How to turn EcoSystem Payments to Baltic Mussel Farms into reality?

WP 5, GoA 5.3:
Payment Schemes
SUBMARINER Network

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About

Baltic Blue Growth is a three-year long project (2016-2019) co-financed by the Baltic Sea Region INTERREG Programme. The objective of the project is to establish large-scale mussel farming and harvesting within the Baltic Sea as an additional measure to remove nutrients from the Baltic Sea as well as a way to close the protein cycle by using the farmed mussels within the feed industry. 18 partners from 7 countries are participating, with representatives from regional and national authorities, research institutions and private companies. The project is coordinated by Region Östergötland (Sweden) and has a total budget of EUR 4,7M.

Partners

- *Region Östergötland (SE)*
- *County Administrative Board of Kalmar County (SE)*
- *East regional Aquaculture Centre VCO (SE)*
- *Kalmar municipality (SE)*
- *Kurzeme Planning Region (LV)*
- *Latvian Institute of Aquatic Ecology (LV)*
- *Maritime Institute in Gdańsk (PL)*
- *Ministry of Energy, Agriculture, Environment and Rural Areas (DE)*
- *Municipality of Borgholm (DK)*
- *SUBMARINER Network for Blue Growth EEIG (DE)*
- *Swedish University of Agricultural Sciences (SE)*
- *County Administrative Board of Östergötland (SE)*
- *University of Tartu Tartu (EE)*
- *Coastal Research and Management (DE)*
- *Orbicon Ltd. (DK)*
- *Musholm Inc (DK)*
- *Coastal Union Germany EUCC (DE)*
- *RISE Research Institutes of Sweden (SE)*

CONTENT

Executive Summary

Despite efforts to improve water quality, the **Baltic Sea remains one of the most eutrophic waters** in the world. To reach the goal of good environmental status, more incentives for reducing nutrient inflow and uptake are needed. Most **efforts so far focus on reducing nutrient inflow** by using land-based measures. - A **complementary measure** suggested by the BBG project is the use of mussel farming to remove excess nutrients from the Baltic Sea as mussels by nature filter considerable quantities of water extracting nutrients and hazardous substances. **Mussel farming is currently the only well researched possible way of extracting nutrients from the water body**. Moreover - as shown by a multitude of studies - mussels perform also other important ecological functions, which generate or contribute to a variety of ecosystem services (ES) such as supporting services (e.g. nutrient recycling, habitats); regulating services (e.g. water purification); provisioning as well as cultural services (e.g. food and tools for jewellery). **This report explores how mussel farmers can receive payments for the provision of these ecosystem services.**

From an analysis of the **existing legislative framework** it can be concluded that all frameworks related to the Baltic Sea region **allow for mussel farming**, as long as mussel farms **support the objectives under the Water Framework Directive (WFD)** and **contribute or at least do not impede on the achievement of good environmental status** as promoted by the Marine Framework Strategy Directive (MFSD) as well as the HELCOM Baltic Sea Action Plan. However, the regulatory frameworks are rather guidelines with general goals and targets. The implementation of those targets is matter of the nation states or regions. **Concrete measures and especially payment schemes are not yet existent**.

The report then deals with the question of **who should pay for the ecosystem services** provided by mussel farming:

1. **Public funding schemes are available**. The European Maritime and Fisheries Fund (EMFF) even explicitly includes such payments. In most cases however, only general measures and priorities are given; how to fill them with life is up to the national operational programs. Moreover, the EMFF as well as other programmes **usually provide funding for the set up of mussels farms and/or short-term projects.** Currently a more long-term institutional funding would be necessary to reflect the ecosystem services provided by mussel farms.
2. Schemes based on the **polluter pays principle** are possible, but may entail the **risk that polluters may pay themselves off** instead of changing their behaviour. This is, however, to the detriment of the ambition to install a system, which is additional to all measures promoting reduction of nutrient inflow. As mussel farms deal with nutrients, which are already in the water, it may also be difficult to properly identify all polluters resulting in a rather unfair payment scheme.
3. To **make the beneficiaries pay seems thus more suitable**. These might be individuals, but also enterprises or public authorities. However, the **danger of free-riders should be minimised and motivation tools are needed**. Different forms of awareness raising and motivating are presented and discussed: ecolabelling and certificates, nutrient calculators and voluntary emission trading systems.

We then consider, how to **determine a fair and accepted prize** for the ecosystem services (ES) of mussel farms. We discuss the advantages and disadvantages of rather objective **cost-benefit calculations** versus rather subjective **willingness to pay** approaches. As shown, while exact amounts may be difficult to extract from the latter, all studies indicate a substantial willingness to pay as long as mussel farms can properly demonstrate that they indeed provide the ecosystem services the claim to deliver.

Finally, we compared the costs associated to mussel farming with the costs of other measure to reduce the nutrient content in the Baltic Sea. Roughly speaking **mussel farming is at a medium level**

of all measures regarding costs per outcome. However, it should be noted that mussel farming is the only measure to pick up nutrients already within the water body and should therefore not really be compared with land-based measures. Secondly as shown by the replacement methods, such comparisons are also case specific as the costs for land-based measures are also not linear. As shown, mussel farming may be a very cost efficient methods in areas, where other land-based measures are no longer possible. So, it seems reasonable to recommend mussel farming as one item in a mix of measures to reach the goal of good environmental status.

Our attempt to design an ES payment scheme for mussel farming in the Baltic Sea region shows, that we are far from having a full 'ready to use' scheme. With the current report, however, we hope to clarify many of the pertinent – often repeated – questions, when it comes to ES payment schemes for mussel farms. And perhaps even more importantly to provide arguments and inspiration to those, who may ask and/or ultimately decide on ES payments for mussel farms.

For the time being we can conclude that in short run a 'one size fits all scheme' may be unrealistic. While national legislation is important to create the necessary legal framework, ES payments for mussel farms should be tailored to the specific regional characteristics, where a mussel farm is situated.

To follow up with the original aim to develop a payment scheme, we recommend the following aspects:

1. Policies should refer to UN SDG 14 "Conserve and sustainably use the oceans, seas and marine resources for sustainable development" and explicitly mention that mussel farms are a contribution to both living seas and coasts.
2. Some EU-wide operational programmes are currently under revision: now is the time to influence decision-makers and for them to take actions. This does not only relate to the Directives such as the WFD or MFSD, but also the funding programmes. Here not only the EMFF is relevant, but also the restructuring of the European Agricultural Fund for Rural Development.
3. Also the current HELCOM Baltic Sea Action plan as well as the EU Strategy for the Baltic Sea region is currently reviewed and updated; sea-based e.g. measures dealing with nutrient content are considered to be included. It is now for the BBG and resulting mussel community to communicate the projects' results and lobby for such measures to be included, accepted and highlighted. HELCOM and its EU Member States should then in turn lobby on a European level
4. Examine the already currently available financial instruments, which are already available in the region / country. The EMFF may already enable mussel farming or may be easily restructured in such way, especially to lower the initial investment costs, but also for further support schemes necessary to promote mussel farming collectively (e.g. site plans, mussel cooperatives, testing payment schemes).
5. Voluntary or local payment schemes in which the benefactors pay are a good alternative or complementary method to ensure short- as well as long-term success. Benefactors may be individuals, enterprises as well as regional public authorities.
6. Regardless of the scheme, it is most important that mussel farms are supported and 'certified' in that they indeed provide the ecosystem services promised. While payments should be based on quantifiable parameters such as P/N uptake or water clarity; a clear, easy, common and cost-efficient monitoring & evaluation scheme should be adopted to showcase these positive impacts to the public.
7. Payments may be organised through reverse auctions, where those providing the best 'offer' for the ecosystem service provision are funded.
8. While emphasis lies on mussel farming as an additional measure to point-source schemes, it may also be interesting to be included as an alternative measure in case other traditional measures to reduce nutrient inflow are not possible or too expensive. Thus mussel farming can be included in a cost-effective abatement mix.

9. Local or regional schemes are the fastest way forward as it is a case by case decision, whether a mussel farm is the best measure.
10. The more mussel farms are established, the lower their cost and the higher the additional positive effects and ecosystem services provided by the mussels produced – as they can then provide an alternative protein source for the feed industry. Any current payment scheme should consider the additional costs associated by supporting the 'forerunners' of this business. This does not only relate to support to the establishment of mussel farms, but also support to act collectively and setting up cooperatives to reach the critical mass necessary to become an attractive supplier to the feed industry.

Last but not least, it is important that also the mussel farm operators learn to organise themselves as to speak with one voice towards policy makers, licensing administrations, the feed industry as well as to those, who want to support them.

1 Introduction

1.1 Mussel Farming - an additional measure to deal with nutrient uptake

Despite efforts to improve water quality, the Baltic Sea remains **one of the most eutrophic waters in the world**.[1] The situation in the Baltic Sea is exacerbated by it being an almost landlocked sea with a water renewal cycle of over 30 years, making its waters very sensitive to any pollution and discharges.[2] **Despite severe efforts and a decrease in nutrients flowing into the Baltic Sea, almost all of its waters are still assessed as having a bad eutrophication status**.[3] The majority of the Baltic Sea coastal waters still have **not achieved Good Environmental Status (GES)** according to the HELCOM Baltic Sea Action Plan.[4]

To reach GES in the Baltic Sea, **more incentives for reducing nutrient inflow and nutrient load** are needed. As 90% of the current anthropogenic nutrient flow originates from wastewater and agriculture,[5] further measures are needed to reduce the nutrients generated by these sectors. These sectors remain the main sources which need to be curbed. However, nutrient leaching from agriculture can never be zero as all land loses nutrient to the water environments. Nonetheless, to successfully combat eutrophication fully, we suggest dealing **additionally with non-point sources as well as the nutrient content**. One option in this context would be to make use of ecosystem services (ES) by implementing water-based measures such as mussel, seaweed or ascidia cultivations. Those are tested methods that have the potential to effectively reduce nutrient content in the water body.

