mussel beds in the German part: 6,6 km² and about 8000 t
- Limitations: missing hard substrate and hypoxia

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

- Filtration rate per m² mussel bed: 1m³/day
- Reproduction at 12-18°C water temperature; larvae settle after 5-6 weeks (June)
- Size after two years: 12-14 mm (max. 30 mm)
- Weight after two years: of 0.5-1 g (max. 2.5 g)



(After Fenske, unpubl.; Wolnomiejski & Woźniczka 2008)

Photo: Stybel (2008)

4. Zebra mussel farming in the Oder Lagoon: Experiments by Sven Dahlke

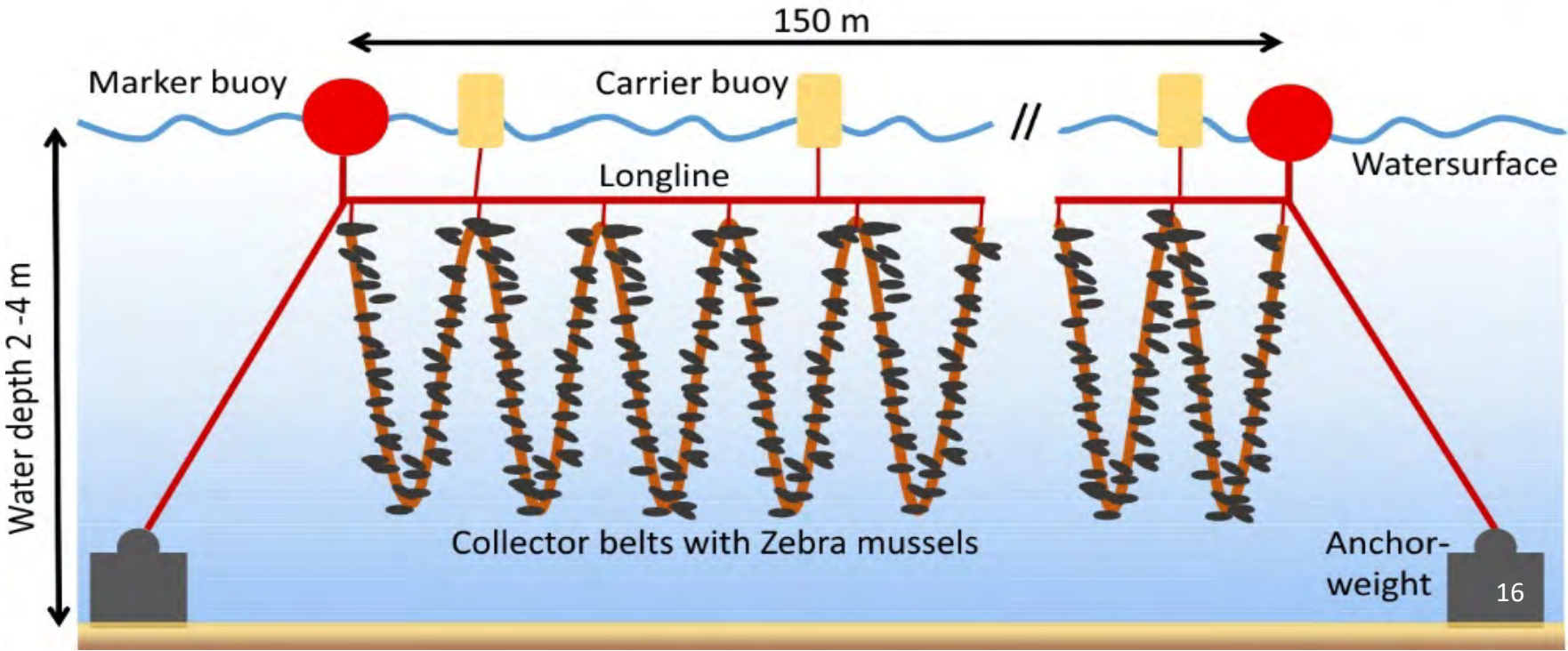
(Fotos: Klamt 2011)

Zebra mussels for human consumption?

