



Creating a Market for Compensatory Mussel Production

Marianne Zandersen, Berit Hasler,
Line Block Hansen, Jens Erik Ørum,
Hans Frost

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Overview of presentation

- › Motivation & Background
- › Starting points in creating a new services market
- › Framework for thinking about the set-up & Issues
- › Conclusions



Research question/Motivation

- › What is the scope for creating a market for compensatory mussel production?
- › Would farmers pay mussel producers for nitrogen uptake if the incentive is to avoid existing and/or new measures?
- › What are experiences from successful PES schemes
- › What issues to be aware of?
- › What type of set up would work best in the particular case?

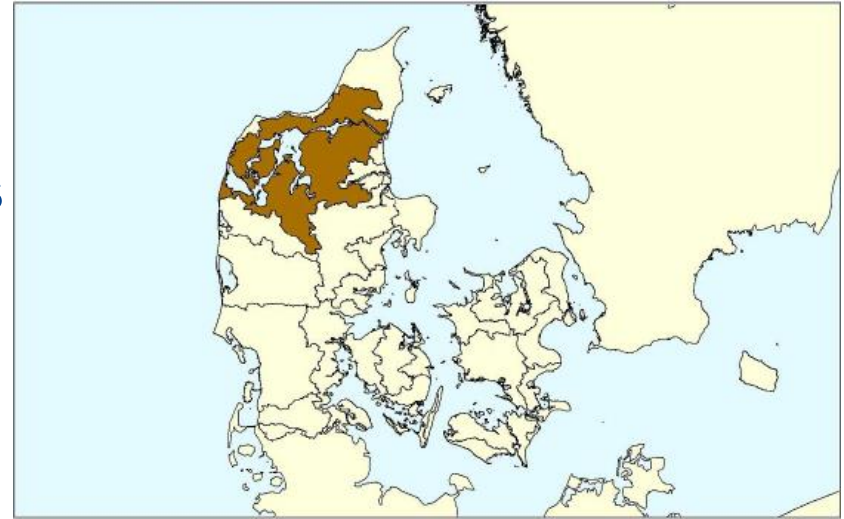


Starting points in creating a new market

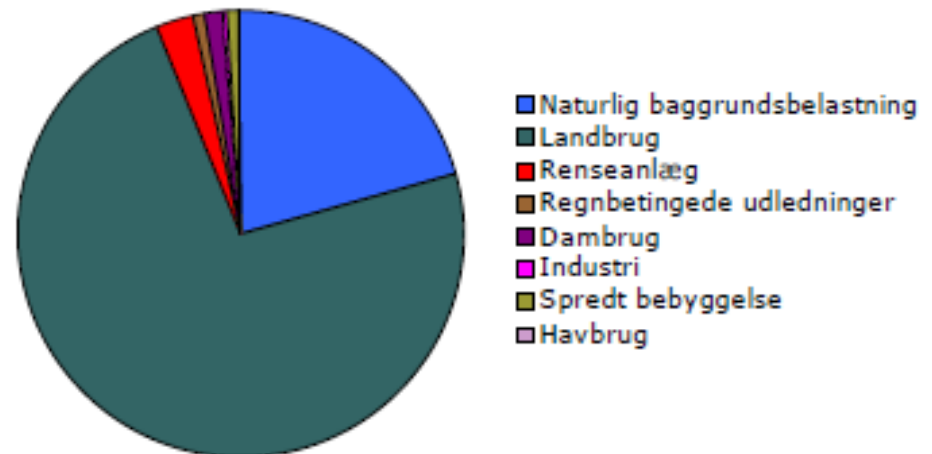
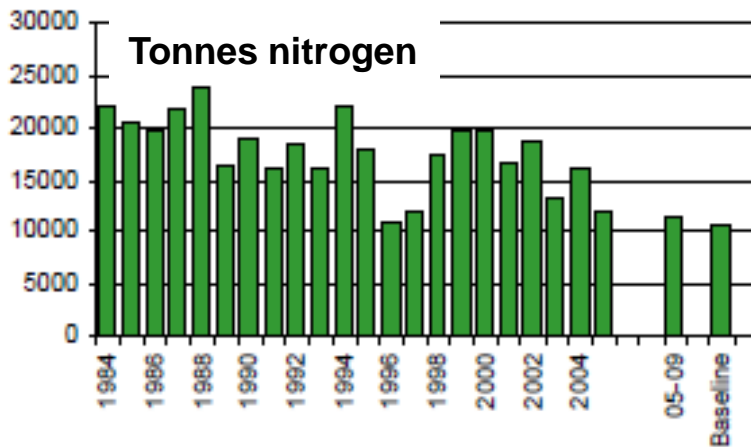
- › What is the problem & How many services are necessary/demanded?
- › What is the service provided?
- › How is it provided?
- › Who are the providers and beneficiaries?