Ecosystem services are "the benefits people obtain from ecosystems".[6] Besides other positive properties (see chapter 2) **mussels naturally filter considerable quantities of the water, consequently extracting nutrients (e.g. nitrogen and phosphorus) and hazardous substances**.[7] With this function, mussels contribute to mitigating eutrophication and to prevent harmful blooms of toxic algae.[8] Thus, mussel farming (in the context of the Baltic Sea we mainly talk about blue mussels) is considered to be one additional possible measure to combat eutrophication. The Swedish Agency for Marine and Water Management (SwAM) has already been investigating possibilities to reduce internal nutrient load in locally eutrophic waters. Additionally, the **Swedish Board of Agriculture is looking into the possibility to financially support the uptake of nitrogen and phosphorous by cultivating and harvesting mussels or seaweed**. Hence, there is interest by some countries as well as regions. In fact, **mussel farming does not only need investments, but also long-term ongoing commitment** provided by regional, national or private actors. But while for land-based measures providing ecosystem services in agriculture and wastewater treatment, there are already funding schemes readily available on the EU-level, **no such clear-cut incentives and instruments exist yet for water-based measures**.

1.2 Rationale and aim of the Baltic Blue Growth Project

The **EU-funded Baltic Blue Growth (BBG)** project dealt with this gap. So far, mussel farms for the purpose of nutrient uptake had only been established in the context of research-oriented projects

1 Tynkkynen et al. (2014)
2 Graneli et al. (1990)
3 HELCOM (2014)
4 HELCOM (2007)
5 Bartnicki & Benedictow (2017)
6 Millennium Ecosystem Assessment (2005)
7 Suplicy (2018)
8 Gundersen et al. (2016)

and therefore only a limited scope and limited timeframe of funding. The aim of the BBG project, however, **was to enable farms to run on a long-term, non-research basis**. At the core of the project are five pilot mussel farms. Based on these farms, in addition to a few other existing or previous reference farms, the project assessed whether full-scale mussel farming in the Baltic Proper is possible and if so, under what biological and financial conditions. Hence, the project aimed to find solutions; establish good practice and develop guidelines along all issues relevant to turn mussel farming into a viable blue bioeconomy activity within the Baltic Sea Region; be it technical, financial, logistical as well as regulatory issues. Moreover, the project intended to overcome barriers arising from a lack of awareness and understanding of these interlinked issues by stakeholders. On that basis we hope to inspire and provide arguments for regions, communities, NGOs and other actors interested in mussel farming for nutrient uptake.

1.3 Structure of this Report

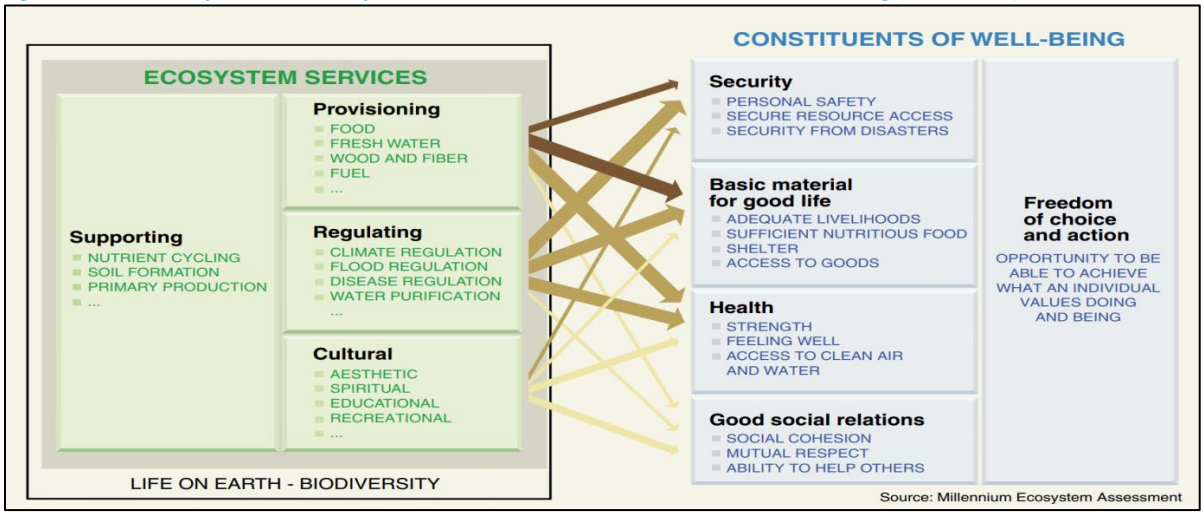
This report is part of the Baltic Blue Growth project and aims in recommending appropriate payment schemes for ecosystem services in mussel farming.

- In chapter 2 we define ecosystem services in general and ecosystem services provided by mussel farming in specific, for setting the scene.
- In chapter 3 we provide an overview of the legislative framework, influencing the possibilities and limitations of mussel farming in the Baltic Sea.
- In chapter 4, we look at existing funding bodies and approaches that could support mussel farms financially for providing ES. In this respect we discuss who should pay for the ecosystem service and also discuss mechanisms for awareness raising and motivation.
- In chapter 5 we discuss approaches to calculate a reasonable prize for the ecosystem services provided by mussels. We also compare the costs and benefits of mussel farms as provider of a specific ecosystem service in relation to other potential measures.
- In chapter 6, we outline first ideas and components of a potential ES payment scheme for mussel farming in the Baltic Sea, based on our findings in the chapters 3-5.
- As a final step, a set of key policy recommendations for designing and implementing payment schemes for ES are presented in chapter 7.

2 Ecosystem Services provided by mussel farming

Different definitions of ecosystem services (ES) can be found within the academic literature: Two of the most prevalent are provided by the Common International Classification of Ecosystem Services (CICES) and by the Millennium Ecosystem Assessment (MEA). Whilst CICES defines ES "as the contributions that ecosystems make to human well-being" and divides them in provisioning, regulating, and cultural services, the MEA defines them as "the benefits people obtain from ecosystems" and divide them in the following four categories: supporting, provisioning, regulating and cultural.[9] As can be seen in figure 1, ecosystem services have an impact on many different aspects of human well-being. The concept is an anthropogenic one originated with the aim to redefine human-nature relations and to highlight the importance of healthy natural ecosystems for providing goods and services.[10]

Figure 1: Relationship between Ecosystem Services and constituents of human well-being (MEA, 2005).



Many components of the ecosystem are able to provide ES and mussels are among those. Following the latest CICES[11] standards for ES published in 2018, the most relevant ES provided by mussels is "regulation and maintenance (biotic) – controlling the chemical quality of salt waters"[12], as illustrated in Table 1.

Table 1: Ecosystem services category relevant to mussel farms (HAINES-YOUNG & POTSCHIN, 2018).

Section	Division	Group	Code	*Class type*	*Simple descriptor*	*Ecological clause*	*Use clause*	Example Service
Regulation & Maintenance (Biotic)	Regulation of physical, chemical, biological conditions	Water conditions	2.2.5.2	*By type of living system*	*Controlling the chemical quality of salt water*	*Maintenance of the chemical condition of salt waters by plant or animal species….*	*…that enable human use or health*	Fish communities that regulate the resilience and resistance of coral reefs to eutrophication

Mussels feed on small algae and plankton, which naturally take up nitrogen and phosphorous from the water. As a result, mussels filtrate the water, and uptake those nutriments. If the conditions are

9 Millennium Ecosystem Assessment (2005)
10 Hansen et al. (2015)
11 Lillebø et al. (2016)
12 Haines-Young & Potschin (2018)

good, one single mussel can filter every hour up to nine litres of water. In the Baltic Sea however, mussels are small and thus the amount of filtered water is lower. A mussel farm producing all eight months 500 tonnes of mussels can filter about one million cubic metres of water, i.e. the water in 25 hectares of surroundings is cleaned and five tonnes of nitrogen and 300 kg of phosphorus are taken up.[13]

In the context of the BBG project, a tool was built for simulating nutrient removal by harvesting mussels from Baltic Sea mussel farms. The model is designed to predict the mass of nitrogen (N) and phosphorus (P) in harvested mussels as a function of environmental conditions and mussel age. It was possible to simulate nutrient removal at harvest by combining a series of published equations and parameter values with a single calibrated parameter representing variation in individual filtration rates. BBG applied the model to the six existing farm locations and two sites, where mussel measurements were available for parameterization and validation.

The estimates of nutrients removed per unit rope length after a two-year growing period suggest similar efficiencies for the Western Baltic (Kiel (230 gN, 16g P), Musholm (200g N, 14 gP) and Central Baltic Sea areas (Sankt Anna (150g N, 11g P)). Simulated removal rates per meter rope were much lower in the Eastern Baltic Sea areas (Kurzeme (50 g N, 3.5 g P), and Vormsi (40 g N, 3 g P).

Moreover, mussels provide a number of other ecosystem services across all the Millennium Assessment categories [14,15] (see Table 3):

Table 2: Ecosystem services provided by mussel farms (GUNDERSEN ET AL., 2016).

Supporting services: *Habitat builder / biodiversity:* • Mussels increase biodiversity by providing substrate for algae and refuge for small animals • Mussels change the local environment and create unique habitats • Structural properties of mussels provide substrate for attachment, shelter and increased habitat complexity *Light climate / turbidity:* • Improves the light climate for benthic algae and increase production of other benthic organisms • Changing the system from a turbid, plankton-dominated one to a highly diverse and productive benthic system *Nutrients / primary production / eutrophication* • Potential to filter considerable quantities of particulate matter from the water column • By filtering phytoplankton, including toxic algae, filter feeders like mussels can inhibit or even prevent harmful blooms • Biological control is essential for many other ES including habitat maintenance, recreation, food provisioning and scenery. The biological control carried out by filter feeders is closely interlinked with mitigation of eutrophication as well as with the control of hazardous substances
Provisioning services: • Food and feed production
Regulating services:

13 For more information see: https://voxeurop.eu/cs/node/78471
14 Vaughn (2017)
15 Gundersen et al. (2016)

- Increase the resilience ("ecological resilience is described as the extent to which ecosystems can absorb perturbations and continue to regenerate")
- Mussels bind CO2 when building their shells and this carbon is stored in the shell until the animal dies"
- The economic value of natural mitigation of eutrophication is estimated to be enormous
- Significant effect on water clarity (Secchi depth), the concentration of chlorophyll and the number of days with anoxia
- Remove organic pollutants and toxic substances
- Through their filter feeding habits, mussels can reduce the amount of phytoplankton and cyanobacteria in the water column and thus contribute to water purification, filtering and removing of hazardous substances

Cultural services:

- Mussels can be used in many different sea food dishes, but also as bait for fishing
- Tourism industry benefits from all ecosystems *supporting* attractive wildlife such as marine mammals and birds
- Swimming / beaching

The listing shows that mussels provide us with a variety of important services, not only as food, but also in terms of cultural services, regulation, turbidity, biodiversity, water clarity and prevention of eutrophication**.**

Those ES often seem self-evident and for free. **However, the amount of freely available ES sometimes is not enough, because the Baltic ecosystem is not capable to maintain the natural population of mussels necessary for complete purification of marine water from nutrients. The serious condition of the Baltic Sea in terms of eutrophication proves that in some cases, incentives are needed to reach desired goals**.