4. Zebra-mussel farms: Approach

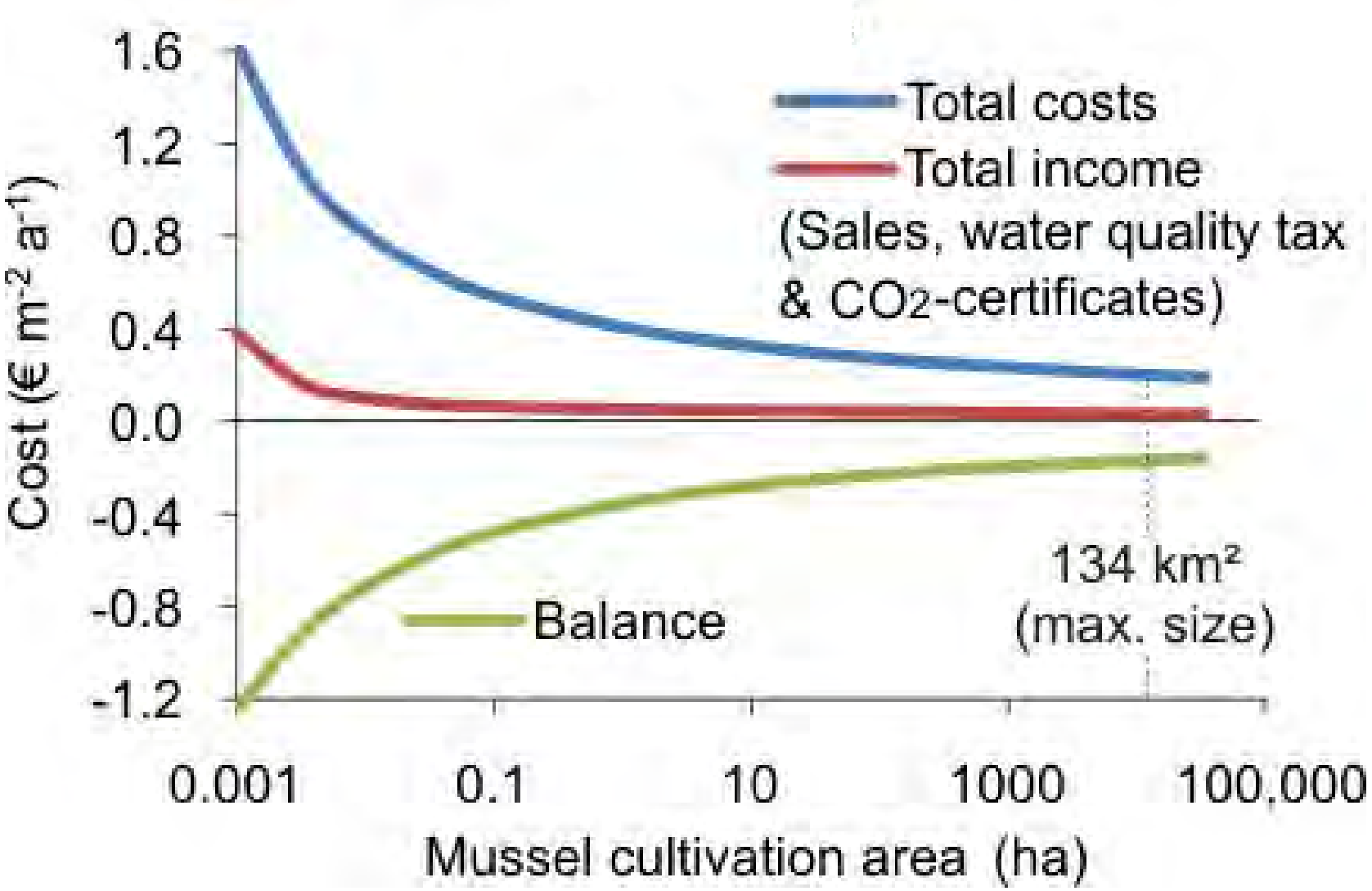
Preconditions:

- Sandy sediments
- Sufficent water exchange
- Natural mussel beds
- Low cultivation density to avoid negative effects on sediments
- No interference with other uses
- No risk of pollution and hyoxia