What is the problem?

- > WFD target: good ecological status before end 2015 -> ■
- > Limfjorden: ■ & ■
- > 1st phase (2012-15): 1911 t N
- > 2nd phase (2016-2022): ca. 3770 t N



Nitrogen emissions by source 2005-2009 to Limfjorden



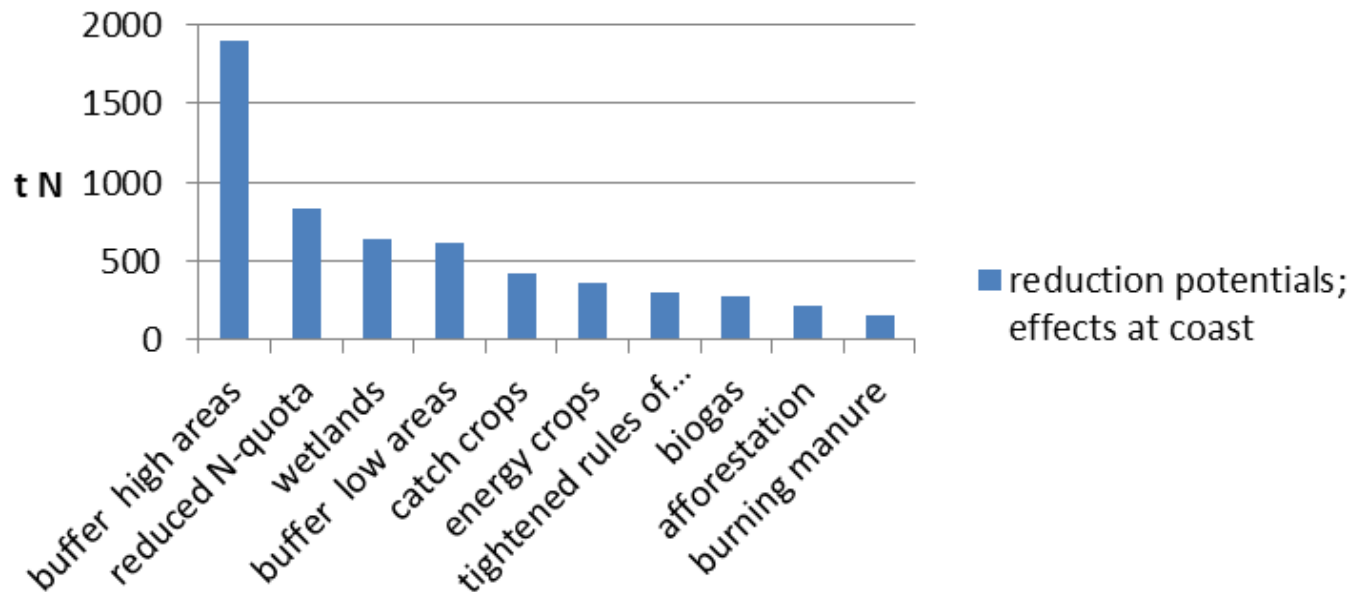


What is the service provided?

