Mussel Mitigation Farming

Transforming eutrophication to high quality protein

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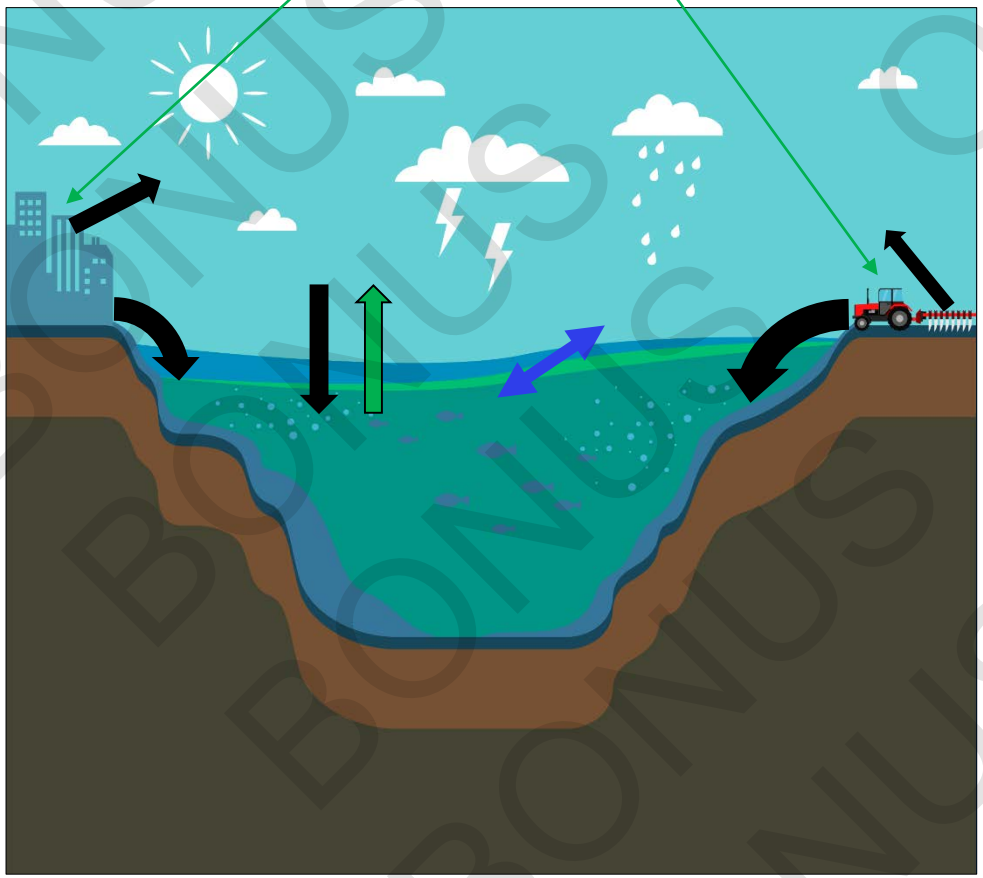
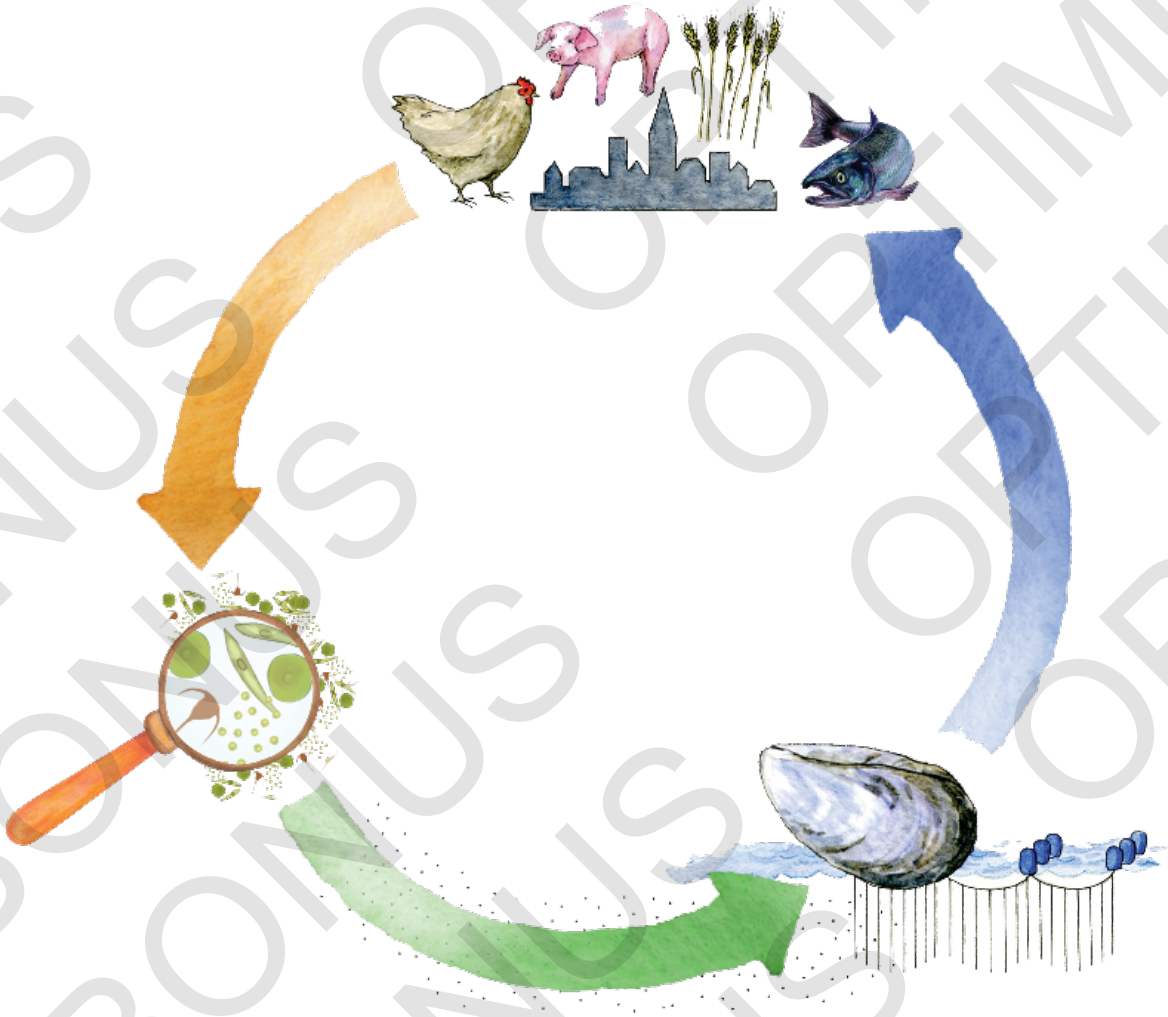
Nutrient sources