4. Zebra mussel farming - profitability

Balance between total costs and total income

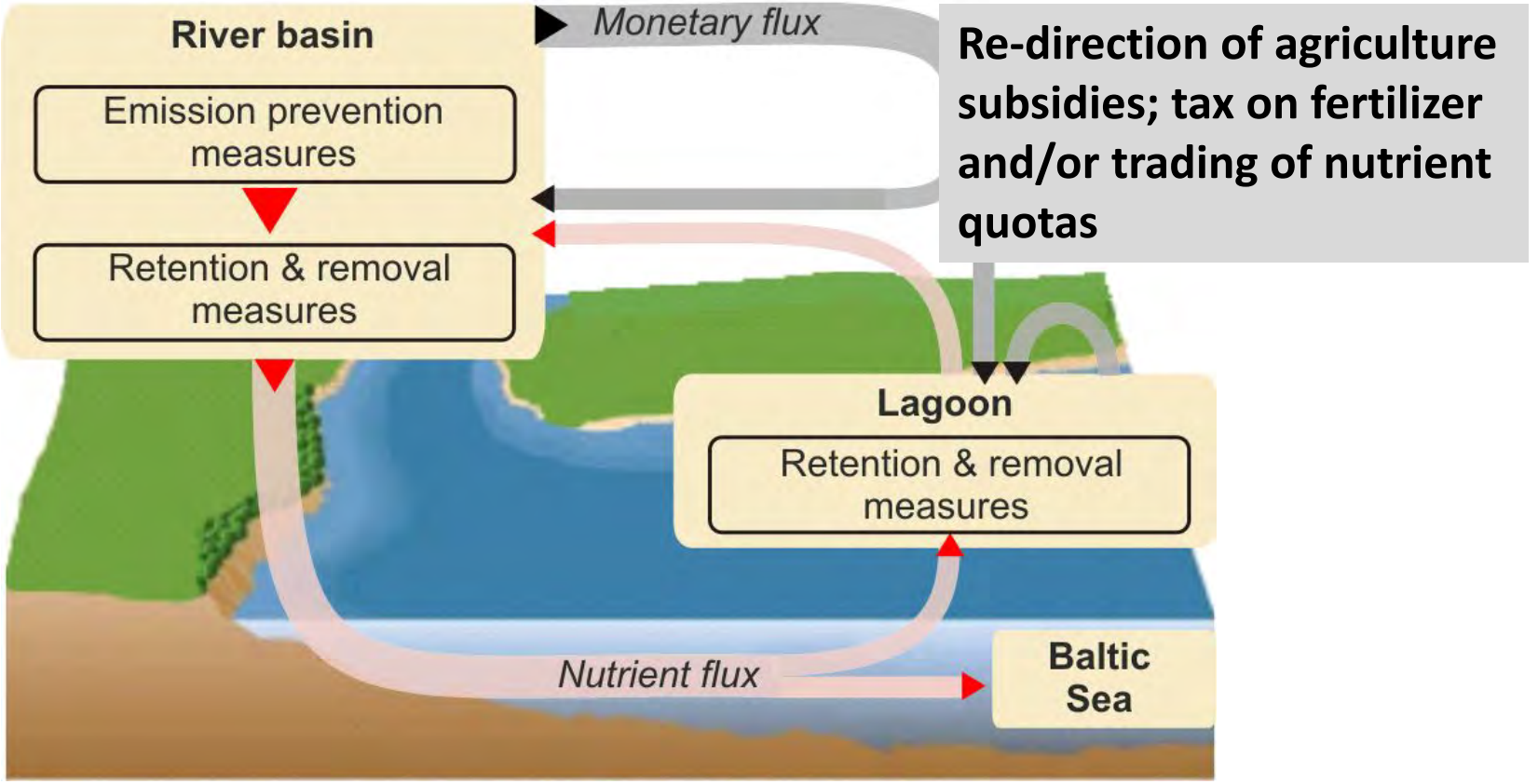


Schernewski et al. (2012): Ecology and Society

Photo: Ritzenhofen

4. Zebra mussel farming – funding