- > Excess nutrient application on farmland lead to leakage of nitrogen to Limfjorden -> eutrophication problems
- > Current land-based means to limit nutrient leakages: Farmers are subject to fixed non-tradable quota of fertiliser at 10 % below economic optimum. Also: tradable catch crop requirements between farms; in-between-crops; limitations to the timing of fertiliser application; burn fibre fraction of manure; tax on phosphorous in fodder; public payments to establish wetlands
- > New water-based means to reduce nutrient content in water body: Growing and harvesting mussels removes nitrogen and phosphorous from the water body -> compensatory mussel production

Potentials for land based nutrient reduction measures

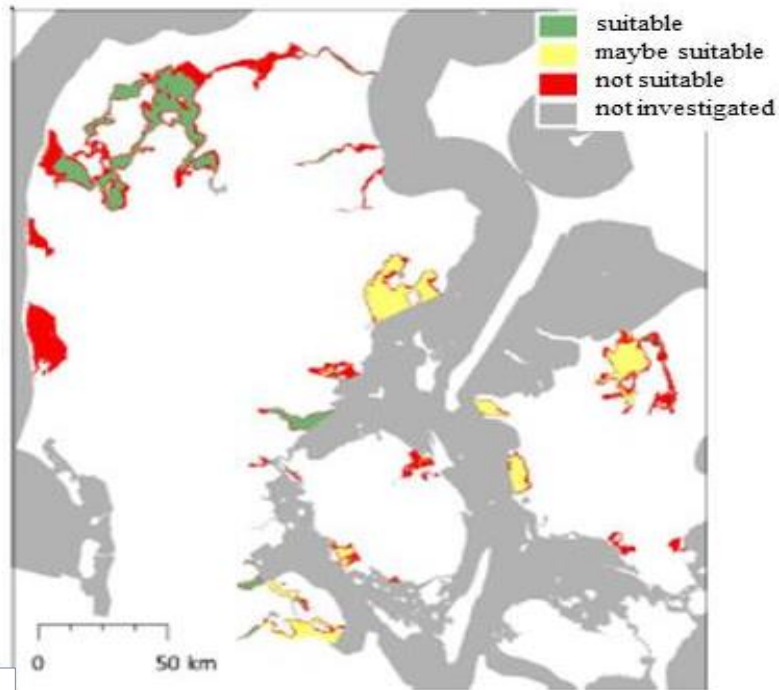
Landbased measures and effects, Limfjorden



Source: DCE (2012) Measures for N-reductions – potentials and effects [in Danish]

Aquatic nutrient reductions measure - *where and how much?*

Capacity for mussel production as
ES in Danish fjords



- › **Limfjorden: 34 000-51 000 t N maximum biological removal capacity**
- › The capacity has been estimated using data on salinity, depth (>5 m) and chlorophyll content (Petersen et al 2013).
- › Competing uses for the fjord area have not been taken into account.

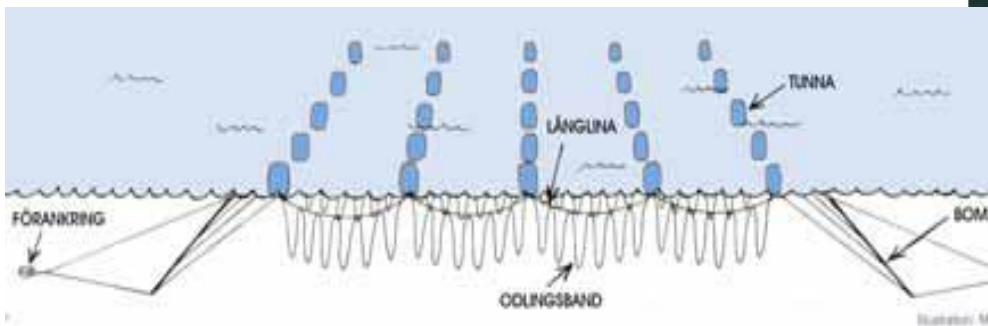
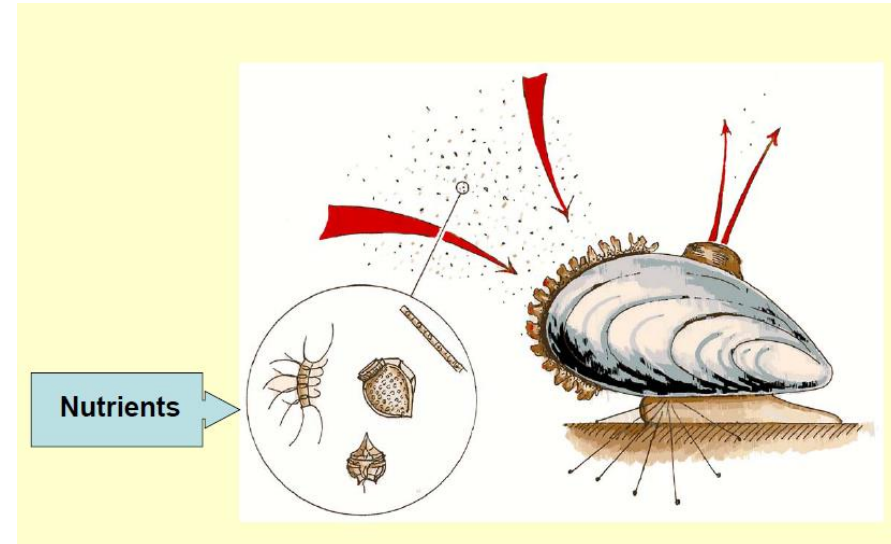