Ideal intervention



Legacy nutrient loads

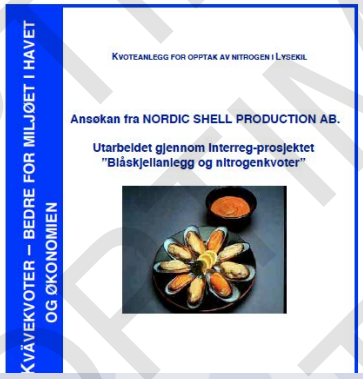
The mussel mitigation farming tool

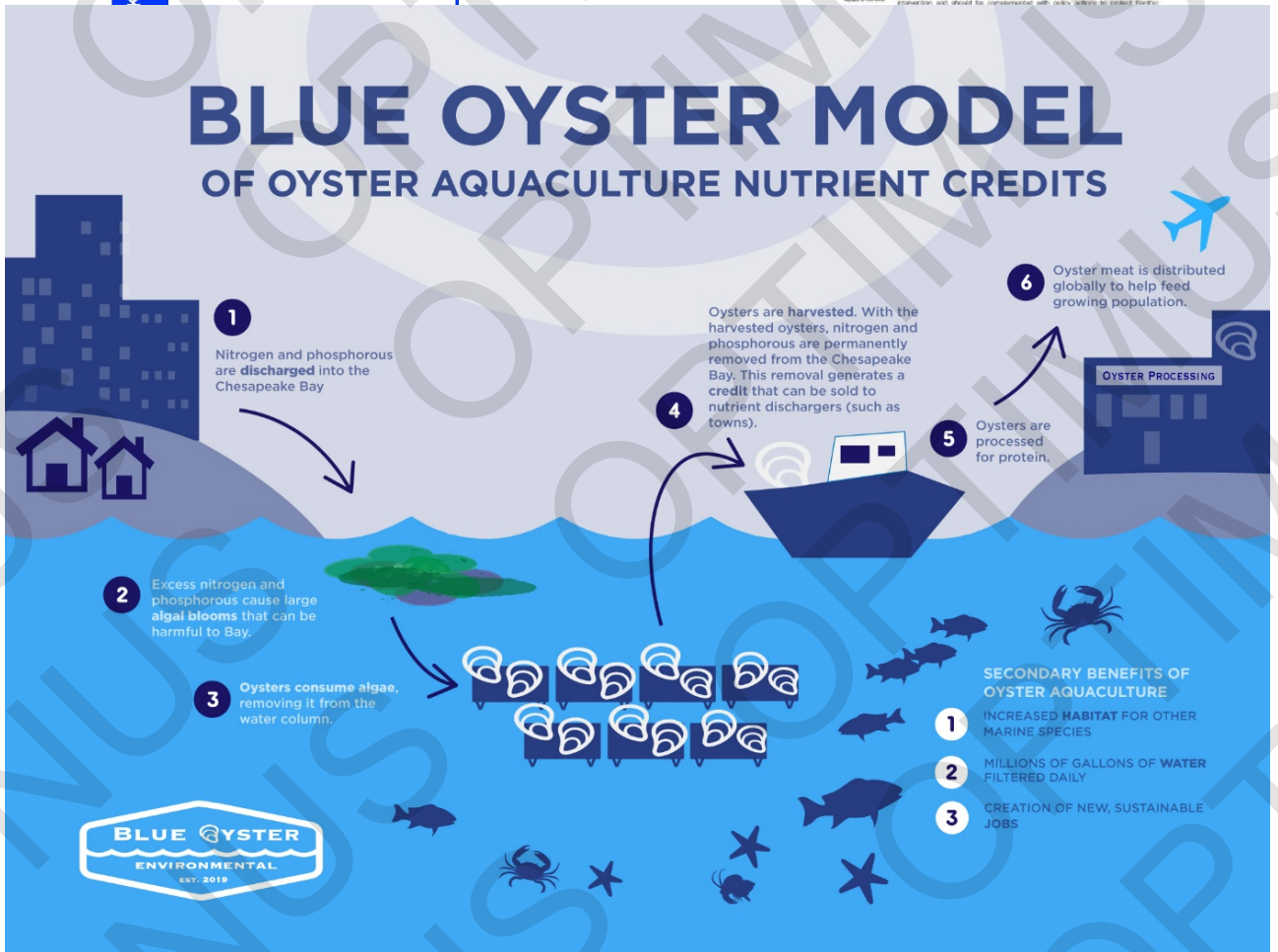


Prerequisite: *De novo* production, not harvesting standing stock

Historical context

Mariager Fjord 1997



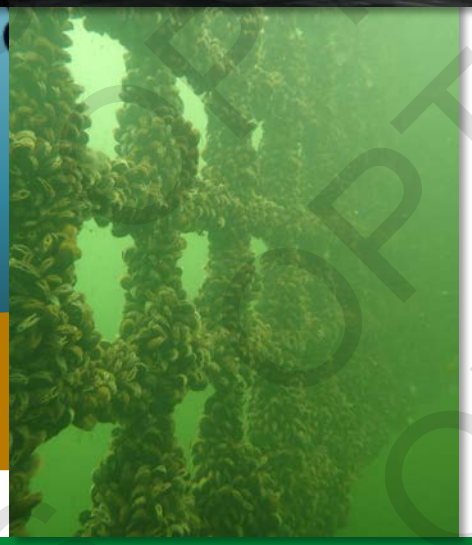


US nutrient credit trading

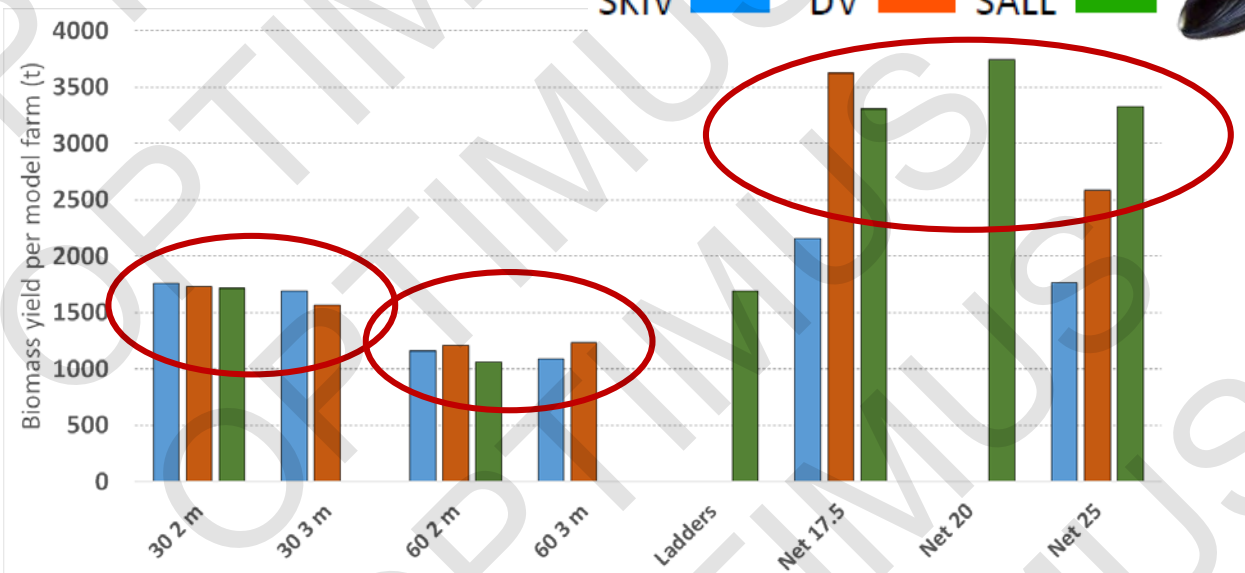
How is it done?