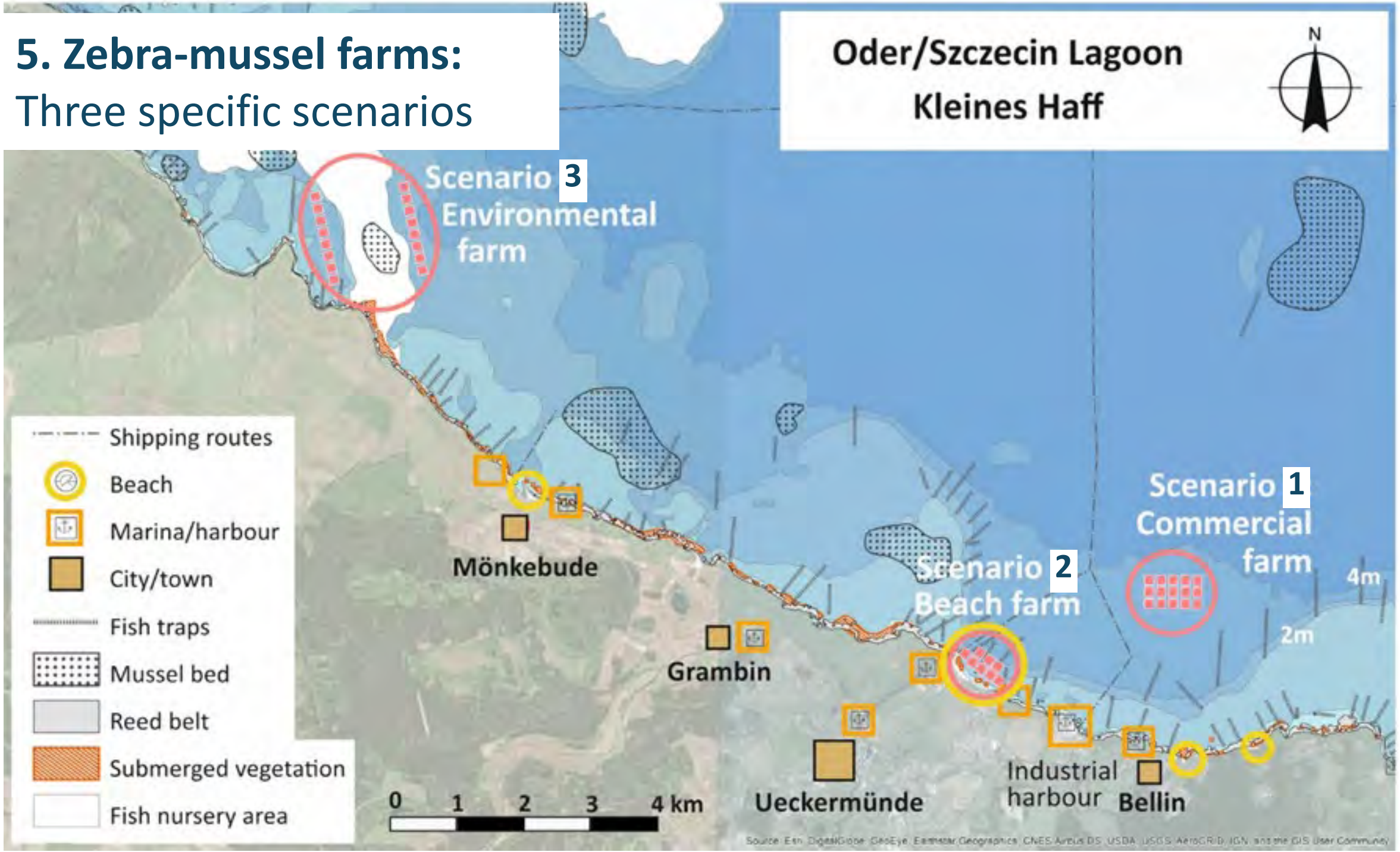
Zebra mussel farming will require additional funding (subsidies). The development of strategies to provide funding for the mussel farming as a nutrient removal measure is a challenge.