How is the service provided?

The idea is that mussel farming enterprises can be paid for harvesting blue mussels. These are harvested before reaching max. size

Blue mussels sequester nitrogen and phosphorous from the water body.

When harvested, N and P is removed from the water body





Who are the beneficiaries?

- › *Farmers*: off-sets or permits allow for changes in nutrient applications on fields i) increasing from current levels; ii) avoiding future reductions due to more stringent targets
- › *WWTPs*: off-sets or permits allow for avoiding additional investments in reducing N and P loads
- › *Government*: as a representative of society, government purchases services to reduce emissions that occurred in the past and that have accumulated in the sediment

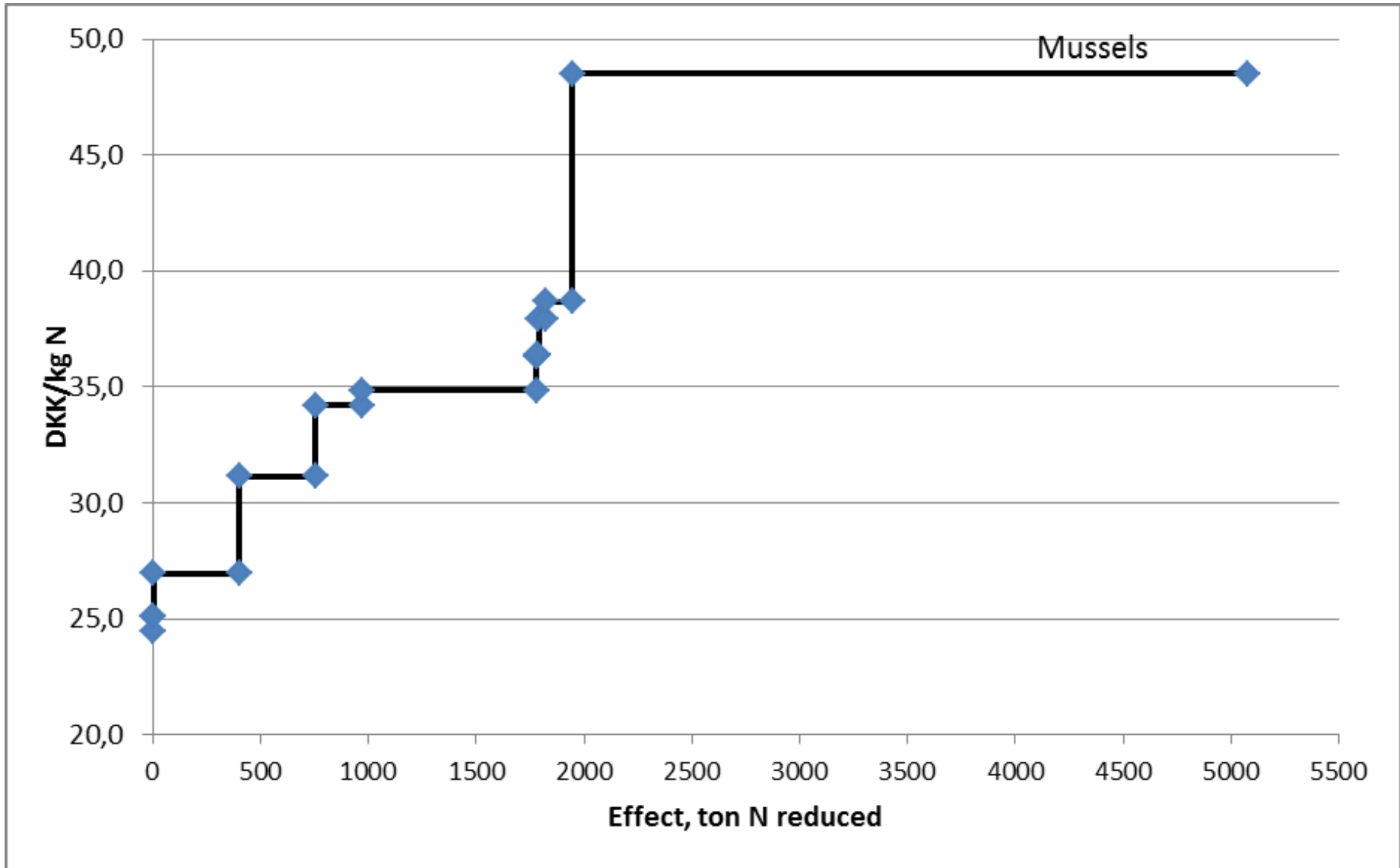


Why would beneficiaries be buyers of nutrient abatement services from mussel farming?

- › Average costs of agricultural nutrient reducing measures (Jacobsen, 2013):
 - 9000 t N : Marginal costs **40 DKK/kg N**
 - additional 10 000 t N : Marginal costs **150-160 DKK/kg N**
- › Costs of mussel nutrient abatement measures: **82 DKK/kg N**
- › The capacity of agricultural and waste water treatment measures is restricted; it's hard to find new measures, growing resistance among farmers
- › Nutrients bound in sediments in fjords and coastal areas also cause eutrophication through internal loading



Farmer Marginal N Abatement Cost Curve





Who are the Service Providers?

- › Currently 50 permissions to farm mussels in Limfjorden; different technologies in use
- › Efficiency in removing nutrients is lower in mussels grown for human consumption than in mussels produced for nutrient abatement purposes