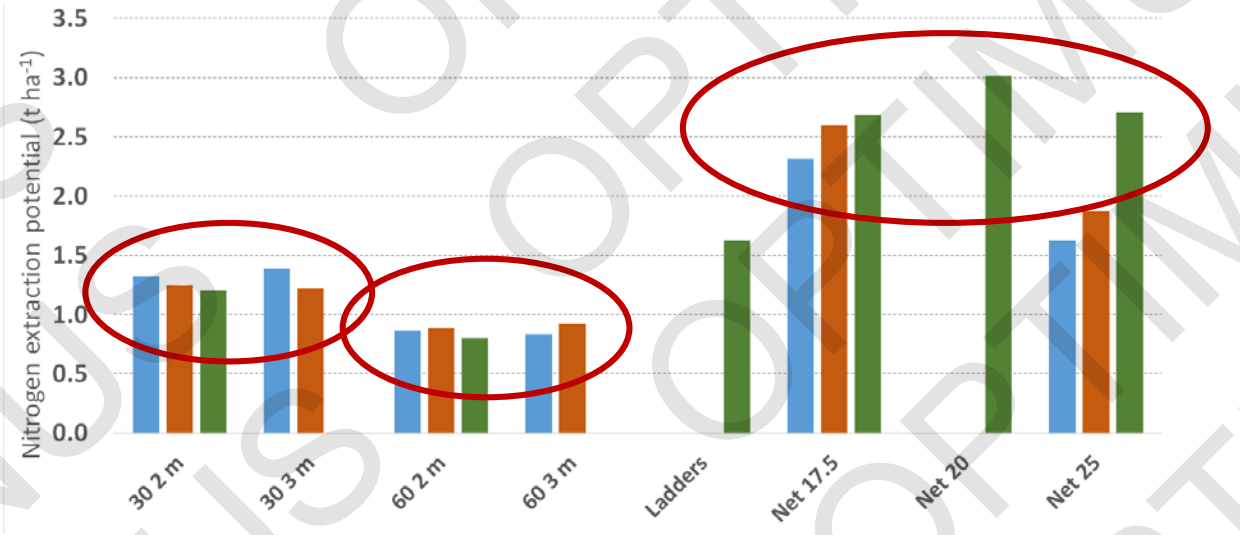
Longlines

Nets+Pipes

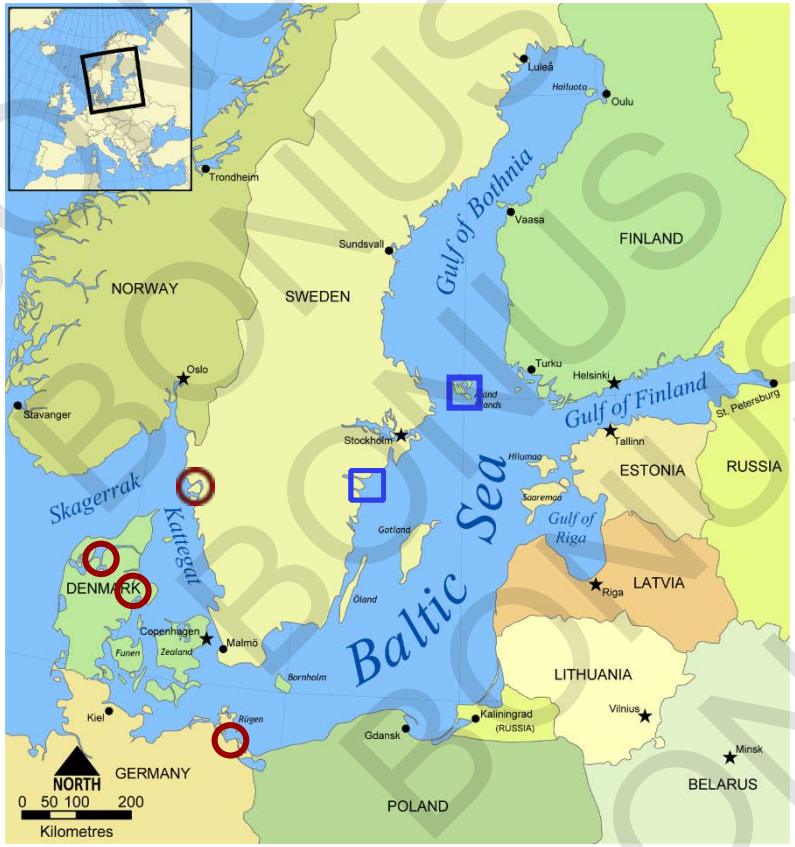


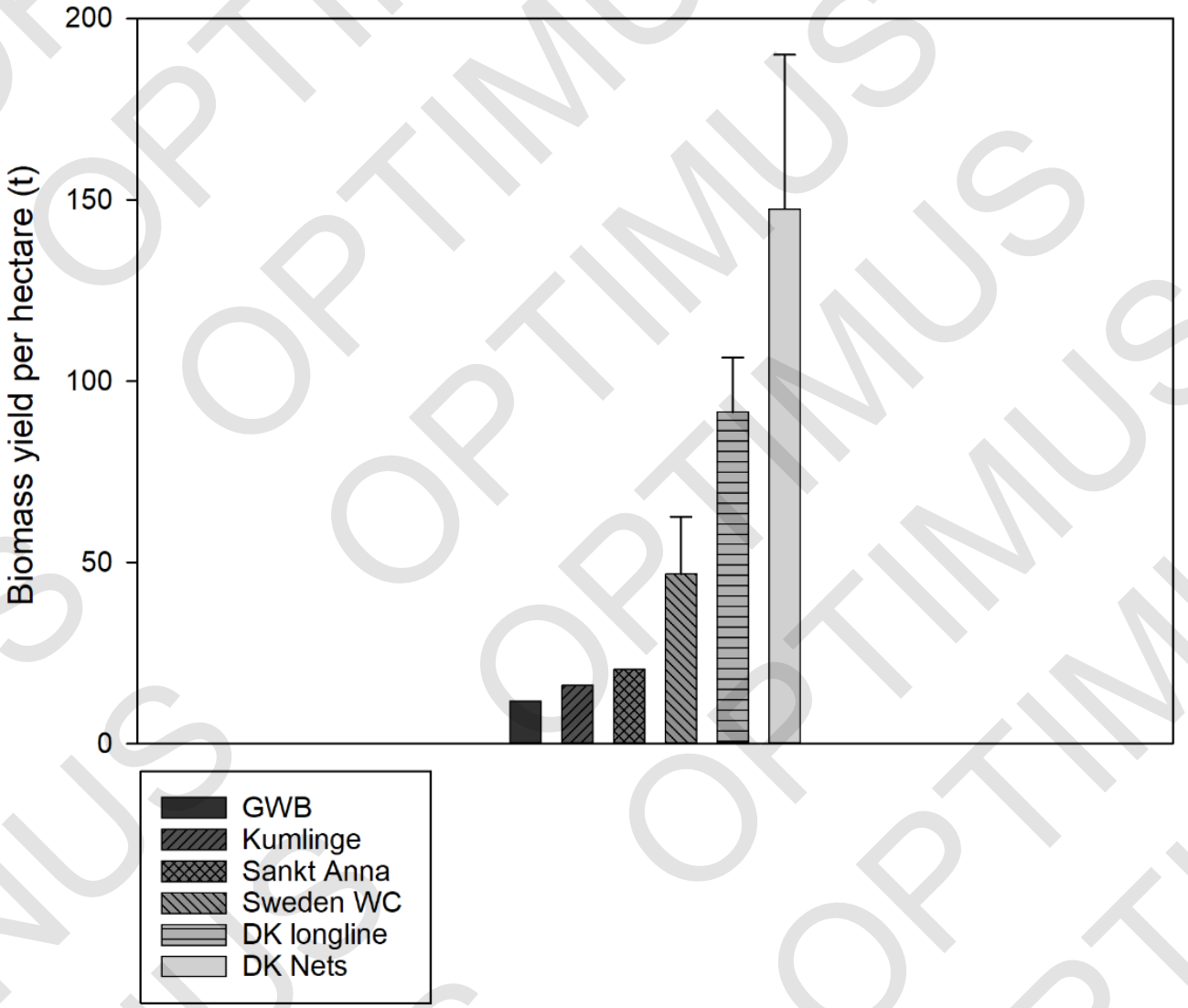
Ecosystem service:
N (& P) removal



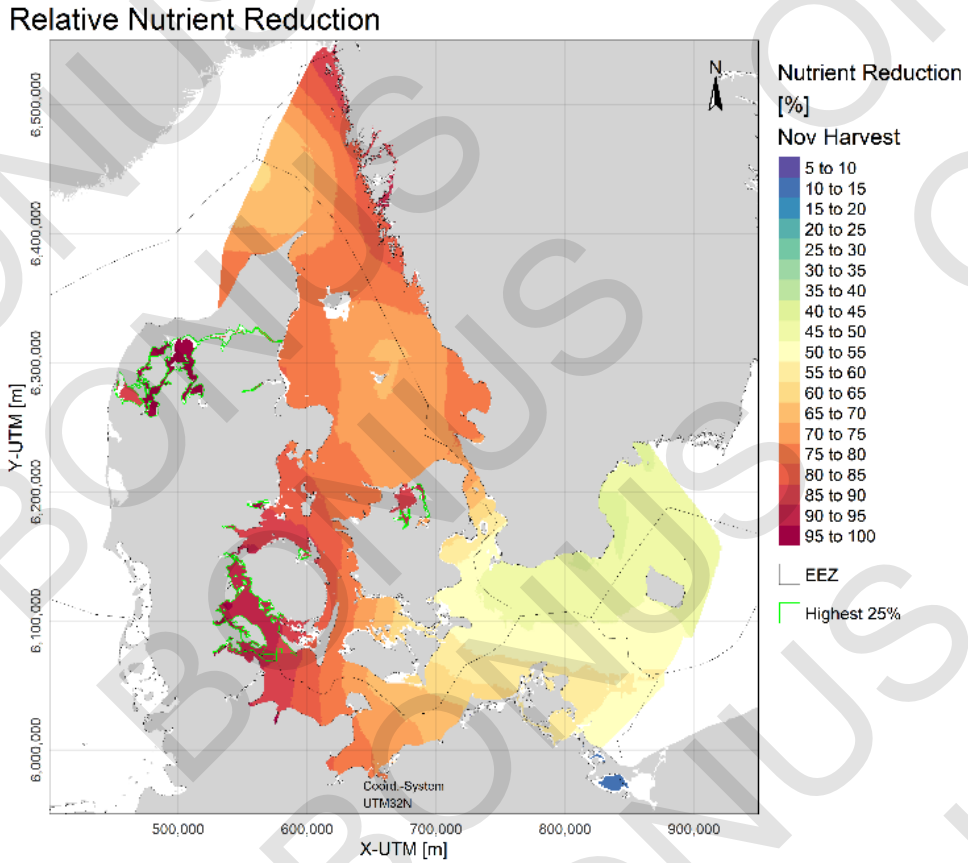


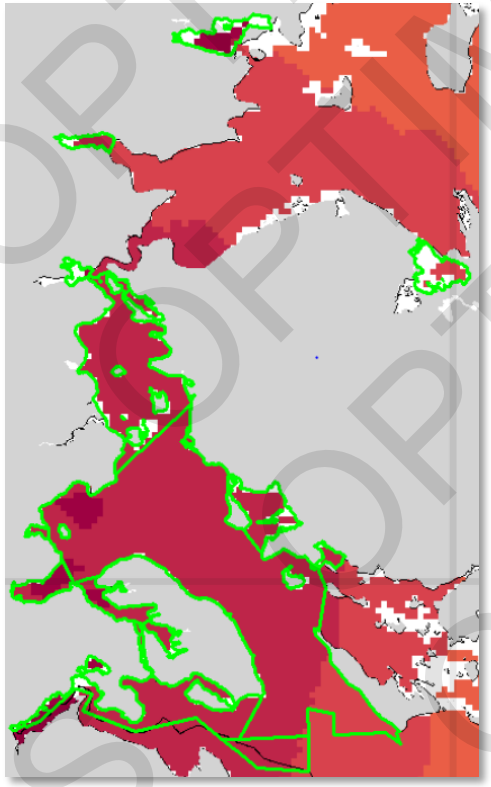
Baltic perspective

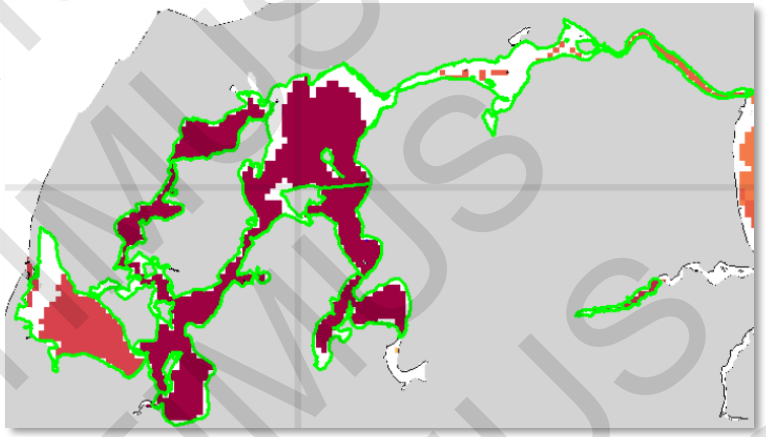




Western Baltic removal potential



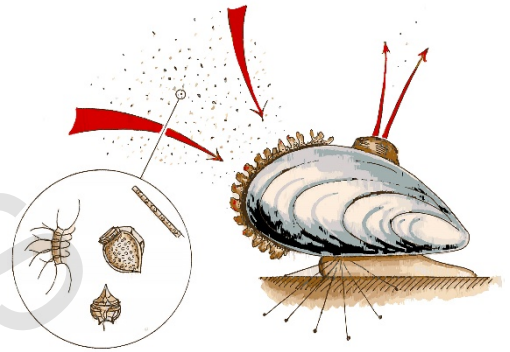