The overview of ES provided by mussels has shown that the services are manifold. Therefore, even though we stress in the following the ES function in view of nutrient uptake; ES payment schemes for mussel farming might not only be an additional and suitable measure to reach the goals of GES in the Baltic Sea, but also be valued for other ES systems.

In the next chapter, we provide an overview of the legislative framework influencing the possibilities and limitations of mussel farming in the Baltic Sea.

3 Legislative framework

Eutrophication, the excessive amount of nutrients in a body of water due to increased input of nutrient fertilizers such as nitrogen and phosphorus, which negatively impact aquatic ecosystems,[16] has been a serious problem in the Baltic Sea for decades and is still on-going. Nitrate pollution in some rivers is at a high level and remains one of the main causes for eutrophication in EU sea basins.[17] In many regions nitrate levels are above the legal standard of 50 mg NO_3/l,[18] coming from both point and non-point sources. A number of regulations have been developed to improve the water quality in the sea basins by reducing nutrient inflow.[19]

Conventions, regulations and directives provide the framework and describe the motivation behind political actions. Regarding the theme of improving water quality in the Baltic Sea one should consider a number of documents developed on different geographical scales. On the international level, the UN Convention on the Law of the Seas (UNCLOS) as well as the International Convention for the Prevention of Pollution from Ships play a role regarding the levels of pollution and eutrophication. On the EU-level, the Water Framework Directive (WFD), the Marine Strategy Framework Directive (MSFD) and the Nitrates Directive (being an integral part of the WFD) are the most prominent binding directives in this regard. On the regional level, the HELCOM Baltic Sea Action Plan also focuses on restoring the Good Environmental Status (GES) in the Baltic environment. Those international, European and pan-regional conventions, directives and action plans provide the framework for national regulation, which finally tip the scales of practical mussel farming. Another very important EU-legislation to prevent eutrophication is the Urban Wastewater Directive (UWWTD). However, as this legislation only deals with one point-source - urban wastewater – this directive is not discussed further in connection to mussel farming.

In this chapter, the above-mentioned elements of the legislative framework are assessed according to the following questions:

- To what extent do these frameworks allow for mussel farming in the Baltic Sea?
- How much is stipulated in the different regulatory frameworks and how much is left for interpretation by national law?
- Do the regulatory frameworks justify establishing mussel farms as a financed ecosystem service to reduce eutrophication in the Baltic Sea?

3.1 International Conventions

The **UN Convention on the Law of the Seas (UNCLOS)** obliges Member States in article 207 to legally require the prevention, reduction and monitoring of land-based marine pollution. Moreover, the **Convention of Biological Diversity** describes eutrophication as one main driver for the loss of biodiversity. Under the **Sustainable Development Goals**, stakeholders are discussing if and how to link land and sea to take interaction into account. However, there are no official proposals underway on how to include current nutrient contents in the sea basins, effectively ignoring the fact that mussel cultivation can address pollution originating from both point and non-point sources including nitrates.[20,21,22]

16 Chislock (2013)
17 EUROSTAT (2018)
18 European Parliament & European Council (2016)
19 European Council (1991)
20 Srisunont & Babel (2015)
21 Rose et al. (2015)
22 Petersen et al. (2014)

The International Convention for the Prevention of Pollution from Ships (MARPOL)

Most research and policy concerning eutrophication concentrates on nutrient input originating from river basins. However, airborne deposition accounted for 32% of total nitrogen input and 7% of the phosphorous input in the Baltic Sea in 2014.23 Considering that a third of all nitrogen pollution is airborne, it is crucial to take atmospheric pollution into account. MARPOL is an important Convention, which inter alia focus on achieving a reduction of nitrogen oxide emissions from ships. The Annex VI sets limits on nitrogen oxide emissions from ship exhausts and prohibits deliberate emissions of ozone depleting substances.24 Moreover, Baltic Sea nitrogen oxide control area (NECA) was established in 2016, aiming at significantly reducing emissions from shipping, one of the main sources of nitrogen oxide. As a combined effect with the North See NECA, recent estimates predict an annual reduction in NOx of 7.000 tons from direct deposition to the Baltic Sea surface. However, years of fleet renewal will be necessary before the regulation will show full effect.25 This, however, is contingent on all member states fully implementing the annex, which as of yet is not the case. MARPOL is focused on the prevention of eutrophication and thus follows a different approach than using mussel farming for nutrient uptake. However, the status of the Baltic Sea in this regard is already serious and sudden radical changes in polluting are not to be expected. Nutrient uptake by mussel farming is still justified as an additional measure as it is a mean to reduce nutrient content originating not only from land, but also from air. MARPOL does not stipulate mitigation measures but does not impede them either.

3.2 EU legislations

There is a variety of EU legislations concerning environmental and water protection. For this study, relevant legislation includes framework directives that cover coastal and marine waters in the Baltic Sea Region, and which could have an impact on future mussel farms set up as an environmental service. Other important EU regulations such as the Urban Wastewater Directive (UWWTD), the Habitat Directive and the Bird Directive are consciously left out from this report.

Water Framework Directive (WFD)

The purpose of the Directive is to establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater across Europe. The directive contains environmental targets that each member state has to incorporate into national law and implement through action plans.[26] Furthermore, the directive provides a basis for a clear and detailed assessment of eutrophication, as well as the potential for a consistent and integrated assessment of water quality. The directive should result in a more coherent and integrated approach to managing nutrient inputs to the water. The WFD aims to introduce the framework for adaptive management, a flexible management approach based on a 'learning by doing' concept, which is widely used in the circumstances with various stakeholders.[27] It emphasises that stakeholders' involvement is required from the early stages of the planning process as it can contribute to their acceptance of certain measures as well as to solve possible conflicts.[28]

The WFD is to be implemented by the member states in a transparent and participatory way through various cost-efficient measures. These measures are part of the national measure catalogue and are integrated into the overarching, so called *programme of measures.* They are reviewed every six years. Up to now, the implementation process has been slowed down by the ambiguity of some of

23 HELCOM (2017)
24 International Maritime Organisation (2018)
25 HELCOM (2016)
26 European Commission (2016a)
27 Allen & Jacobson (2009)
28 Newton & Elliott (2016)

the obligations, resulting in different national interpretations and implementations, which in turn caused legal uncertainty and differing approaches across the EU.[29]

Many activities need approval before they can be started. They must provide a WFD assessment to understand the possible impact of the activity on the immediate water body, any linked water bodies and in some cases whether the activity complies with national river basin management plans. The WFD itself does not mention mussel farms as activity; however, it includes a paragraph on the prohibition of further deterioration. This paragraph tackles and restricts all uses of the sea that might cause negative impacts. The European Commission staff document on the "application of WFD and Marine Strategy Framework Directive (MSFD) in relation to aquaculture",[30] expand on that issue and lists five potential negative impacts of aquaculture in general:

1. Benthic impacts and nutrient enrichment;
2. Disease and parasites;
3. Chemical discharges;
4. Escapees and alien species;
5. Physical impacts, disturbance and predator control.

However, impacts of aquaculture systems depend on several factors, including farm location, type of cultured organism, methods used, and the sensitivity or vulnerability of the environment. Thus, the danger of potential negative impacts on the quality of water caused by mussel farming cannot and should not be generalised.

The directive actually recognises positive effects of certain types of aquaculture. As shown above, in case of mussel farming the quality of water is better than before, including nutrient uptake or the extraction of hazardous substances.[31] However, also the type of farming is essential. A correct, environmentally friendly farming means that the animals do not get into contact with the seabed. Hence, mussels must not be harvested with industrial devices and should be cleaned in a time-consuming way. This approach would even meet standards of an organic aquaculture according to EU certification (EG 710/2009 on organic aquaculture animal production amending the EU rules on organic farming by July 2010).

The WFD protects the chemical status[32] of coastal waters up to 12 nautical miles from the baseline. All **existing mussel farms** currently are located in coastal waters; therefore, they **fall under the jurisdiction of the WFD and thus need to be in line with the prohibition of further deterioration**. **This paragraph restricts mussel farming, but does not prohibit it**. However, as shown by BBG study mussel farms do not show any negative environmental impacts. Furthermore, as technology is developing, future farms might be installed outside the coastal zone, but within the Exclusive Economic Zone[33] and will thus fall under the jurisdiction of the MSFD instead.

Marine Strategy Framework Directive (MSFD)

The Marine Strategy Framework Directive complements the WFD and is strongly interrelated with it. Its scope of application extends to coastal waters concerning aspects of environmental status which are not yet covered by the WFD, as well as the full extent of Member States territorial waters over which they have or exercise jurisdictional rights (MSFD, Article 3.1). The aim of the MSFD is to protect and restore European marine waters and to ensure their long-term, sustainable use. The directive

29 Rijswick & Backes (2015)
30 European Commission (2016b)
31 Ibid
32 European Parliament & European Council (2000)
33 Rößner (2018)

pursues the target of reaching the "Good Environmental Status" in all EU marine waters by 2020. To reach this goal, the MSFD is based on the ecosystem-based approach to management. This means that an inclusive resource planning and management approach has been chosen. The ecosystem approach integrates the connections between land, air and water, as well as all living things, human beings their activities and institutions.[34]

The core of the MSFD consists of 11 descriptors of environmental status for which good status must be achieved by 2020. Each Member State is obliged to draw up a programme of cost-effective measures to attain good environmental status. Descriptor 5 of the MSFD explicitly sets the goal of minimising human-induced eutrophication in European waters by 2020. Member states are responsible to evaluate the environmental status of the marine waters within their borders. Where the GES is not yet achieved, environmental objectives have to be defined and implemented.