- › Scope for new entrants in the market, if sufficiently attractive
- › Additionality issue -> should mussel farmers who already harvest mussels be paid for the nutrient removal service or should only *additional* farming that remove nutrients be paid?



Framework

	Off-set	No-offsets
Non-tradable	An agent (farmers/WWTPs) is allowed to carry out an activity that causes pollution if he also purchases an off-set that decreases the pollution by at least the same amount.	The agent provides an ecosystem service. The state compensates for the costs of delivering the ecosystem improvement
Tradable	Same as above BUT the property right for the nutrient harvesting activity may be exchanged via an intermediary before being used as an off-set	A cap is set on nutrient loads to the water body. The property right of the nutrient harvesting activity can be transferred several times unless already consumed

Framework & basic set up

	Off-set	No-offsets
Non-tradable	<p>An agent (farmers/WWTPs) is allowed to carry out an activity that causes pollution if they also purchase an off-set that decreases the pollution by at least the same amount.</p> <p><i>Self-organised</i></p>	<p>Mussel farmers provide an ecosystem service by harvesting nutrients from the water body. The state compensates for the costs of delivering the ecosystem improvement.</p> <p><i>Public Payment</i></p>
Tradable	<p>Same as above BUT the property right for the nutrient harvesting activity may be exchanged via an intermediary before being used as an off-set.</p> <p><i>Trading</i></p>	<p>A cap is set on nutrient loads to the water body. The property right of the nutrient harvesting activity can be transferred several times unless already consumed.</p> <p><i>Trading</i></p>