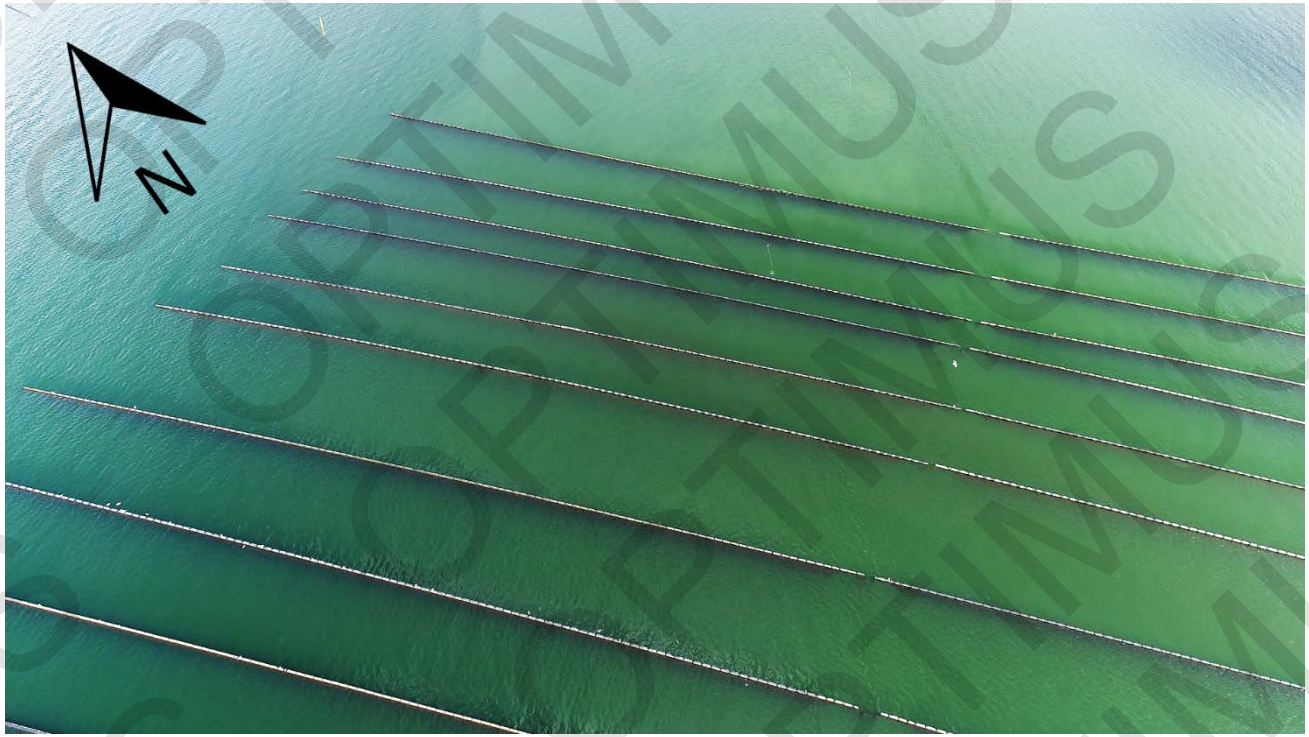


- Mussels can be produced in most Western Baltic waters
- Potential N removal depends on salinity, phytoplankon, cultivation technique, and water depth
- Relatively broad spatial variability
- Greatest relative removal potential in DK waters

100/red indicates:
Longlines: 0.7-1.4 t N/ha
Net+pipes: 1.6-3.0 t N/ha

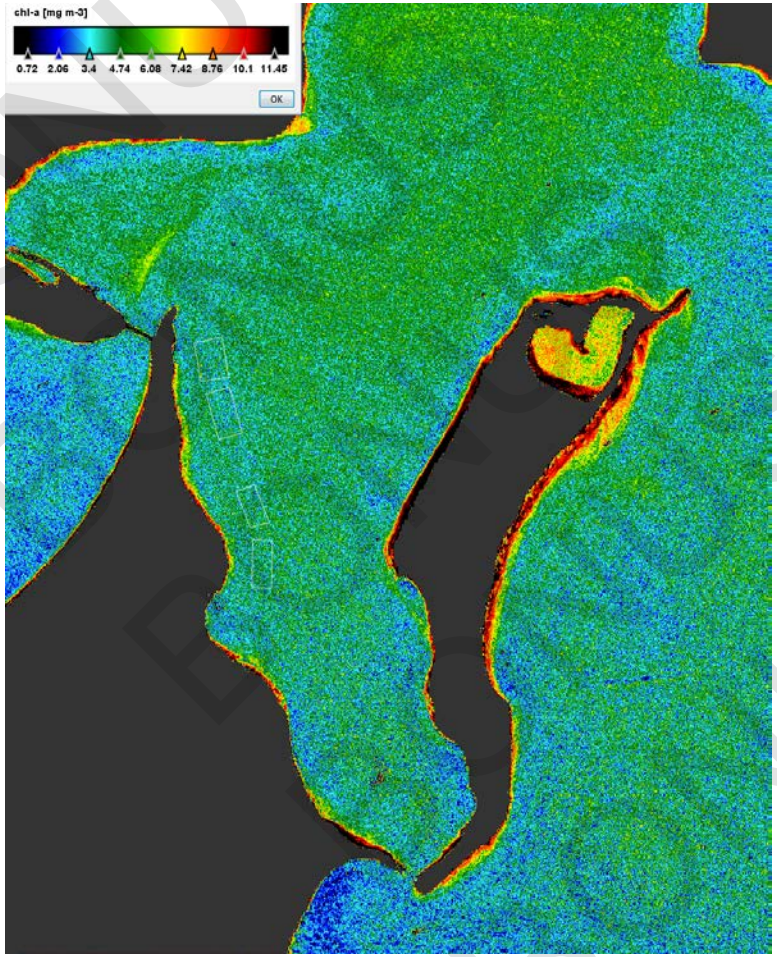
Ecosystem service:
Water quality improvement