Mussel farms need to respect the MSFD principles and comply with the environmental objectives to achieve the GES. As part of her study within the BBG project, Yvonne Rößner outlines the potential impacts of mussel cultivation on the 11 descriptors of the MSFD.[35] According to her assessment, **mussel cultivation in the Baltic Sea, if done correctly, has little or no negative impact on the MFSD descriptors**. Moreover, an analysis of the potential impacts of mussel farms on the 11 descriptors of the MSFD has been carried out (see table 1) and concludes that **mussel farming in fact provides positive effects to almost all descriptors.**[36] Since some descriptors are interrelated (e.g. eutrophication has a direct impact on sea floor integrity, food webs and biodiversity), mussel cultivation, having a positive impact on eutrophication, also positively effects other descriptors.

Table 3: The impacts of mussel farms on the 11 Descriptors of the MSFD (Jefferey et al., 2014).

MSFD Descriptors	Possible environmental impacts
Biodiversity	The shifting of organic load from the water column to the benthic habitat may even have local positive effects on benthic species abundance and diversity close to the farm. However, this is conditional on finding the right site with a healthy benthos.
Non-indigenous species	Mussels also suffer from the negative impacts of invasive species, but a farm can act as a rapid warning system as they are under constant environmental monitoring and new invasive species can be quickly discovered.
Commercial fish & shellfish	Even if diseases and parasites may have localized effects on wild commercial shellfish, mussel farms also improve water quality which in turn can have a positive impact for fish aquaculture.
Food webs	Mussel cultivation may decrease water turbidity and thus increase water transparency through filtration activity. Mussel metabolic products such as faeces or pseudo faeces accumulate beneath mussel farms. Food webs therefore may be influenced by shifting of organic load from the water column to the benthic habitat, which has a positive impact on the organisms living on the benthos.
Eutrophication	No additional feed is used in mussel culture. The environmental balance is negative and counteracts eutrophication.
Sea floor integrity	As mussels fall down to the sea bed, they can build up a more stable sea-bed structure, however, only where such a reef structure naturally occurs.
Hydrographical conditions	The reef structure of mussel farms located in coastal waters can protect the coast as the mussel farms act as wave breakers.

34 For more information see: http://www.msfd.eu/knowseas/ea.html
35 Rößner (2018)
36 Jefferey et al. (2014)

Contaminants	Mussels take up contaminants as well as nutrients. More importantly, the regular environmental monitoring provides researchers with more accurate water measurements and an extensive data bank with historical data from many more sites.
Fish & seafood contaminants	See above
Marine litter	small impact of lost nets / buoys
Underwater energy	n/a

In the European Commission staff document on the "application of WFD and Marine Strategy Framework Directive (MSFD) in relation to aquaculture" **mussel farming is mentioned as a means to support the MSFD targets**. The document clearly states that "the natural filtration feeding of shellfish also leads to improvements in water clarity, as demonstrated by mussel farms in the Baltic".[37] So in general, the MSFD supports mussel farming for nutrient uptake. **However, Member States are given plenty of leeway to decide whether their national legislation would permit mussel cultivation and how to finance it**. Leaving a lot of manoeuvre for Member States to decide whether mussel farms can be regarded an environmental service is not necessarily a negative outcome as long as political will and a readiness to pay exist.

Nitrates Directive

The European Nitrates Directive from 1991 aims to protect water quality across Europe by preventing nitrates from agricultural sources polluting ground and surface waters.[38] The directive focuses on three aspects: 1. Establishing codes of good agricultural practices and measures to prevent and reduce water pollution from nitrates, 2. Designation of nitrate vulnerable zones, 3. Monitoring of water bodies with regard to nitrate concentrations. Even though these actions are important means to avoid future deteriorations in water quality, they have **little impact on reducing the nitrate content already existent within the water bodies**. Furthermore, the Nitrates Directive has not always been implemented correctly as various Member States failed to successfully keep their pollution in check, which resulted in high levels of nitrates in watercourses[39].

Organic aquaculture according to EU certification (EG 710/2009)

Another aspect one shall take into consideration is **animal welfare**. In 2016, the United Nations report on the State of World Fisheries and Aquaculture[40] mentioned animal welfare for the first time as something that "adds to uncertainties in the aquaculture sector" and added "consumers are increasingly requiring high standards of quality assurance and demanding guarantees that the fish they purchase are produced sustainably". If mass production of animals is continued, it would be best to mass produce animals that are as plant-like as possible. They should not require fish feed, should not require conversion of habitat, and should minimize pollution. They should experience the least amount of pain and suffering in captivity as possible. Of all the aquatic animal species groups that are farmed for food, bivalves (mussels) appear to be the most promising in terms of meeting these goals.[41]

37 European Commission (2016b)
38 European Council (1991)
39 Le Goffe (2013)
40 For more information see: http://www.fao.org/3/a-i5555e.pdf
41 Jacquet, Sebo, and Elder (2017)

3.3 HELCOM Baltic Sea Action Plan

Adopted by all coastal states in the BSR in 2007, the Baltic Sea Action Plan (BSAP) aims at restoring a good ecological status of the Baltic marine environment by 2021. One of the milestones is a Baltic Sea unaffected by eutrophication, including clear water, natural levels of algal blooms, natural distribution and occurrence of plants and animals as well as natural oxygen levels. BSAP provides a framework for states to implement environmental protection on the national level.[42] While HELCOM's recommendations are not binding in terms of international law as opposed to EU directives such as the WFD and MSFD, , they are of substantial political and moral significance and facilitate EU directives.[43] In fact, HELCOM's high-ranking committee can assert influence on member states to adapt their national laws to match the objectives of BSAP.

A key part of the BSAP's eutrophication vision is the nutrient reduction scheme in which each country being part of the HELCOM, shares the burden of nutrient reductions. The scheme has two main measures: Maximum Allowable Inputs (MAI) of nutrients indicates the maximum level of input of water and airborne nitrogen and phosphorous to the Baltic Sea basins allowed in order to reach the zero-eutrophication target. To achieve this, each HELCOM state has its own Country-Allocated Reduction Targets (CART), which indicate how much each state has reduced its nutrient input compared to the reference period (1997-2003). Reduction targets and MAIs are revised by HELCOM's special working group periodically for the Baltic Sea basin.[44] For GES to be achieved, the Baltic Sea can absorb a maximum of 21,000 tonnes of phosphorous and about 600,000 tonnes of nitrogen in total. Simultaneously, HELCOM countries have to reduce annually around 15,000 tonnes of phosphorous and 135,000 tonnes of nitrogen in order to reach the BSAP's crucial "clear water" sub-objective.[45] So far, the scheme has proved to be successful: the last three-year assessment (2012-2014) reveals that the average input of nitrogen was reduced by 19% and phosphorous by 24% for the whole Baltic Sea since the mid-1990s.[46]

The current reduction targets of the BSAP, however, only concern further nutrient inflow, and do not reveal anything on the current total nutrient content in the Baltic Sea and the need to reduce it. Even if measures to reduce the inflow are slowly taking effect, it will take decades before the Baltic Sea has adequately recovered.

Thus GES can only be achieved within the coming years by dealing with eutrophication from two sides: minimising further contamination **and** reducing the current content by using measures for nutrient uptake. **But so far there is a clear lack of incentives in the BSAP to implement measures to reduce content, even though researchers agree on the need of nutrient uptake to achieve GES.**[47] Some decision-makers still doubt about the effect of mussel farming and there is a fear of diminishing grants for point source treatment facilities. At same time, the current update of the HELCOM Baltic Sea Action Plan provides a good chance to push for measures related to nutrient uptake. There is a growing acceptance and understanding for such additional measures.

A second problem is also that providing solid estimates on the nutrient content in the Baltic Sea is complicated because the nutrient content in the Baltic Sea consists of partly active nutrients (especially phosphorous) in seawater and organisms, but also of those fractions buried into deep water sediment. During periods of low oxygen, the release of bottom nutrients (phosphorous) may

42 HELCOM (2007)
43 Söderström (2017)
44 HELCOM (2009)
45 For more information see http://www.helcom.fi/baltic-sea-action-plan/nutrient-reduction-scheme/
46 HELCOM (2017)
47 Ahtiainen et al. (2014)

exceed ten or even 100-fold the nutrient content caused by land-based pollution, which complicates calculations.[48] This is called the internal load.

Despite difficult analysis and missing incentives, in order to reach the target of GES as soon as possible, all suitable measures should be taken into consideration. Those measures should be complementary not substitutional.

It can be concluded that the BSAP is an important political tool to push HELCOM states to reduce their nutrient input and thus pollution. Its nutrient reduction scheme could be combined with framework directives such as WFD and MSFD that provide operational incentives and the legal backing to implement measures.

3.4 Conclusion: current legislation

Coming back to the questions raised at the beginning of this chapter, it can be concluded that **none of the frameworks impede mussel farming**, **as long as mussel farming supports the objectives under the WFD and contributes to a good environmental status, but they do not directly support mussel farming either**. Most problematic is the "**no deterioration rule**" in the WFD, which does not hamper but could limit mussel farming, depending on the interpretation of the directive. However, concrete measures and especially payment schemes are not yet existent. The international conventions (UNCLOS and MARPOL) rather focus on reducing nutrient inflow. EU directives such as the WFD and the MSFD have, together with the Baltic Sea Action Plan, driven Member States to take measures to improve water quality. However, most measures are land-based, setting stringent goals for farming and wastewater plants to reduce their nutrient pollution.