4. A first summary – Zebra mussel farming

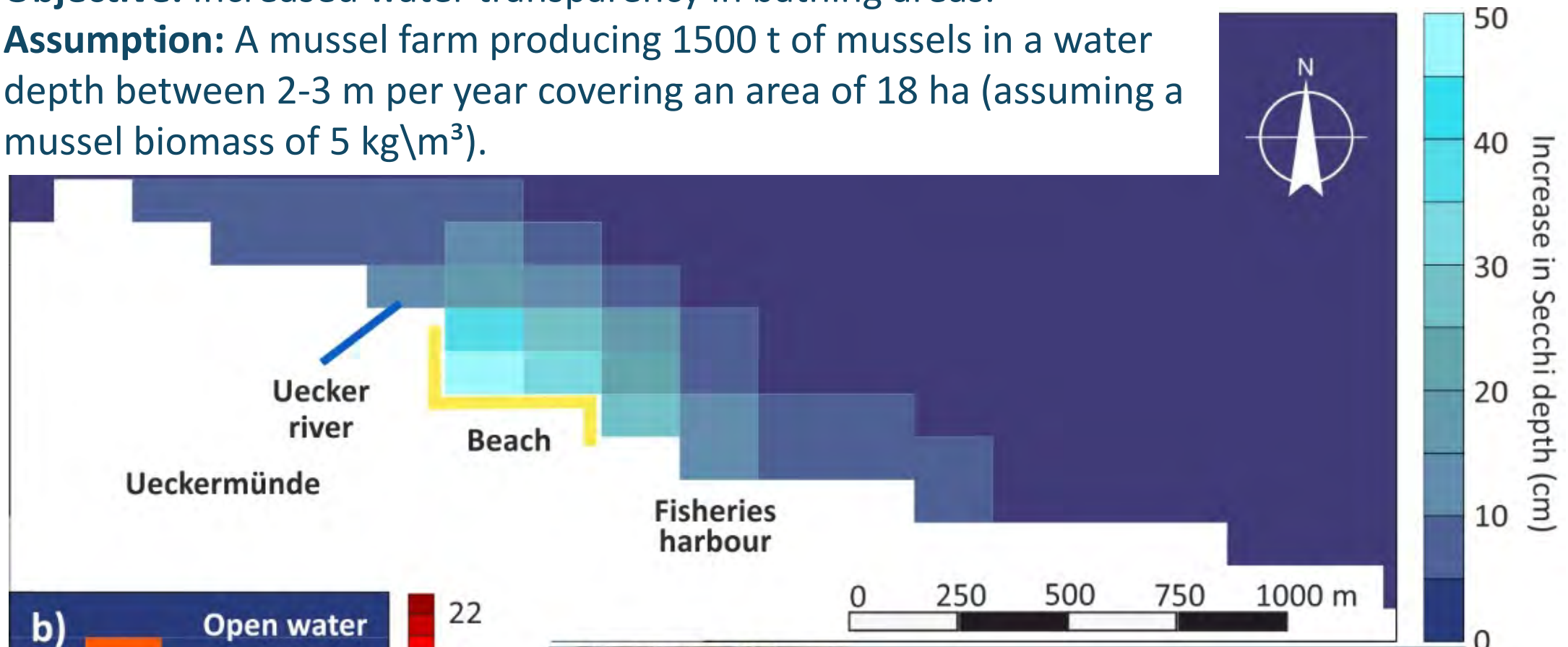
- It is a **suitable supportive measure to remove nutrients** and to protect the Baltic Sea. In the Oder/Odra mussel farming potentially could remove nearly 1000 t N per year or 2 % of the annual Oder N-loads. Its potential is limited in the Oder Lagoon, but this is different for other systems.
- In the lagoon it is **not profitable** and would require additional subsidies;
- It 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.
- It can be regarded as **environmental friendly** as long as the carrying capacity and specific max. density are not exceeded.
- Mussel meal as the major product of Zebra mussel farming can substitute fish meal and help to implement a sustainable aquaculture.
- in the Oder Lagoon it cannot cause a **regime shift** from a phytoplankton dominated into a clear water, macrophyte dominated system.

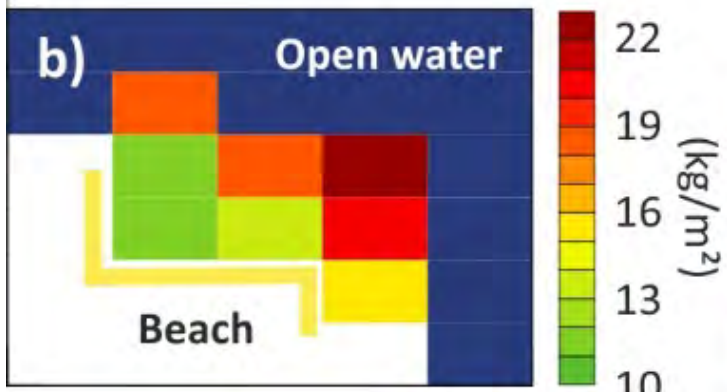
5. Zebra-mussel farms:
Three specific scenarios