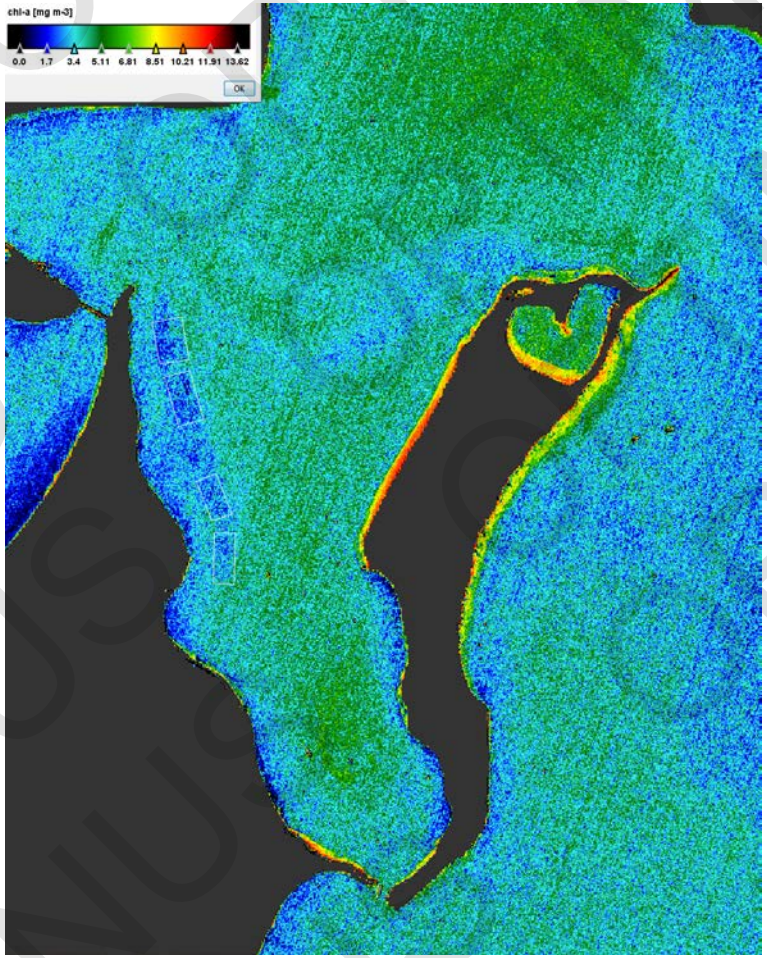


→ 3-7 km^3 daily per farm

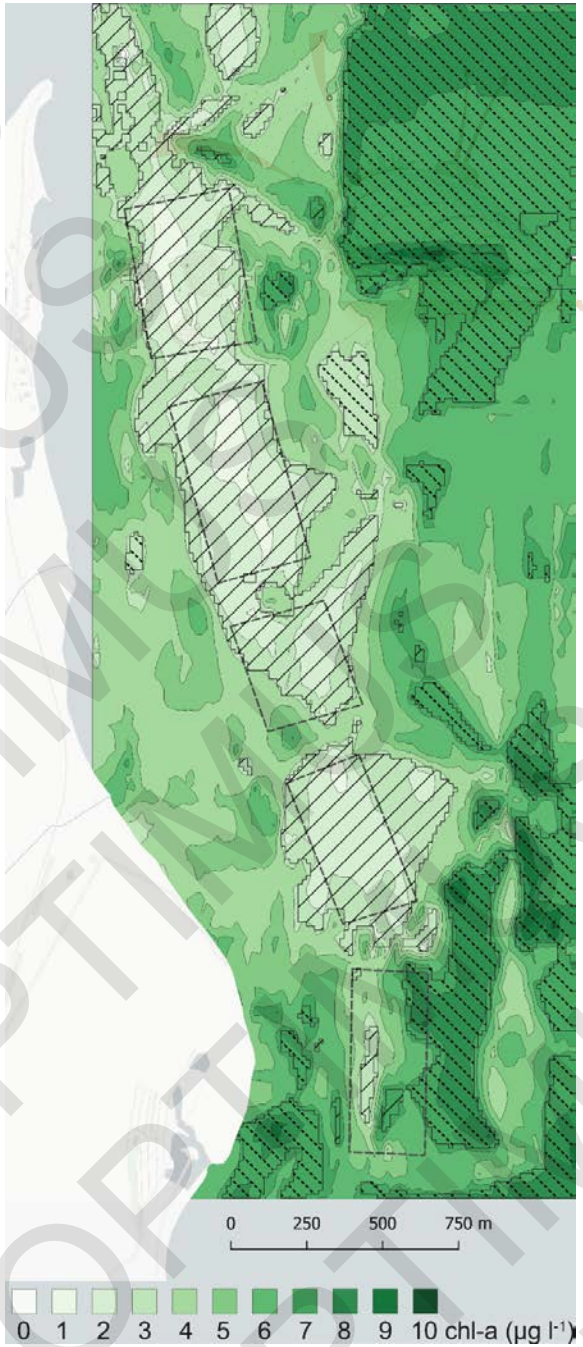
Effect of filtration on water quality



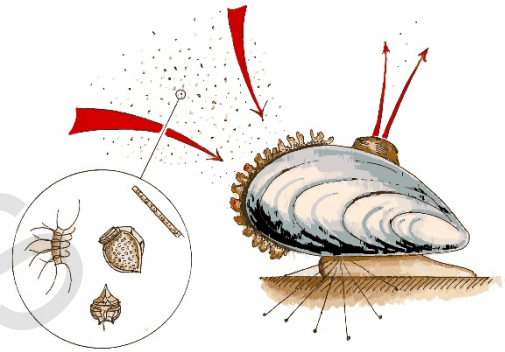
2018 – farm not operational

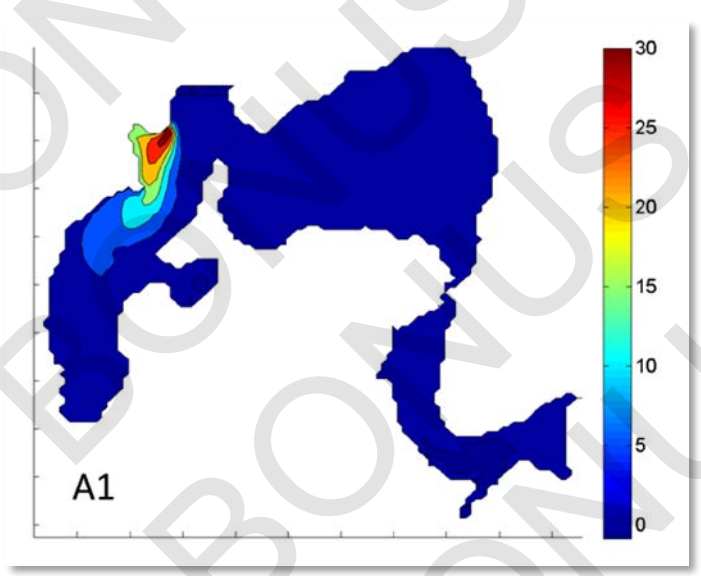


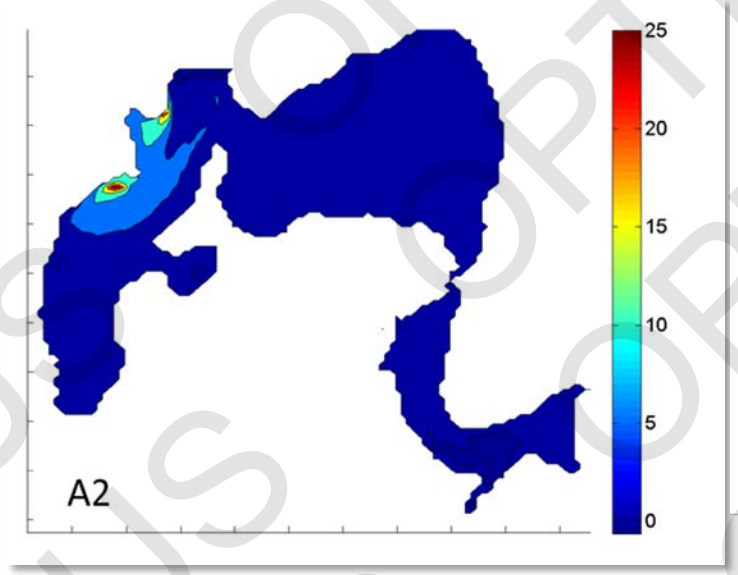
2019 – farm operational

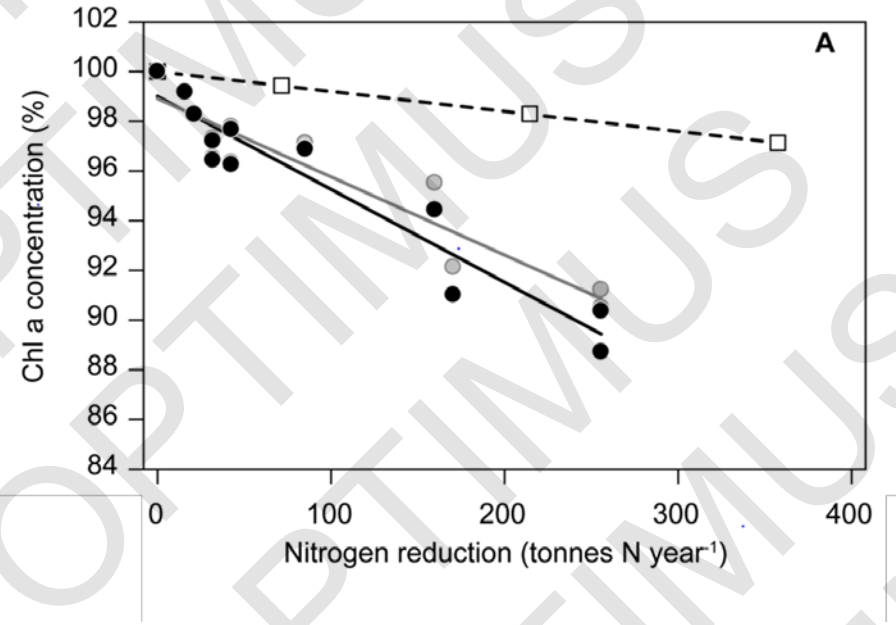


Effect of filtration on water quality



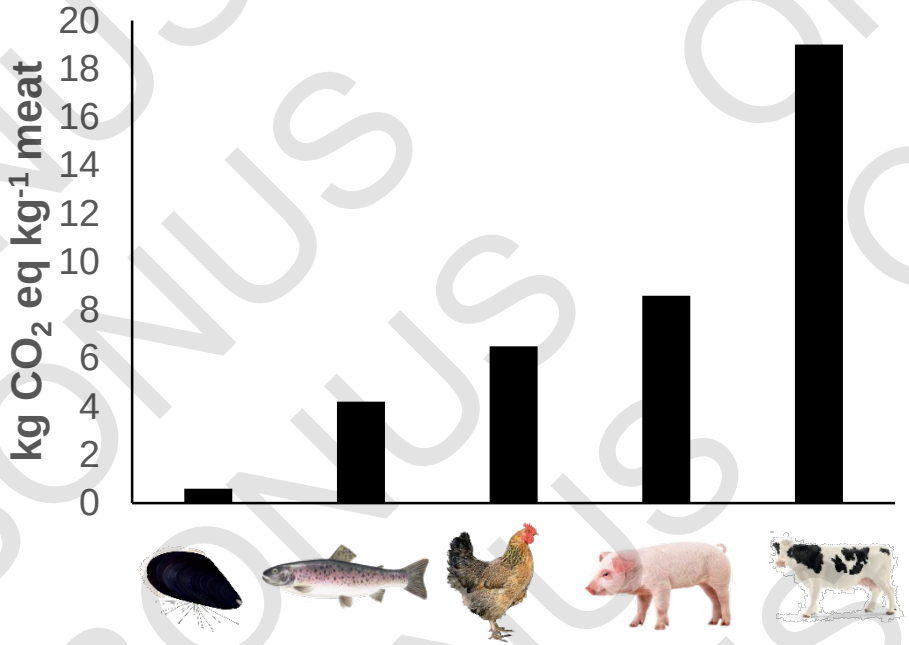






→ Chlorophyll concentration is significantly reduced around the farm and improves basin-scale water quality

Ecosystem service: Provisioning



	Indhold/100 gr
Protein	17,8 gr
Carbohydrate	4,1 gr
Lipids	2,8 gr
Water	73,7 gr

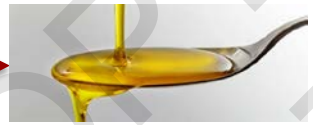
Processing options – focus on meals

Cook →  → Dry → 

Mussel meal
(0% shell
65-70% protein)

Mince → Dry → Sieve → 

Mussel meal
(?% shell
40-60% protein)

Mince → Freezedry → CO_2 ekstraction → 

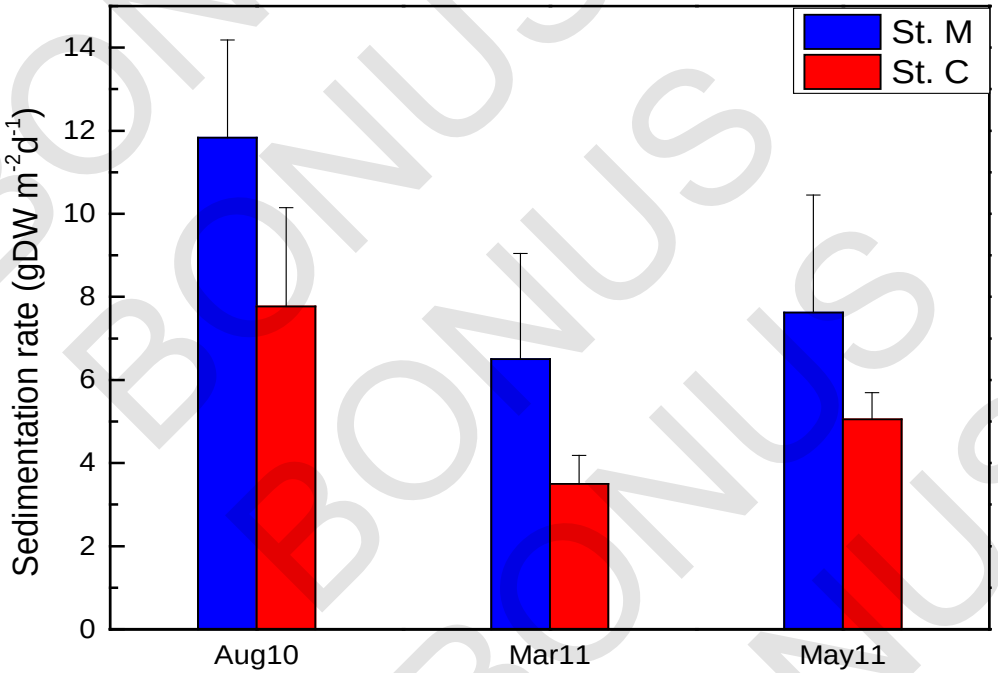
Mussel oil

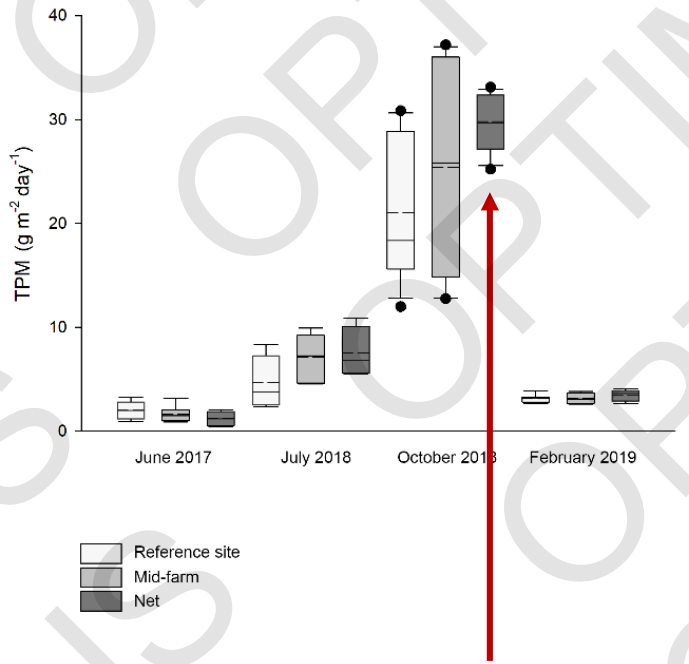
Freezedry → Water

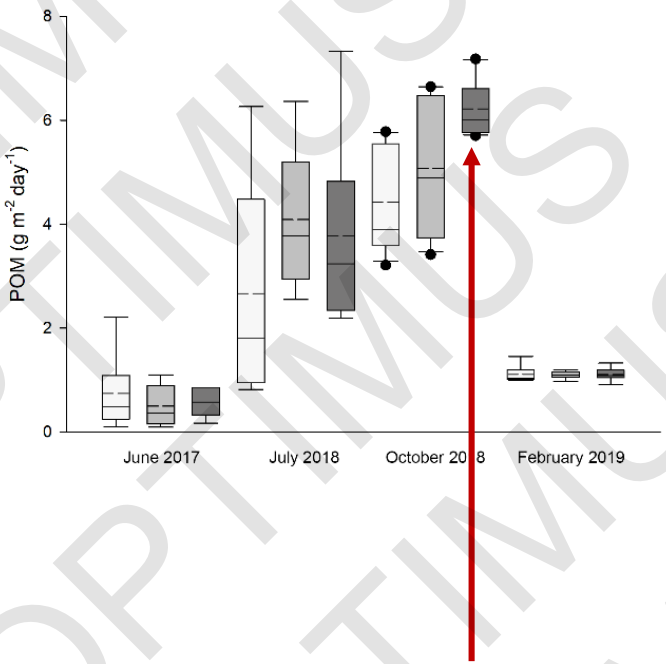
CO_2 ekstraction → Sieve → 

Mussel meal
(?% shell
50% protein)