The second question deals with the relation of EU and national law: **"How much is stipulated in the different regulatory frameworks and how much is left for interpretation by national law?"** The analysis of the different international and EU directives has revealed that those regulatory frameworks are rather guidelines with general goals and targets. The implementation of those targets is matter of the nation states or regions. In EU legislation goals and priorities mostly refer to aquaculture in general. Mussel farming is, if at all, mentioned as an example. **Supporting legislation for mussel farming as an ecosystem service can thus rather be found in national than EU legislation**. This structure of rather general EU targets and more precise national/regional law could be an advantage for mussel farmers. **National or regional regulations can be tailored on the specific needs and facilitate quicker decisions.**
This brings us to the last question – **"does current legislation justify payments for ecosystem services provided by mussel-farms?"** In most cases, directives and regulations do not provide funding sources. They rather pave the way by formulating goals and concrete aims. Mussel farming for nutrient uptake is a mean to reach several of the goals mentioned in the studied legislative documents. Therefore, the **directives indirectly justify mussel farming as a measure and thus also its funding**. However, in this regard, the directives do not provide any recommendations for action. To implement the directives and to reach the mentioned goals, a variety of public funding schemes is currently available, like EMFF, NCFF, EAFRD or ERDF. We will present and discuss the possibilities arising through those funds in chapter 4.1.1.

The deadline for HELCOM's goal of a healthy Baltic Sea without eutrophication is approaching fast (2021). Against this backdrop mussel farming should be considered as a complementary measure to land-based activities reducing nutrient inflow. As shown by other BBG reports, mussel farming can efficiently support the removal of existing nutrients in the sea. However, this option of combating eutrophication by nutrient uptake is so far no priority in EU legislation, but it is not excluded either. A

[48] Kotte, J. UTARTU – email correspondence

clearer statement would be helpful but predominantly it is a national issue to reach the given goals with the most appropriate measures.
In the next chapter we will present and discuss several existing approaches dealing with the questions of how to pay for ecosystem services and who should pay for it and why? For mussel farming, such a payment scheme is not yet in place, but based on experiences from other fields, we will present some ideas for how such a payment scheme could look like in chapter 5.

4 Who should pay for mussel farming?

4.1 Ecosystem service payment schemes

The idea of implementing market-based mechanisms for ecosystem services emerged in the 1970s. The discussion was based on the belief that the free market, being competitive and efficient, is the right place to generate an appropriate market value/ price[49] for ecosystem services. According to Wunder (2005) payments for ES can be described as:

1. a voluntary transaction for a well-defined ecosystem service;
2. being "bought" by at least one buyer;
3. being "sold" from at least one ecosystem service provider;
4. the payment is conditional if the ecosystem service provider secures the provision of the ES.

Although it may seem straightforward, this definition hides many technical complexities, e.g. the issue of conditionality. Only a few existing schemes fulfil all criteria. Based on real-life examples in the past, Tacconi (2012) proposes a broader definition that encompasses more existing PES schemes: a payment for ES is "a transparent system for the additional provision of environmental services through conditional payments to voluntary providers".[50] In other words: payments for ES policies support individuals or communities for undertaking actions that increase the provision of ES.
Translating those different aspects of the definition to the case of ES payment for mussel farms, some can be ensured, others need to be discussed. It can be stated, that mussel farms do provide well-defined ecosystem services: food, feed and nutrient reduction among others, having been presented in chapter 3. Furthermore, mussel farmers serve as providers. Other aspects needed to design an ES payment scheme according to Wunder (2005), need further elaboration and discussion:

- Who is a potential (voluntary) payer for ES provided by mussel farms?
- How to motivate someone to pay for ES provided by mussel farms?
- How (much) to pay for ES provided by mussel farms?
- Why using an ES payment scheme for mussel farms to combat eutrophication?

According to the definition of ES payment schemes by Wunder (2005), the transaction has to be voluntary and there has to be at least one buyer. When talking about establishing an ES payment scheme to reduce eutrophication by mussel farms, three different approaches seem realistic: The use of public funding, the polluter pays principle and payments by beneficiaries using the service provided.

4.2 Public Funding Programmes

Within the European Union, several funding programmes are in place to reach the goals of the regulations and conventions discussed in chapter 3. So far project funding for nutrient uptake by mussel farming is provided by the European Maritime and Fisheries Fund (EMFF) and the Natural Capital Financing Facility (NCFF). However, those sources do not provide long-term, institutional support. Therefore, the European Agricultural Fund for Rural Development (EAFRD) as funding source of the EU Common Agricultural Policy (CAP) should be studied additionally. The EAFRD provides ecosystem service payment schemes for several agricultural sectors, however not yet for mussel farming. Nevertheless, the existing measures could be inspiring for developing such a supporting scheme for mussel farming.

[49] Wunder (2005)
[50] Tacconi (2012)

4.2.1 European Maritime and Fisheries Fund

The European Maritime and Fisheries Fund (EMFF) is the main fund for the EU's maritime and fisheries policy 2014-2020 with a total budget of EUR 6.5 billion.[51] A considerable share of the fund (20%) is allocated to support sustainable aquaculture. In particular, the EMFF aims at supporting new farmers entering the sector, as well as farmers converting to eco-management schemes.[52]

Similar with other European operational funds, the EMFF only co-finances national projects that are linked to one of the six EMFF union priorities. Depending on the size of its fisheries sector, each member state is allocated a certain share of the fund. The states then draw up an operational programme, outlining how it intends to spend the money, and on which projects. As the final step, the programme is approved by the EU.

Sustainable aquaculture development is one of the main priorities of the EMFF.[53] The money allocated to this priority can be spent for different issues such as innovative investments in equipment, management and advisory services, training education and certification of staff, support for new farmers entering the sector and converting to eco-management schemes. Furthermore, in article 52 it is clearly stated that "it should be possible for the EMFF to also support aquaculture which provides special environmental services".[54] Mussel farming falls under the 2nd union priority - fostering sustainable, resource efficient, innovative, competitive and knowledge-based aquaculture, and the 5th priority – fostering marketing and processing.[55] In particular, the EMFF seeks to promote innovative aquaculture with high-growth potential, such as offshore and non-food aquaculture (e.g. mussel meal) and multifunctional aquaculture.[56]

Regarded as aquaculture, mussel cultivation is eligible for funding through the EMFF. However, **it is up to each EU member state how to use the EMFF funds**: **In Sweden, no mussel projects have so far been funded through the EMFF**, despite a national priority towards increasing investments in sustainable aquaculture.[57] **In Denmark, mussel and seaweed cultivation is seen as an opportunity to reduce nitrogen,** as well as being used in innovative food sectors in their operation programme.[58]

4.2.2 Natural Capital Financing Facility

The Natural Capital Financing Facility (NCFF) is a financial instrument that combines financing from the European Investment Bank (EIB) with EU Commission funding under the LIFE programme. The facility consists of two components; the finance facility that provides loans ranging from 2 – 15 million Euro and the technical assistance facility that provides a grant for up to 1 million euro for project preparation, implementation and monitoring.[59] To equally distribute the funding within EU countries, only a limited number of projects will be funded in each member state. The following types of projects will be funded:

- Payment of ecosystem services;
- Green infrastructure projects;
- Pro-biodiversity and pro-adaptation businesses;
- Projects involving biodiversity offsets.

[51] For more information see: https://ec.europa.eu/fisheries/cfp/emff_en
[52] For more information see: https://ec.europa.eu/fisheries/cfp/emff_en
[53] For more information see: https://ec.europa.eu/fisheries/cfp/aquaculture/funding_en
[54] European Parliament & European Council (2014)
[55] European Commission (2016c)
[56] Rößner (2018)
[57] EMFF (2014a)
[58] EMFF (2014b)
[59] For more information see: http://www.eib.org/en/products/blending/ncff/in-a-nutshell/index.htm

Funding includes both direct and indirect finance to project developers through funding mechanisms such as:

- Direct loans to individual, large projects
- Indirect loans through financial intermediaries for smaller projects
- Indirect investment aimed at smaller projects via equity funds

In the pilot period from 2014-2017, the aim was to provide finance of 125 million euro to back up around 12 projects across Europe.[60] After a slow start, the facility is investing in three different projects which will support activities in 12 EU countries[61] and the facility has been extended to accept proposals until end of 2021.[62] Current projects include a EUR 12.5 million initiative to support sustainable forestry in Ireland and a further EUR 15 million to support nature conservation in Croatia, in cooperation with the Croatian Bank for Reconstruction and Development.[63]

The NCFF is currently focusing on larger projects in collaboration with national financing institutions. As such, the fund is currently less relevant for small-scale mussel farming but could in the future support larger blue catch crop initiatives.

4.2.3 European Agricultural Fund for Rural Development (EAFRD)

The European Agricultural Fund for Rural Development (EAFRD) is the funding scheme of the Common Agricultural Policy (CAP), launched in 1962. The CAP supports the agricultural sector in Europe, because farmers are important to secure our food supply; they enhance rural development and are in a key position of contributing to environmental protection. Concerning environmental protection, the agri-environment measures provide payments to farmers, who voluntarily subscribe to environmental commitments. Those measures make up 22% of the expenditure for rural development (20 billion 2007-2013)[64] and provide farmers with a monetary incentive for implementing environmentally-friendly farming techniques that go beyond legal obligations. Farmers are paid for the compliance with fundamental EU legislation related to environment, health, animal welfare or soil management. The payments only cover additional costs or forgone income when establishing wetlands or cultivating catch crops that bind nitrogen or phosphorous to decrease nutrient flow. Currently, those measures only apply to conventional (agri-)farming.

It should be discussed to what extend these measures could also be extended to sea-farming and/or could serve as a blueprint for how payment schemes could look like for sea farmers.

Several suggestions on how to improve these agricultural environmental programmes exist, e.g. to regionalise these programmes and focus more on specific natural areas. For the future CAP after 2020, nine clear objectives have been elaborated: “Environmental care” and “preserve landscapes and biodiversity” are just two of them. Furthermore, the question whether these programmes should pay for specific results (e.g. the increase of a specific bird population) instead of activities is under discussion. Farmers commit to measures to be undertaken for at least five years. Non-compliance causes shortages of direct payments. Each member state is legally obliged to offer such payments as part of their rural development plans. As pointed out above, even if the agri-environmental services are directly linked to WFD, as many of the measures are aimed at improving water quality, the WFD is, however, not part of this cross-compliance mechanism.