Issues that are common across set-ups

- › *Discrete group of sellers* – no existing compensatory mussel farmers today; existing mussel farmers for consumptions + new entrants
- › *Ensuring service provision* – periodic verification of nutrient removals in harvested mussels
- › *Transaction costs* – potentially large TCs in upstart on sellers' side as new activity; Feasibility depends on gap between WTP and WTA. Other TCs: ecological studies, verification costs, facilitation of compensation market

Self-organised : non-tradable & offset

Mussel farming projects reducing N content in inland waters (1kg N=1ERU)



Emission Reduction Units (ERUs)

Period :
2016-2022



Compliance buyers
- Farmers
- WWTPs

Requirements: Auditing; Monitoring and Verification Reporting



Self-organised : issues

- › **Quality of service provision** – both buyers and sellers are not interested in the *quality* of the credit. Price and compliance matters -> need for third party verification
- › **Sufficient knowledge of biophysical links** between nutrient applications on fields and loads to the aquatic environment
- › **Information asymmetry** - buyers have at least some knowledge of their own opportunity costs for land based abatement measures on their own land -> reduces issue of hidden information
- › **Risk sharing** – buyers are compliance buyers & mechanism is output based -> risk of non-delivery is crucial.
- › **Additionality** – if current mussel farmers are paid for compliance purposes, water quality will decrease

Public payment : non-tradable & no offset

Mussel farmers harvest nutrients from inland waters (unit Nitrogen)



Units Nitrogen Removal

Period :
2016-2022

State buys nutrients removed





Public Payment: Issues

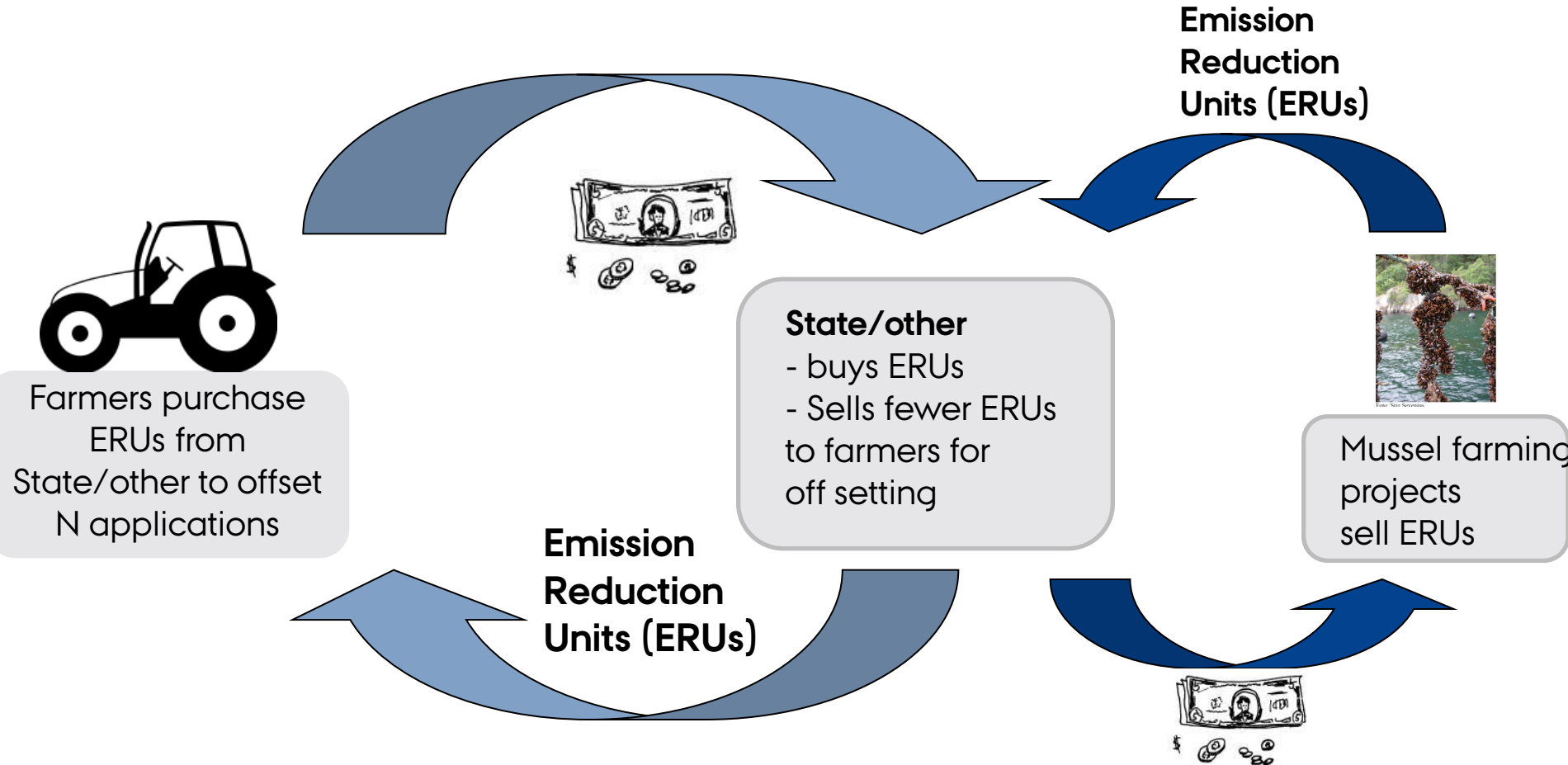
- › *Quality of service provision* – buyer is interested in the *quality* of the nutrient removal service. Price matters; efficiency matters.
- › *Information asymmetry & rent seeking* - if substantial heterogeneity in opportunity costs -> risk of adverse selection => try to shift burden of information to seller
- › *Risk sharing* – the state could have an interest in seeing this service provision extended from the current mussel farmers-> only measure available to reduce internal loading
- › *Additionality* – no risk of leakage -> existing mussel farmers can be included in payment scheme