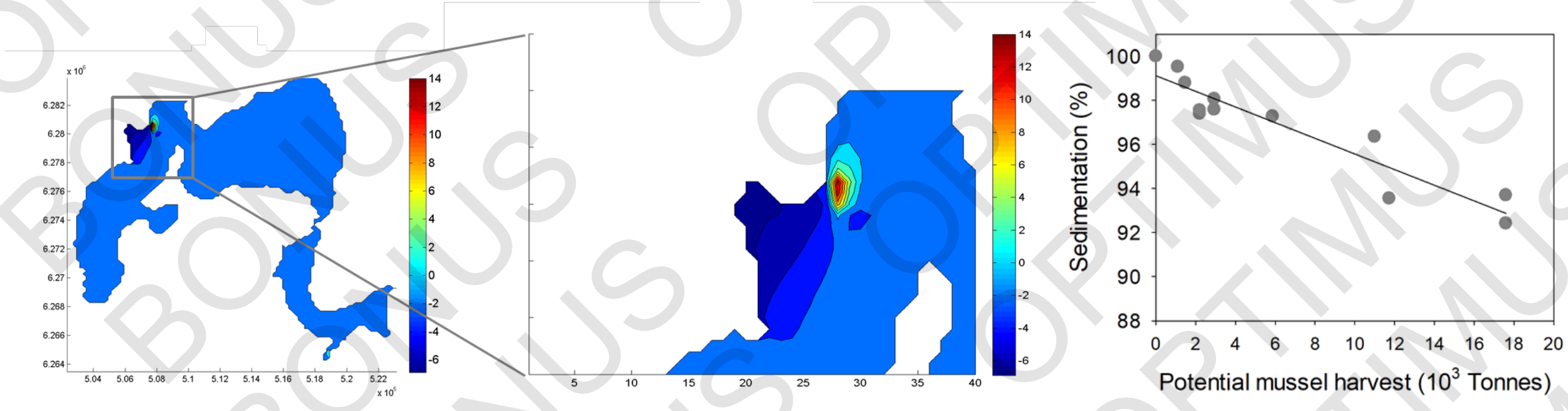
Challenge: Sedimentation





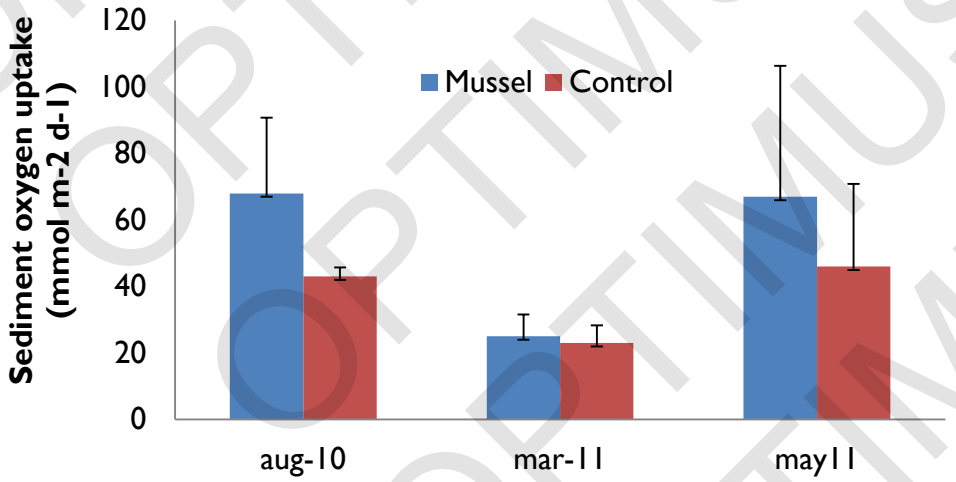


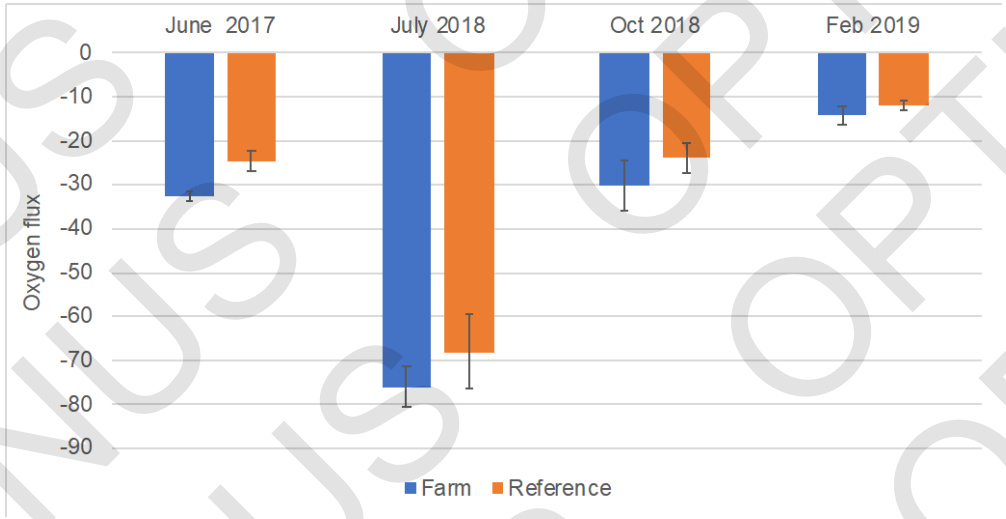
Bigger picture on sedimentation



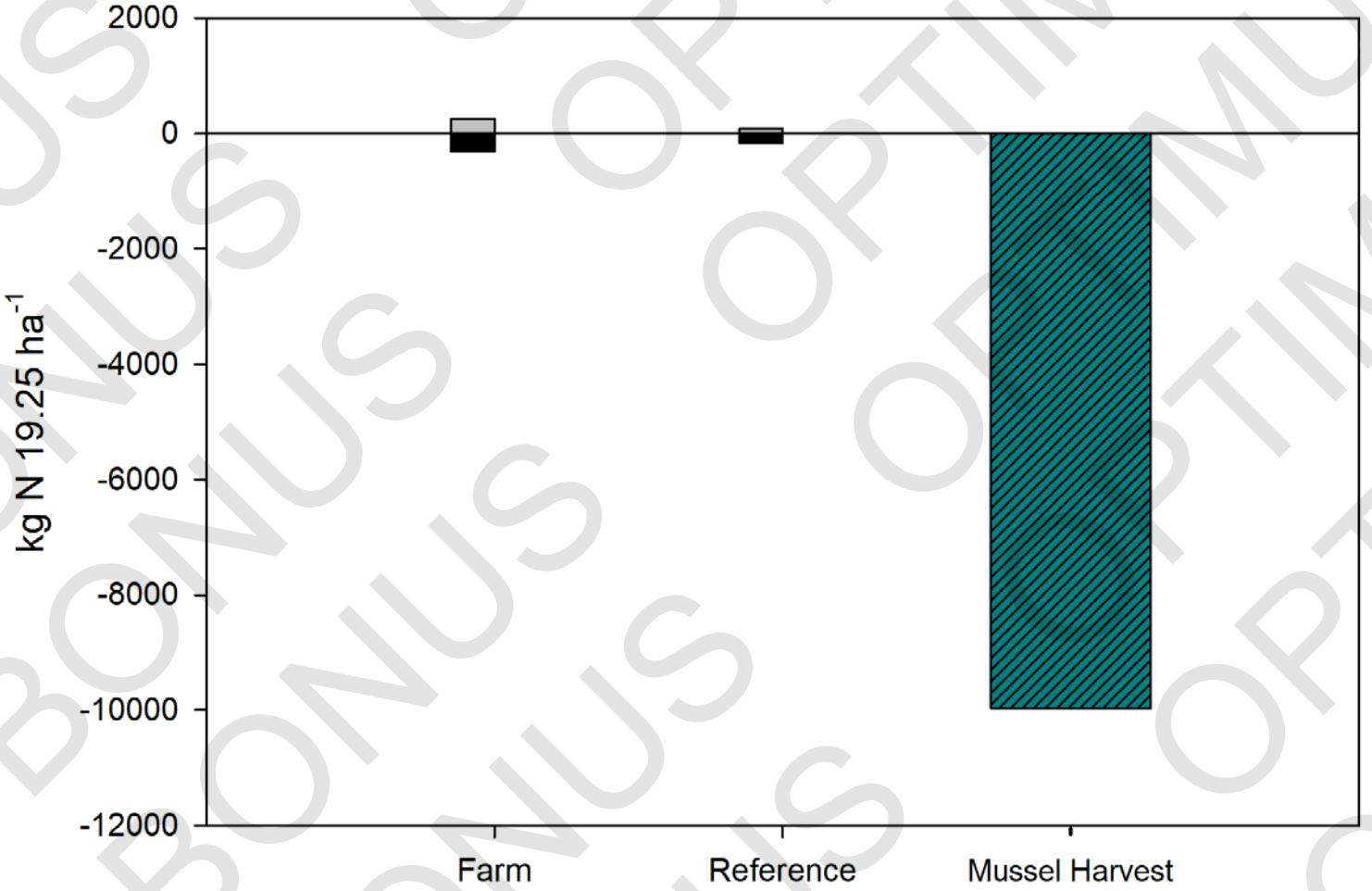
→ Although there is increased sedimentation under a farm, it decreases on a basin scale