[60] For more information see: https://ec.europa.eu/environment/efe/themes/more-financing-natural-capital-projects_en
[61] European Investment Bank (2018)
[62] For more information see: http://www.eib.org/en/products/blending/ncff/index.htm
[63] European Investment Bank (2018)
[64] For more information see: https://ec.europa.eu/agriculture/envir/measures_en

The agri-environmental services are funded by the EAFRD and give member states the freedom to decide what measures to support. Based on the needs of their territories, each member state draws up its own rural development programme by choosing at least four out of the six EU priorities[65] for rural development. The programme's main priority is an "intelligent and sustainable growth for all". [66] The following table shows some of these funded nutrient flow reduction measures and how much farmers are paid:

Table 4: payment for measures to reduce nutrient inflow in Sweden (Jordbruks Verket, 2019). [67]

Type of measure	Payment/ support
Catch crops	110 € / hectare
Spring preparation	60 € / hectare
Cultivating / building embankments	50 € / hectare
Protection zones	300 € / hectare
Taking care of wetlands / dams	400 € / hectare

It is noteworthy that even though agri-environmental payments are only supposed to cover additional costs or income forgone, payments in this case are made for environmentally friendly actions, not for waiving actions that pollute the environment. In this regard, those payments are similar to the discussed payment schemes for mussel farming with the aim of nutrient uptake.

4.2.4 European Regional Development Fund/ Cohesion Fund

The EU cohesion policy has selected 11 priority fields for the funding period 2014-2020. The first four priorities are related to research and development. The priorities 5-7 cover environmental issues, while the priorities 8-11 deal with social aspects.

The European Regional Development Fund (ERDF) is generally open to all priorities. The Cohesion Fund in turn focuses on environmental issues, but is only available for those EU states with a gross national income per inhabitant lower than 90% of the average EU level.

Even though the main reason behind setting up mussel farms is the positive environmental impact, most farms will probably be located in rural areas characterised by unemployment and an outflow of young people. Therefore, municipalities may not only be interested in mussel farming as a measure to improve water quality as well as to provide jobs for the local population.

It is worth keeping rural development funds in mind when exploring financial options for mussel farming as an ecosystem service. Certainly, the combination of improving the environment and supporting rural areas when establishing mussel farms could be an indicator, that cohesion policy might offer possibilities in this regard.

For local and regional public authorities, paying for ES is typically motivated by the need to provide services to its population, like safe drinking water or regulating river flows. In our case, it's motivated by the need to restore the Baltic Sea, to achieve the targets set by the WFD and MSFD and the Baltic Sea Action Plan, even if the latter does not imply legal requirements. Moreover, there is also recognition of the additional benefits that mussel farming can offer to local/regional population, going beyond clearer water.

[65] For more information on the six priorities see: https://ec.europa.eu/agriculture/rural-development-2014-2020_en

[66] For more information see: http://www.jordbruksverket.se/amnesomraden/landsbygdfiske/programochvisioner/landsbygdsprogrammet20142020/omlandsbygdsprogrammet.4.1b8a384c144437186ea10a.html, in Swedish "Smart och hållbar tillväxt för alla"

[67] The used currency converter you find here: http://www.jordbruksverket.se/amnesomraden/stod/jordbrukarstod/miljoersattningar/ersattningsnivaer.4.613fbaa714bedd0f2d319ee8.html, 1 SEK = 0,1 EUR.

4.3 The polluter pays principle

The polluter pays principle is seen as the general framework for internalizing environmental externalities, i.e. the environmental costs are reflected in the price and output of goods and services. The principle has increasingly gained acceptance in the last 20-30 years and assigns responsibility for addressing pollution to the polluters. The polluter pays principle requires polluters to take measures to reduce pollution, measure pollution and in some cases pay taxes or charges for pollution and compensate for pollution impacts.[68] **In Sweden, farmers pay an environmental tax when using fertilizers. Reducing nutrient content could potentially be funded by using the deposited amount of money.**

However, to apply the polluter pays principle to mussel farming bears some problems:

- Even if considered desirable from an economic point of view for those who pollute to also pay for measures to be taken, it may, however, be **difficult to implement the polluter pays principle from a political point of view**. Who ultimately bears the cost for providing the ES will have a big impact on the prospects of the payment scheme gaining political acceptance as a policy instrument. To put an (additional) financial burden on sectors that compete on an international market can cause political problems.
- Moreover, there is a **danger of polluters not changing their ecologically critical behaviour but instead buying themselves free from obligations**. As stressed at the beginning, **mussel farming should by no means replace any other measures, which incentivise reduction of nutrient inflow**, but be an additional measure. Thus farmers should for instance by no means be given the impression that mussel farming may be a way to 'compensate' for use of more fertilizers. Only in case that no further land-based point source and/or reduction measure is no longer feasible, mussel farming should come in. Any payment scheme has to be organised accordingly.
- Finally, in the case of eutrophication, it is **not so easy to identify all sources and all polluters**, so probably the **polluters pays principle would in this case only reach some polluters but not all. This in turn might be interpreted as not being fair**.

4.4 Beneficiaries paying

Another approach regarding who possibly pays for ecosystem services looks at the different **beneficiaries, using the provided ecosystem services**. With regard to mussel farms providing ES in form of a cleaner sea, obviously several beneficiaries might be suitable to pay for it: private foundations, private foundations, private persons via crowdfunding, companies from benefiting economic sectors or public authorities.

4.4.1 Private foundations

There are a few larger private foundations within the Baltic Sea Region, which fund projects to improve the ecological status of the Baltic Sea. The John Nurminen Foundation, "Zennström philanthropies" ("Race for the Baltic") and the Danish VELUX fund are among the most prominent foundations. Most often these foundations have a base funding from one private donor, but also continue to raise additional money from individuals, organisations as well as third-party funding to finance their Baltic Sea projects.

- In case of the **VELUX** fund, between 2012-2018 almost EUR 11 million were dedicated to fund marine protection and restoration projects in Denmark, including establishing reefs, raising awareness of the sea and stop littering.[69]

[68] Ten Brink et al. (2009)

[69] For more information see: https://veluxfoundations.dk/en/environment-and-sustainability

- The **John Nurminen Foundation's "Clean Sea Fund"**, which funds the Clean Baltic Sea projects, received EUR 227,950 worth of private donations in 2016. Individual donations represented 27% of the total funding. The rest originates from private organisations, public money, and third-party funding.
- The **Zennström philantrophies** started the Race for the Baltic, a non-profit foundation focused on restore the health of the Baltic Sea. Race for the Baltic works on improving dialogue, close-loops systems and innovation to solve the problem of euthropication in the Baltic Sea. The foundation works by bringing together politicians, scientists and different stakeholders as well as implementing nutrient reduction projects in the Baltic Sea.[70]
- Other private foundations include the **Baltic Sea Conservation Foundation** (baltcf) that was created in 2014 as a result of an agreement between the environmental organisations BUND Mecklenburg-Vorpommern, WWF Germany and the founder Nord Stream AG. The agreement resulted from discussions on how Nord Stream should compensate for the ecological impacts of the gas pipe running through the Baltic Sea. The Baltic funds, implements, and supports projects on ecosystem restoration and habitat protection.[71]
- The **Coalition Clean Baltic** (CCB) is a network of 17 environmental NGOs from 11 countries around the Baltic Sea including Belarus and the Ukraine. The main goal of the CCB is to promote the protection and improvement of the environmental and natural resources in the Baltic Sea Area. This politically independent network campaigns, educates and takes part in field projects to reach its goal.[72]

So far, however, most voluntary initiatives have been small and rather symbolic than effective. Philanthropic donations often have the character of a limited project. Campaigns such as "adopt a mussel" and "oysters for life" are on the rise as they are easy to implement and raise awareness, but are so far too volatile to secure a systematic and continuous funding for the ES provided by mussel farmers.

4.4.2 Crowdfunding – the NutriBute Platform

As part of the EU funded project NutriTrade, the crowd-funding platform NutriBute (nutrient contribution) was developed to raise funds for nutrient reduction projects. **The aim is to connect efficient nutrient abatement projects with voluntary financiers who are interested in lowering their nutrient footprint. Individuals as well as organisations can donate to projects of their liking.** Organisations can design their contribution to offset their nutrient emissions, but donations will always be voluntary on top of any regulatory requirements. For example, Helsinki city aims to become the Baltic Sea's first phosphorous neutral city in terms of its municipal wastewater treatment by offsetting nutrient emissions and by investing in various clean water projects.[73]
Nutribute will particularly support small, innovative projects that are proven and verifiable nutrient reduction measures but which are not yet market-driven or integrated into governmental policies.[74]
Organisations as well as individuals can launch a campaign on the platform, as long as it adheres to the following criteria:

- It reduces nutrient discharges, bind nutrient or remove them from the Baltic Sea;
- The campaign is allowed to be up on the website for a maximum of 365 days from the day the campaign starts;

[70] https://www.raceforthebaltic.com/foundation
[71] For more information on the Baltic Sea Foundation for Nature Conservation see: http://baltcf.org/foundation/history/
[72] For more information on the Coalition Clean Baltic see: http://www.ccb.se/about-ccb/
[73] E-mail from Anna Saarentaus, Project Manager at Nurminen Foundation
[74] For more information on the project NutriTrade see: https://www.luke.fi/wp-content/uploads/2016/12/NutriTrade_ProjectDescription101116.pdf

- Any donations have to comply to the Finnish Fundraising Act as well as other regulatory provisions;
- It is not allowed to offer any incentives in form of gifts or other payments to donators.

The NutriBute platform was launched only in early 2018 and is still in the process of being established. Only time can tell whether this kind of voluntary offsetting scheme will prove to be a monetary success or not. Currently there are already six projects from Finland, Belarus, and Russia that are seeking funding.

Similar to donations from private foundations and their campaigns. Such a **crowd-funding platform could potentially finance the start-up costs of a mussel farm**, but may not secure long-term, stable funding. However, if marketed properly, it is an **excellent opportunity to raise awareness among the general population about the eutrophication issue** as well as how one can contribute to a healthier marine environment.