Combining public payments and self-organising

- › Public body could pay both existing and new mussel farmer for the output of their activities (nutrient removal) while compliance buyers should only enter contracts on *additional* nutrient removals -> base year needs to be decided => periodic verification of nutrient content of harvest for production optimised for human consumption and production optimised for compensation
- › Risk issue: *Price risk reduction* through e.g. fixed forward contracts; *Production risk reduction* when farmers only use off sets for compliance once these have been delivered; Risk sharing through insurance or buffer production and contractual agreement;
- › Public body could act as intermediary carrying risks of underperformance

If the State were to carry the production risk issue for compliance buyers...



The State as an intermediary carries the risk that mussel projects underperform by keeping a credit reserve of ERUs. The State also keeps part of ERUs to compensate for past emissions



Conclusions: Public Payment

- › **Social and financial efficiency** is essential;
- › **No additionality concerns** as current nutrient removal activities represent a positive externality -> both existing mussel farmers and new entrants can rationally be part of the payment scheme.
- › Likely to **see heterogeneous costs** between mussel production for human consumption and compensatory mussel production -> adds to transaction costs on the public authority to reduce information rents and differentiate contracts
- › **Opportunity to combine** public payments and self-organiser schemes



Conclusions: self-organised

- › The compliance market necessitates extra vigilance wrt. **monitoring, verification and biophysical modelling.**
- › Additionality and risk of leakage means that **existing mussel farmers should be excluded from this market**
- › Immature compensatory mussel market means significantly **higher transaction costs in the beginning**
- › Farmers at least partly know their nutrient abatement opportunity costs on their own land and **risk of high information rent is relatively low**
- › **Risk sharing is a crucial issue**, especially as market is output based and farmers are compliance buyers
- › **Intermediary body necessary** to facilitate market; possibly lift (some of) production risks



And finally....

- › In terms of **cost efficiency and biophysical feasibility**, there is definitely a scope for including compensation mussels as one of several measures to reduce N load to and in water bodies
- › Without **public involvement**, facilitation and possibly risk mitigation, a private off set market is highly unlikely
- › **Very different from existing successful PES schemes** (output, water based, no/few discrete providers, immature production technology)



Thank You for Your Attention !

- › Acknowledgements :
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