5. Mussel farm near beaches

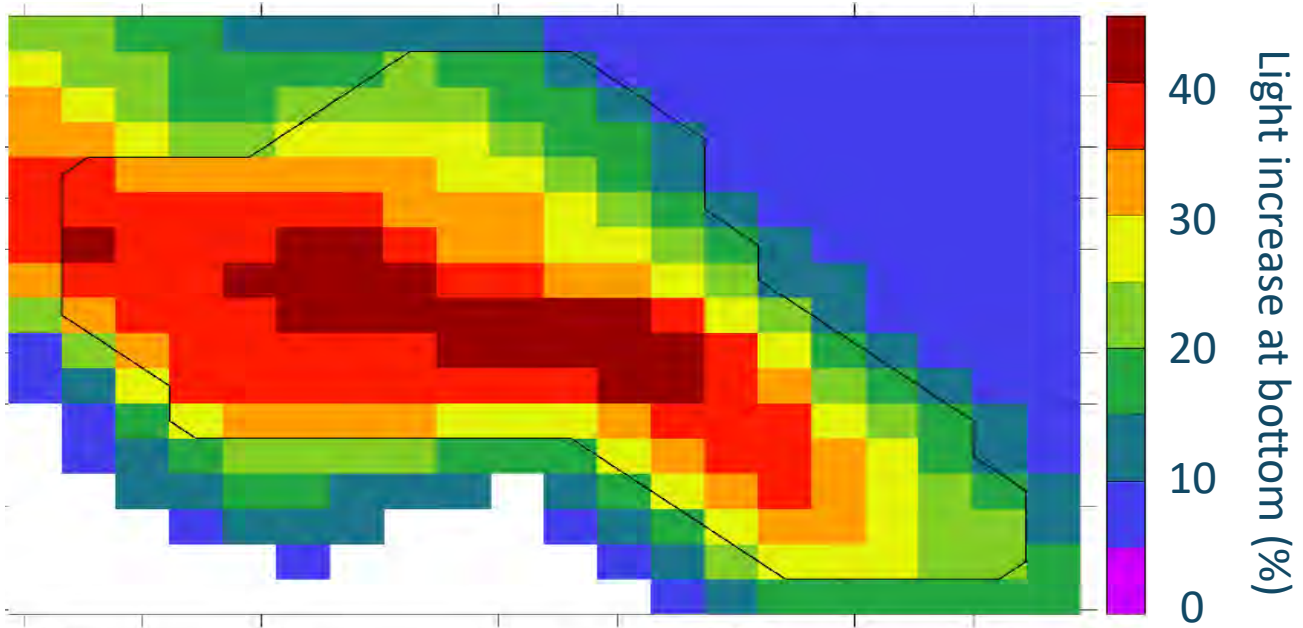
Objective: Increased water transparency in bathing areas.
Assumption: A mussel farm producing 1500 t of mussels in a water depth between 2-3 m per year covering an area of 18 ha (assuming a mussel biomass of 5 kg\m³).





5. Mussel farm to enable macrophyte recovery

- Establishment of a low density mussel farms (0.9 kg/m^3) in shallow areas where macrophytes did grow in the past.
- Musselfarms allow an increase of water transparency by 7% and an increase of available light at the bottom by up to 45%.
- Removal of the farms once stable macrophytes areas are re-established.
- Macrophytes are a biological element (target parameter for a good status) in the Water Framework Directive.



5. Summary

Strengths

Removal of nutrients via harvest and reduction of summerly algal blooms

Suitable measure to **increase water transparency** (ecological quality according to WFD)

Re-settlement of macrophytes due to improved water transparency (possibly regime shift)

High-quality protein and fat acid source with increasing prices for products

Mussel meal as subsitute for fish meal reduces pressure on wild fish stocks

„Native“ species used and knowledge from Blue mussel cultivation exists

Synergy with local fisheries and potential source of income

May support tourism (improved water transparency, local attraction new product)

Weaknesses

End-of-pipe solution with respect to nutrients removal

Uncertain effects on the ecosystem (denitrification, shifts in species composition, increased risk of hypoxia)

Accumulation of **pollutants and human-pathogens**

Damage of farms by **drifting ice**

Losses due to **predation**

Spreading and settling of mussels on constructions and boats

Not profitable without subsidies and requires large scale investments

Uncertain legal situation

Lack of tradition, poor acceptance of fresh mussels uncertain commercial use

Mussel meal production requires large farming area

- Zebra mussel farming seems to be the most effective measure in fresh waters.
- It could support reaching a good ecological status in waters with limited external loads (measure within the Water Framework Directive).
- With a financial compensation for nutrient removal and water transparency improvement, Zebra mussel farming could even be a profitable business.

Thank you for your attention!

Prof. Dr. Gerald Schernewski
gerald.schernewski@io-warnemunde.de
Leibniz-Institute for Baltic Sea Research, Warnemünde, Germany; Klaipeda University, Lithuania