4.4.3 Companies

The discussion during the "Financing Environmental Services" workshop at the Better of Blue Conference in September 2017 highlighted an important premise for companies being the payers for an ES payment scheme: many companies are slowly coming to realise that circular economy principles are in their best interest[75]. Moreover, companies started to understand that they bear a responsibility to society and embraced the idea of Corporate Social Responsibility (CSR), a private way for business to self-regulate their business with the aim to reduce their negative impacts.[76] Profit will always be the main motivation behind a company's actions but depending on what company, preserving ES might play an important role and expand a normal business model. **The tourist industry as well as fishing or real estate can increase profit by investing in a more environmentally sound company policy.**

As customers become increasingly environmentally aware and business practices are brought out in the open, companies are more frequently judged on the basis of their environmental stewardship. This also means that corporate social (and environmental) responsibility is an integral part of companies' marketing strategy as a way to distinguish themselves from competitors.

Supporting different environmental causes has become a fixture of most company's marketing strategies. Many companies present in the Baltic Sea support local environmental projects. To gather more momentum in the private sector, the Baltic Sea Action Group established a commitment bank to showcase private commitments towards an improved Baltic Sea environment.
Between 2009 and 2014, a total of 268 commitments were made by private and public actors, including individuals and NGOs. These commitments were not necessarily financial contributions but rather helping out with equipment or expertise.[77] Other examples of companies funding various environmental projects in the Baltic Sea include:

- The shipping line Viking Lines donates to the initiatives "Keep the Archipelago Tidy Association", "Keep Sweden Tidy Foundation", "Baltic Sea Action Group (BSAG)"
- The chocolate producer Fazer has a "Baltic Sea Commitment" and supports the Baltic Sea Action Group

[75] For more information on the workshop see: https://www.submariner-network.eu/network/better-off-blue/54-workshop-sessions/financing-environmental-services/264-financing-ecosystem-services)
[76] Sheehy (2014)
[77] For more information see: https://bsag-public.sharepoint.com/Documents/Commitment%20report%202015.pdf

- The interior architect office Kehrä Interior donates EUR 20-40 to the BSAG's work for each "Guardian of the Baltic Sea" jewellery piece sold.
- The plant technology company Verdera Oy donates a part of its Rotstop product's sales to the BSAG's work for the Baltic Sea.

It should be noted that the commitment bank does not provide a comprehensive overview on possible payments of companies to environmental projects. It can, however, be assumed that there is an increasing number of companies, which are getting involved in environmental projects to improve the ecological status of the Baltic Sea. Whether part of their corporate social responsibility (CSR) strategy or not, most companies acknowledge that pollution is a consequence of poorly managed resources.[78] Therefore, by improving their efficiency in using resources, companies could reduce their contribution of waste by simultaneously increasing their profit. **These initiatives will always be voluntary and depend on the good will of each donor.**

4.4.4 The tourism sector

Tourism could be a key sector for any potential private scheme. Clean water and beaches are imperative for a thriving tourism industry. **Paying for ecosystems services might also raise the profile of any resort, city or region and make it stand out in the competition to other places along the Baltic Sea coast**. Particularly the increasing competition for tourists requires the development of a specific image and target group-oriented advertisement, whereby environmental friendliness or nutrient neutrality can be one key factor for a destination to stand out.[79]

Another option could be to brand the whole Baltic Sea Region as one tourist destination focusing on innovative environmental solutions and clean water.[80] In other destinations, such as the eastern Caribbean, **hotels have started to charge guests a tax related to ecological conservation and restoration**. Such an approach seems also promising to consider for the Baltic Sea Region.

Linking the financing of a mussel farm to a particular business sector and its customers may indeed be a very interesting option also in the immediate future. It, however, affords careful design and ultimately depends on the ability of the mussel farmers and their supporting community to convince the given business owners and their managers on the value of their ES proposition.

4.4.5 Public authorities

It is possible to design a payment scheme whereby the paying benefactor is a public authority. In this case, the scheme would have the same features, except that the buyer is a public body, such as the regional authority.

However, it should be noted that it is so far not allowed for a municipal wastewater treatment company to use their money outside "treatment of wastewater and production of drinking water". To include mussel farming in wastewater treatment has been tested in Sweden but failed in court.

Another way for public bodies to be involved is through capital investment to private organisations that then pay back the loans through a PES scheme, such as the EU-financed NCFF fund.

[78] Porter (1998)
[79] Schernewski & Sterr (2002)
[80] Andersson (2007)

4.5 Conclusion and discussion: who pays?

Several possible sources for ecosystems service payments for mussel farming have been described. All of them show advantages and disadvantages.

The EMFF as one possible public funding option encourages aquaculture in terms of environmental services. This is a clear statement for mussel farming as ecosystem service. The Natural Capital Financing Facility (NCFF) also provides payments for ecosystem services. However, the fund is focused on large projects and thus not perfectly suitable for small-scale mussel farming. Furthermore, both funds are supporting projects of a limited timeframe, and therefore do not fully capture the aim of a long-term financial assistance for mussel farming. The European Agricultural Fund for Rural Development (EAFRD), even though focused on traditional agricultural sectors and not on aquaculture, provides an interesting scheme of payments for ecosystem services. This might be a way forward to develop suitable payment schemes for mussel farming. However, the EU regulations concerning those funds only provide frameworks, to be substantiated in national operational programs. **It can be concluded, that especially the EMFF, but also the other funds open possibilities for EU Member states and their regions to support mussel farming as an ecosystem service financially by using those funds.**

The polluter pays principle sounds fair on first sight, but is difficult to apply as it harbours several risks: Polluters might pay themselves free without changing their behaviour. It may bear the risk of being a disincentive to the highly important schemes designed to reduce nutrient inflow. Moreover, it entails the risk for political discussions of fairness as it cannot capture all polluters and may provide an additional burden to sectors, already facing international competition.

To use beneficiaries as payers seems to be a more promising approach, but requires careful design. Foundations, private persons or companies need to be convinced that mussels are indeed the best measure they can invest in, in order to receive the ES they want. This also means that there has to be a clear cause and effect, where sellers can guarantee that the ES will be provided.[81] Currently there may be a yearly risk of amounts of mussels harvests; but as is the case for any kind of agri- or aquaculture production an average harvest can be calculated over a range of 3 or 5 year production targets. Furthermore risks can be covered by insurances and/or other forms of public or private guarantees. In order to proof the ES effect there has to be a monitoring scheme in place, which measures how much weight of mussels are harvested and how much nutrients they contain. In addition, however, it is also necessary to have a clear, easy and commonly agreed monitoring & evaluation programme in place, which measures the environmental impacts on the given site, which are assumed to be positive; e.g. improvements in the water quality. For this one would also need to have a baseline, such as the current environmental status.

In addition, to turn beneficiary payments into reality, it is necessary to connect sellers with potential buyers, drawing on local knowledge, expertise and networks as a first step. The ES then needs to be advertised in order to gain awareness among the general population. This can be done by the administrative body handling the ES payment scheme or those who benefit from the service, such as the tourism sector. Depending on the ES payment scheme, there is the risk of free-riders; meaning that some beneficiaries pay, others may use the same service for free. This can, however, be avoided in case **a public institution acts as the intermediary between sellers and buyers.**

4.6 Motivation tools and awareness raising

The sub-chapter on possible payers referred to possible beneficiaries as well as public & private institutions as the possible bodies to pay for mussel farming. As explained above these payments

[81] Fripp (2014)

assume an intrinsic motivation to pay for ecosystem services. In the following chapter we elaborate on studies undertaken in relation to the willingness to pay (WTP) regarding the ES provided by mussels. Further, we present three different mechanisms that might be suitable to increase the motivation of stakeholders to pay for ecosystem services provided by mussel farming.

4.6.1 Willingness to pay

One of the approaches to estimate the price for ES is to determine a population's willingness to pay for the respective ES, like a cleaner sea with less algae blooms or with improved water clarity. **Willingness to pay is a good tool for politicians to find out the readiness of the society to pay for certain services and conditions, based on their preferences. It is a good way to secure, that public money is spent according to public demand for something worth paying for**. Environmental values are anthropogenic and people are willing to pay how much they think they those values/services are worth. It should be understood, that 'willingness to pay' is therefore only an 'indicator'; it is, however, by no means a tool to be used to come to a specific 'price' for ES payments.

The most extensive and recent study on willingness to pay for the benefits generated by reduced eutrophication is the "Baltic Sea survey on use and non-use values" published by the BalticStern network.[82] The study looks at the willingness to pay for different scenarios for 2050, based on the Biodiversity Strategy and Action Plan and report.[83] Descriptors for the scenarios included 5 stages of water quality and the indicators turbidity (water clarity), algae blooms, seagrass meadows, fish stocks, and oxygen supply on the sea bed. Many of the respondents viewed the Baltic Sea as a whole and were not only concerned about their own region. They had experienced algae blooms, turbidity, a change of fish species composition, and loss of underwater meadows. Thus, their willingness to pay corresponded to these experiences. **According to the study, algae blooms (59% of respondents), fish species composition (51%) and turbidity (47%) were the ecological consequences that respondents were most worried about and most willing to pay to mitigate**.[84] In total, the potential benefits, based on willingness to pay, for reaching the BSAP eutrophication targets would be in the range of EUR 3.6 to 4 billion annually. In Germany alone, conservative estimations calculate the average household willingness to pay around EUR 48 per year, with an annual total between EUR 440 and 991 million.

Smaller regional and national surveys show similar results. A survey carried out in Randers fjord, Denmark with 226 respondents evaluated the maximum willingness to pay for improved water quality in the fjord. The local community was asked how much they were willing to pay for an increased water transparency of 2.5 to 3 meters throughout the fjord, meaning the "bottom of the fjord will be visible whilst boating, swimming and fishing in most locations". From those who responded, 70% were willing to pay on average EUR 12.02 per person each month for the next ten years. This would amount to EUR 5.5 million per month if considering all individuals in the county.[85] A Swedish study investigating the regional willingness to pay for reduced eutrophication in the Stockholm archipelago with 1,840 responses found that the average willingness to pay for adults living in the counties of Stockholm and Uppsala was 436 – 725 SEK (EUR 43–73) annually.[86]

It is assumed that the richer a country is the more purchasing power its inhabitants have, the more they are willing to pay for cleaner water. A study[87] compared the willingness to pay for a large-scale international action plan to reduce eutrophication in the Baltic Sea of Polish and Swedish respondents. For Sweden, with a current GDP per capita of EUR 44.200, the average annual WTP per

[82] Add reference
[83] Biodiversity Strategy and Action Plan (BSAP) and report (add reference)
[84] Ahtiainen et al. (2014)
[85] Randers fjord survey (2003)
[86] Söderqvist & Scharin (2000)
[87] Turner et al. (1999)

person was in the range from EUR 350 to 630 (0.8%-1.4% of the average income), while for Poland[88], with a GDP per capita of 25,460 the figure was between EUR 46 and 90 (0.2%-0.4% of the average income). **This result generally supports the assumption that the willingness to pay for cleaner water depends on the economic situation of the population as it may be a value which is higher on the ladder of priority needs**. These differences may, however, also derive from factors such as preferences, culture etc.