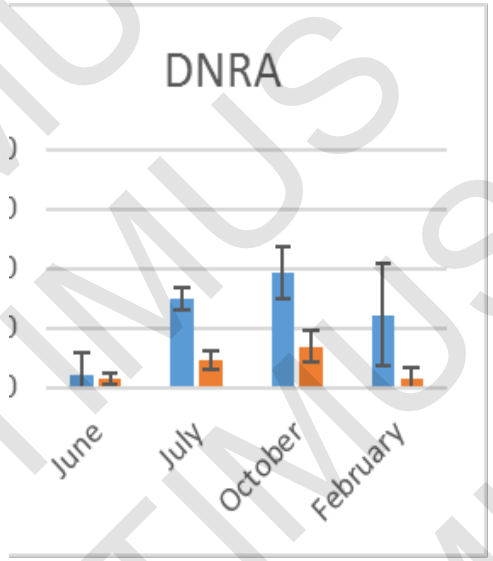
Effect of sedimentation - oxygen



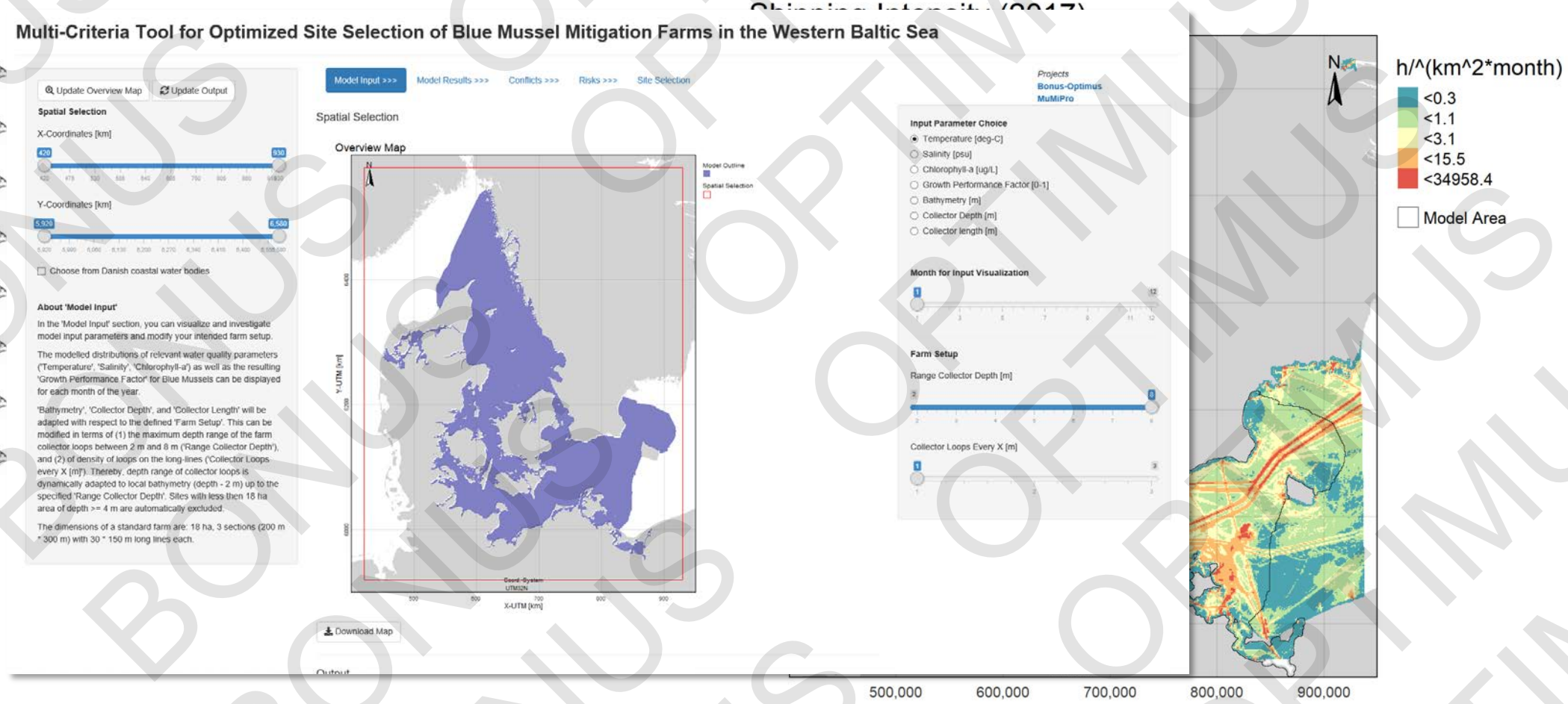


Effect of increased sedimentation - nitrogen





Challenge: Site selection



Eider ducks – a special challenge

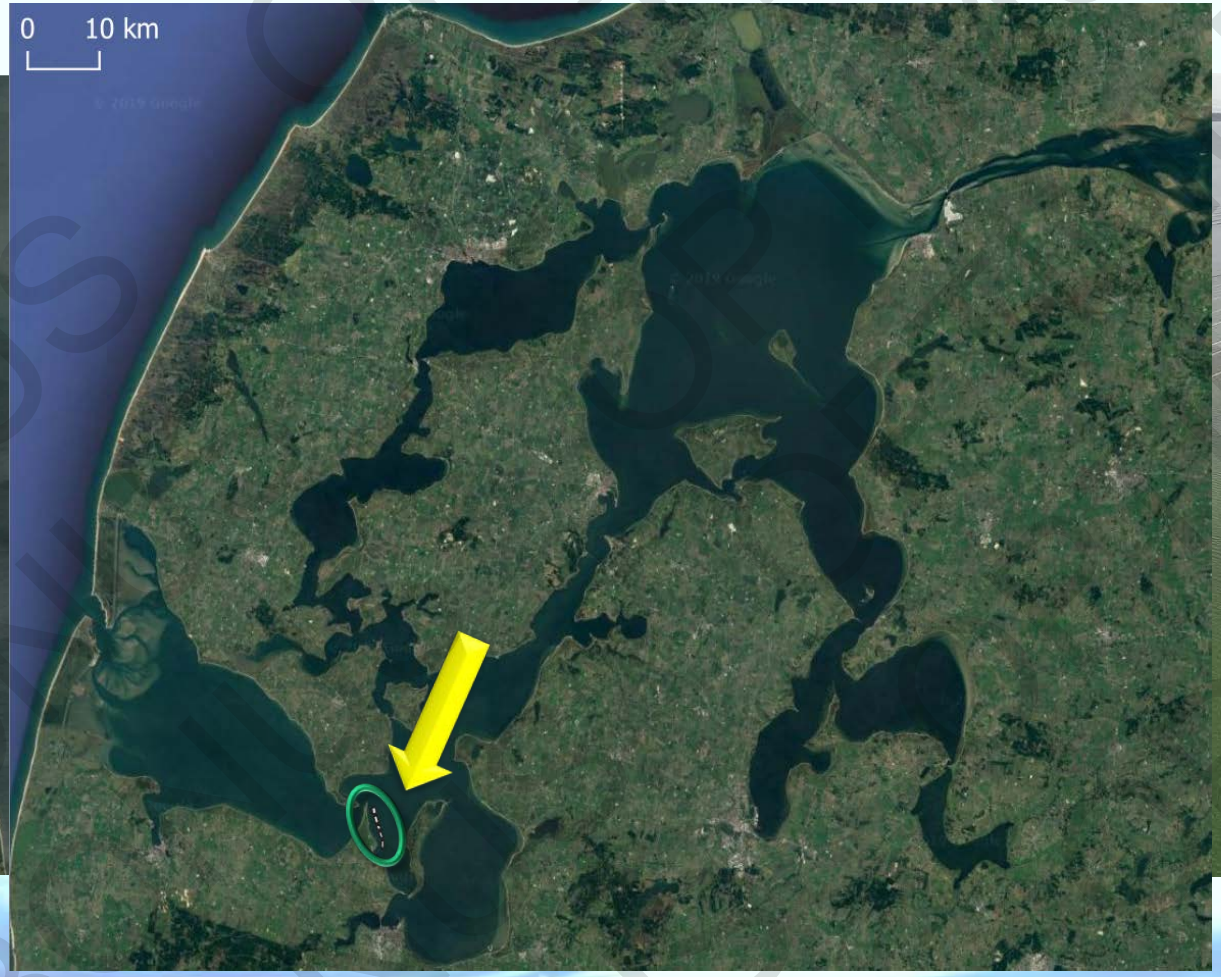
August

September

Measures:

- Harvest timing
- Protection ne
- Deterrents

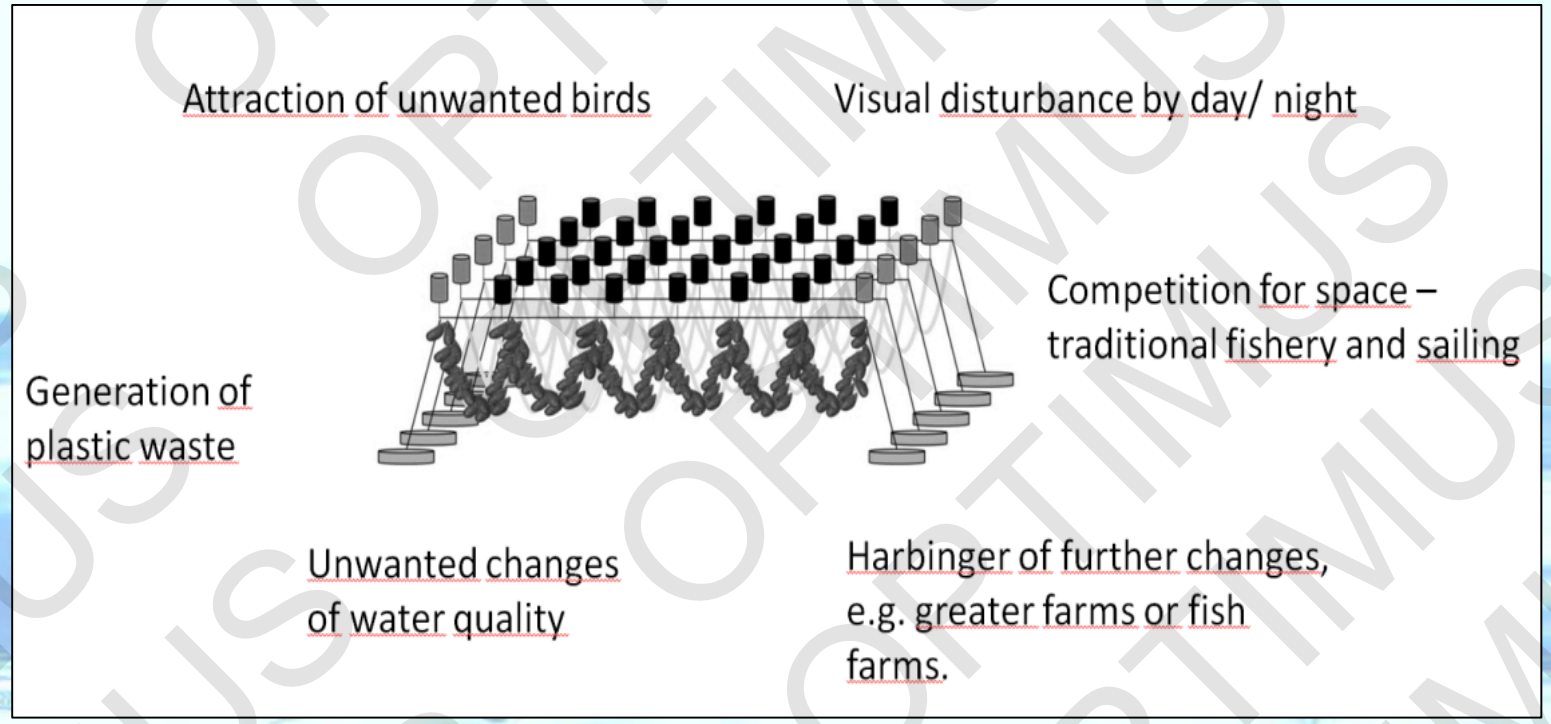
Challenge: Visual disturbance and social acceptance



→ Present annual removal capacity 100-150 t N

Social acceptance - main concerns

- Fish farming is coupled to mussel farming
- Space matters
- Longing for undisturbed scenery/nature
- Lack of proper regulation and management



Sources of social acceptance

Mussel cultivation in accordance with local values

- Sustainability
- Local identity

Stimulates local development

- Good to be frontrunner

Prevents unwanted measures on land

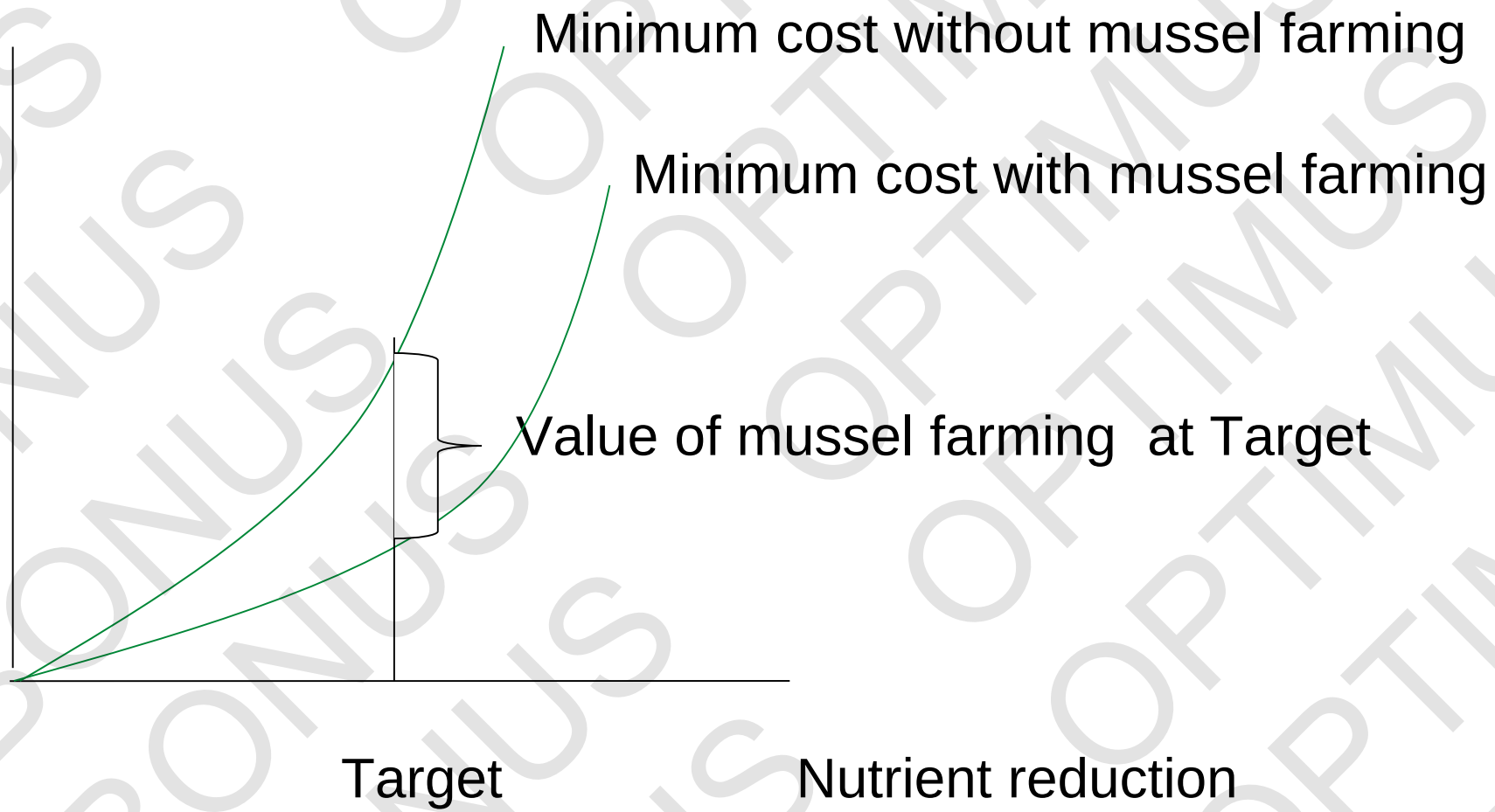
Summary

- Mussel cultivation can be an area-efficient tool that can remove 1.4-3.0 t N / ha in the top 25% most suitable areas.
- Net+pipe is the most efficient method for mitigation cultivation.
- Mussel cultivation provides other ecosystem services in the form of better water quality and sustainable protein sources that can be used for food or feed.
- Ecosystem services provided will require compensation to the operator.
- Implementation of the instrument requires local dialogue in relation to the use of the water areas.
- Social acceptance will depend on information on goods and services provided, dialogue with local stakeholders and firm control with the operation
- Placement of mussels as a tool will always depend on a specific assessment in the relevant water areas and can take advantage of expert knowledge.
- Further research and development is primarily necessary for optimization of farming practice in the central Baltic.

Economic value of mussel farming for nutrient removal

- Principle for value calculation
- Value of mussel farming for reaching HELCOM targets in the Baltic Sea Action Plan (BSAP)
- Local scale; nitrogen reductions in Limfjorden in Denmark
- Alternative policies

Principles for calculating value of mussel farming for nutrient removal

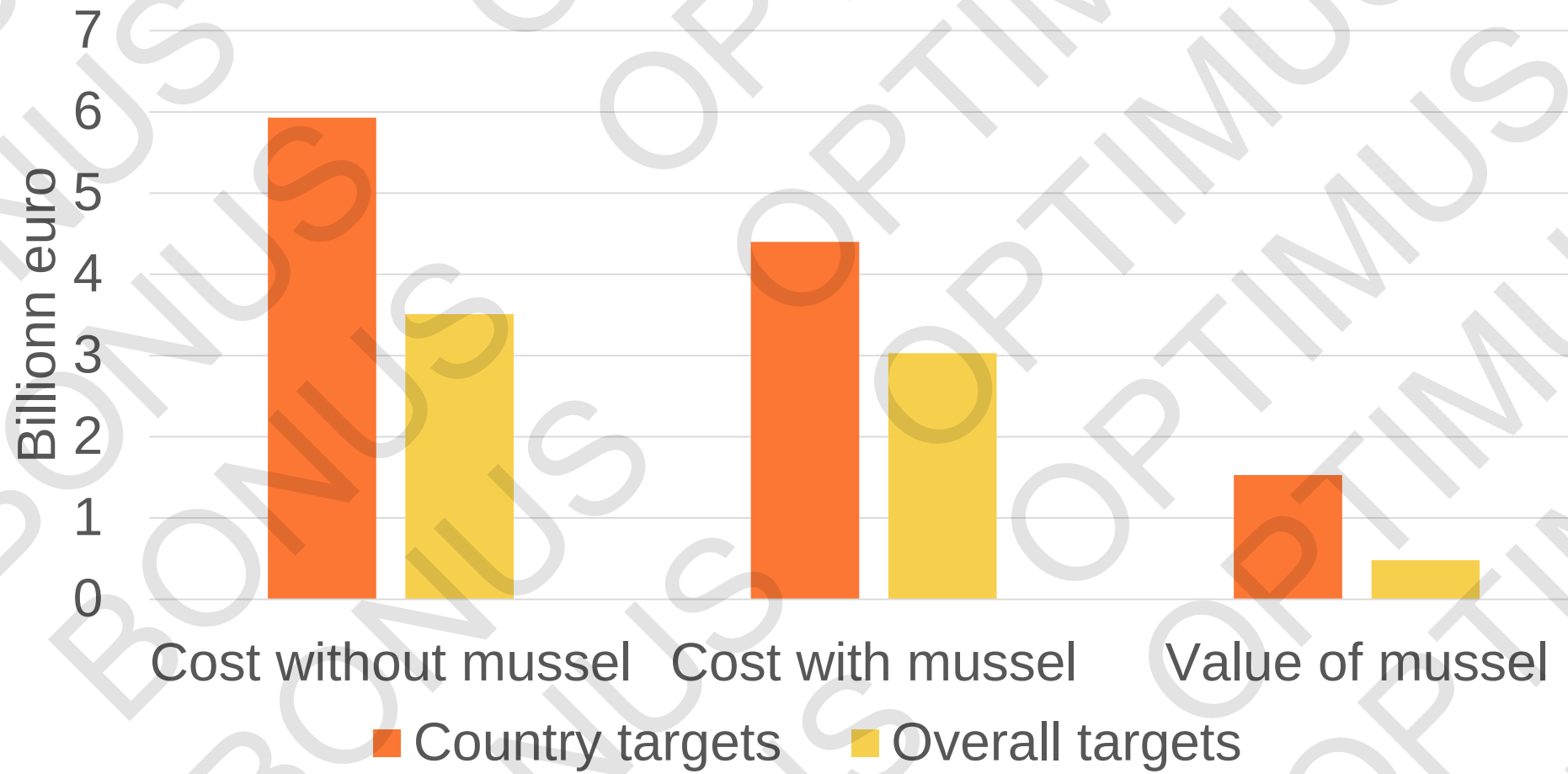


Value of mussel farming for BSAP

- **Costs and impacts on the Baltic Sea** from:
  - agriculture (livestock and fertilizers reductions, catch crops, increased grassland, construction of wetlands)
  - Improved cleaning at sewage treatment plants and industry
  - Reductions in air born nitrogen emissions

- **Targets**
  - BSAP country targets
  - Overall nitrogen and phosphorus reductions by 13 % and 48 %

Value of mussel farming in the BSAP under two target regimes, billion Euro



Allocation of values of mussel farming among mussel farmers and land based measures under two target regimes, billion Euro

Local scale: nitrogen reductions in Limfjorden, Denmark, Euro/kg nitrogen removal

	Location 1 with long line	Location 2 with nets+pipe
Cost of mussel farming	12.64	6.4
Cost of land based measures	16.75	23.85
Value of mussel farming	4.11	17.45

Policies for mussel farming: principle issues

- *Payments for nutrient removals*, mussel farming as an offset:
  -gives incentives for technological development
  - stacking (i.e. payment for both N and P reductions)
  - additionality
  - uncertainty in predicting nutrient removal

- *Payment for costs of mussel farming;*
  - no incentives for technology development
  - simple to measure (but, risk of misreporting costs)

- *Transaction costs from implementation, monitoring and verification*

Policies for mussel farming: examples from practice

- Mussel farming as an offset for increased cleaning at sewage treatment in Lysekil at the Swedish West coast (2007-2010). 3900 ton biomass to compensate for 39 ton N load from the plant.

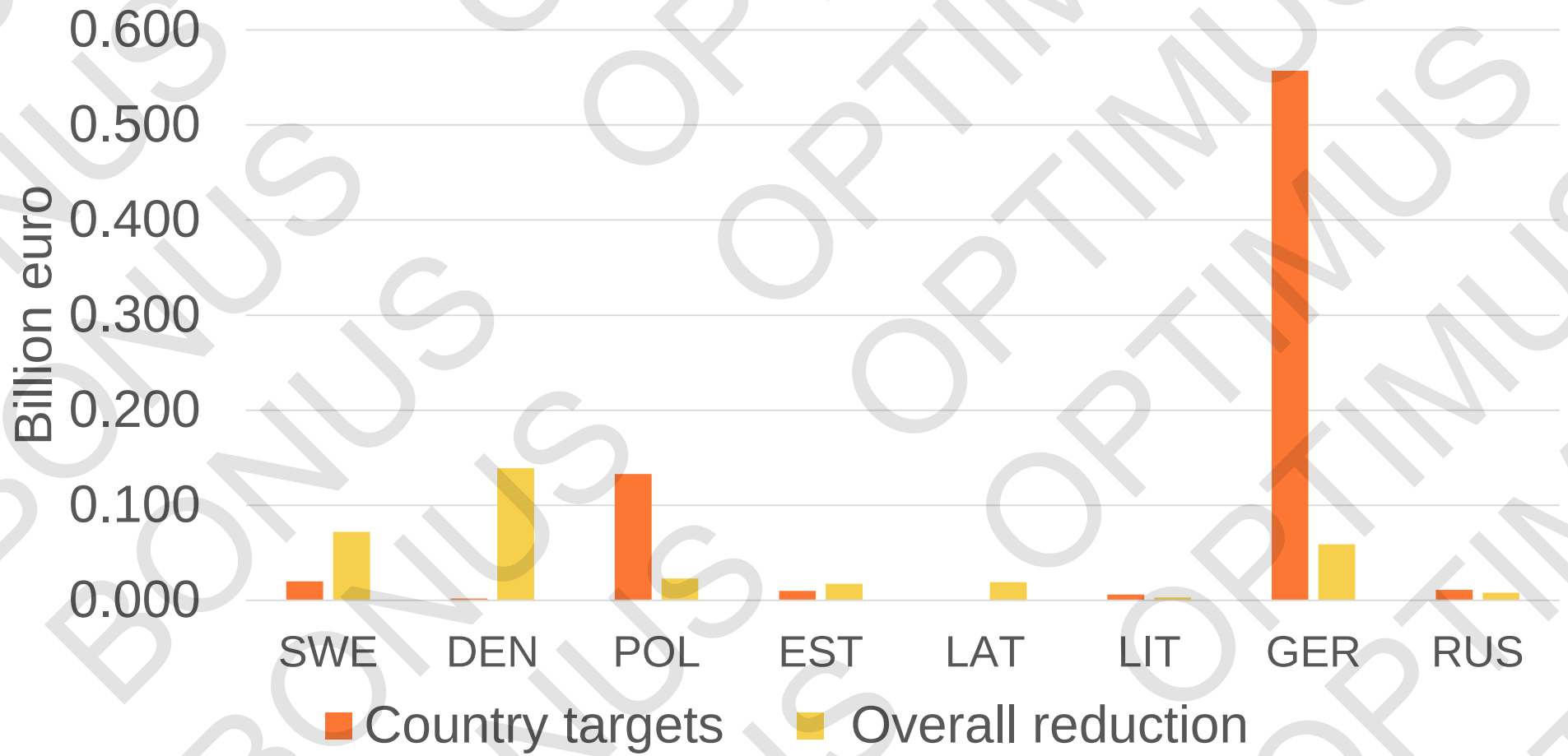
- Oyster as an offset for point sources in Virginia and Maryland with caps on emissions of N and P (2020 -)

Conclusions

- The potential economic value of mussel farming for nutrient removal is positive and can be high

- More focus needed on how to implement mussel farming (payment mode, additionality, stacking, monitoring and verification)

Profits for mussel farmers in a offset system for BSAP under two target regimes, billion euro



Questions

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