Willingness to pay is also related to the extend, a specific group of people benefits from the respective ecosystem service, like cleaner water. In one study, the national recreation inventory data was combined with water quality data to model recreation participation and to estimate the benefits of water quality improvements. The model was based on results from Finland and considered swimming, fishing and boating. Whilst having no effect on boating, improved water clarity would increase the frequency of close-to-home swimming and fishing. If water transparency increased with one metre on average, swimmers' benefits would increase by EUR 31 – 92 million annually, whilst fishers would enjoy even greater benefits, from EUR 43 to 129 million annually. If water clarity were to be reduced by one meter, it would mean an annual loss of EUR 29 - 87 million in swimmers' benefits and a loss of benefits in the range of EUR 38 – 113 million for fishermen.[89]

The willingness to pay is also influenced by an increase in pro-environmental behaviour. Scientists and journalists alike inform and warn about environmental damage caused by human activities, resulting in climate change or other natural disasters. **People are better aware of their ecological footprint and appreciate their surrounding natural environment. This kind of awareness also contributes to a higher willingness to pay.** A healthy natural surrounding is no longer taken for granted. Other factors that could have an impact on our willingness to pay are:

- Individual factors (income, socioeconomic factors, etc.)
- Worldviews (how do we view ourselves and our environment)
- Cultural influences (how do we value that natural environment)
- Social relations (family, work, etc.)
- Contextual factors (local environment, home area, etc.)

Although results from these studies show that there is a considerable willingness to pay for cleaner water in the Baltic Sea and that these ES are important for the BSR population, a few aspects should be kept in mind: there may be differences between perceived benefits and actual benefits. Hence it is important to look at the method used.[90] Moreover, **results may change over time. Thus, an increase in income might raise one's willingness to pay**. In this context a study by Hökby & Söderqvist (2003) conclude that a 1% increase in income, results in about 0.3% increase in willingness to pay.[91]

4.6.2 Ecolabelling and certification schemes

One well-established marked-based mechanism to motivate potential payers and to raise awareness on the necessity to safe our environment, is the use of eco-labelling and certification schemes.[92] The label or certificate assures the consumer, that he buys something that is good for the environment/ sea. In return, he pays more than the market price. This additional amount of payment is then passed on to the producer, in our case the mussel farmer.[93]

88 Ressurreição et al. (2012)
89 Vesterinen et al. (2010)
90 Turner et al. (1999)
91 Hökby & Söderqvist (2003)
92 WBCSD & IUCN (2007)
93 Smith et al. (2006)

One initiative in the Baltic Sea Region is the Clean Baltic Sea labelling on fish steaks to support local fishery of the bream (Abramis brama) along the Finnish coast.[94] The John Nurminen Foundation that created the label decides what products can use the label and thus gives fishermen the opportunity to sell their seabream catch at a higher price. Similarly, feed produced from or containing mussel meal could have its own label marketing it as sustainable and organic. Thus, it could be sold at a higher price payed to mussel farmers for the ecosystem services they provide.

Mussel farms can potentially be funded through ecolabelling, whereby different actors in the tourist sector financially support local mussel farms and in turn receive a label or certification as "nutrient neutral".

4.6.3 Nutrient emission calculator

One way of making individuals aware of how their lifestyle contributes to eutrophication is a nutrient emission calculator. Whereas in climate campaigns it is possible to calculate the carbon footprint and get advice on how to reduce it, nutrient calculators estimate the nitrogen or phosphorous footprint.

The case of the Chesapeake Bay nutrient calculator:
The Chesapeake Bay area on the east coast of the United States is the largest estuary in the U.S., and one of the most affected by eutrophication. More than 150 major rivers and streams flow into the bay's drainage basin, which covers all of Washington D.C and parts of six states including New York and Pennsylvania. To reduce environmental pressure and to restore important ecosystems in and around the bay, numerous initiatives and projects aiming at reducing pollution have been initiated, including a nutrient calculator. The calculator is the first step of four that the Chesapeake Bay Foundation wants to involve citizens and companies to work towards a cleaner bay.[95] The steps include: 1. Estimate your nitrogen footprint with the calculator 2. Reduce the onsite and individual emissions 3. Purchase offsets for emissions that cannot be reduced 4. Chesapeake Fund invests the offset money in best practice projects
The Chesapeake nutrient calculator is meant to be "an educational tool that engages the public and makes them more aware of their collective impacts".[96] It gives your footprint a score, an annual emission value, advice how to change your behaviour and compares your footprint to that of others. Afterwards you are requested to pay for the emission you cannot avoid. This might be another way to raise awareness and motivate people to pay for ecosystem services.

In the Baltic Sea, the Finnish Environment Institute (SYKE) has launched a similar nutrient footprint calculator.[97] Based on similar educational premises as the Chesapeake Bay calculator, you answer a set of questions about diet, housing and transportation to get a personal footprint which you can compare to the Finnish average. So far, the calculator is only available for those residing in Finland, but has potential to be extended to all Baltic Sea countries.

[94] For more information on clean Baltic sea projects see: https://www.johnnurmisensaatio.fi/en/clean-baltic-sea-projects/about-clean-baltic-sea-projects/
[95] Chesapeake Bay Foundation (2013)
[96] Blankenship (2008)
[97] For more information see: http://www.syke.fi/balticseacalculator

5 How much to pay for ecosystem services?

After having shown different possibilities of who could be the payer in an ES payment scheme for mussel farming and how to motivate them, we will discuss in this chapter different ways to determine how much the provider of the ecosystem service should be paid for and whether such payments are in line with the costs associated with other nutrient reduction measures. It should be stressed, however, that such comparisons are problematic as such and currently 'unfair' towards mussel farming. First it should be stressed once more that mussel farming is a measure to take out nutrients and should therefore be compared only with possible other such measures available. However, for the time being such measures do not exist. Secondly, mussel farming is currently still in pilot phase without having reached the critical mass to create a push in the feed market. In addition, some efficiency gains may be achieved in input costs (e.g. harvesting machines); these may, however, not be decisive.

5.1 Cost-benefit analysis

A cost-benefit analysis is the most appropriate tool when attempting to quantify the costs and value of mussel farming as it considers both direct and indirect benefits and costs. As a complete cost-benefit analysis is beyond the scope of the study, we try to use literature results from similar cases together with data from the BBG project farms, to approach the costs mussel farming causes as well as the benefits they provide.

Figure 2: Research methodology.

5.1.1 *Absolute costs of mussel farming*

Academic studies on the topic employ different views on costs, with some including only running and investment costs and others, including monitoring costs, if the mussels are processed into food goods. In the BBG project the following costs for mussel farming have been taken into consideration (see Table 5:

Table 5: Different production costs related to mussel farming.

Investment	Set-up costs	Maintenance	Production results	Harvest costs	Other costs
Equipment costs **Boats** **Bank loans**	Work hours Boat hours Fuel price Bought boat services	Work hours Cost of equipment (repair, replace units)	Production study (growth rate per area) Estimated loss to predation Harvest result	Bought boat services Work hours Boat hours Fuel price Washing Packing Storage Logistics	Quality control (=sample and lab costs) Water area rental costs (if in private ownership)

This list includes the most relevant cost items that need to be considered by potential mussel farmers. Many of the costs for equipment and marketing could be shared within a mussel farmer cooperative. The main issue would nevertheless be quantity – how many mussels could be produced as the mussels settling will vary from year to year.

One of ambitions of the BBG project was to the project aims was to calculate the average production costs for mussel farming in the Baltic Sea in EUR/kg. However, due to the limited number of study objects, different prerequisites in terms of boats and other equipment, and the high variation in production success, this turned out to be a difficult task.

The following table from the BBG Report 'XXX' therefore only shows the investment costs and the operational costs based on the 2-3 years time period that the BBG farms have been active. Data has been normalized to per 100 m farm unit and per year, in order to facilitate the comparison between farms. So far only the reported operational costs are shown in EUR per kg, but not the overall production costs.

In order to calculate production costs, the investment and establishment costs should be divided either by the life-time expectancy of a farm. But since the expected duration and life of these investments for the given mussel arms is largely unknown as well as the long-term cost for boats and other necessary equipment, the authors of the reports refrained from guess estimating these figures. The numbers given in the table below have therefore not been extrapolated to include hypothetical future harvests, cost of loan interests, possible support from investment aid, or any other assumptions. More details are given in the site-specific development/business plans for each BBG farm; which provide for a deeper understanding of the factors determining real mussel production costs in EUR/kg.

Table 6: Investment and operational costs for small scale mussel-production in the Baltic Sea.

Costs EUR	**St. Anna**	**Byxelkrok**	**Musholm**	**Kiel**	**Pavilosta**	**Västervik**	**Hagby**	**Åland**
Investment + Establishment	156.873	145.638		20.000	112.000	37.037	58.536	89.817
per 100 m farm unit	6.536	12.137	13.403	6.667	44.800	15.447	12.725	19.525
Operational costs per year	7.119			7.441		5.256	8.612	14.467
per 100 m farm unit	297			2.480		1.143	1.872	3.145
Harvest (kg) per year	39.341		12.500	5.000		5.250	4.635	7.200
per 100 m farm unit	1.639		3.125	1.667		2.188	1.008	1.565
Operational cost EUR per kg mussel	0.18	N/A	N/A	1.49	N/A	1.00	1.86	2.39

Data from under the dotted lines should be read as the value above the line, normalized per 100 m farm unit. The data has been collected by interview of the farm responsibles Mats Emilsson, Tim Staufenberger and Susanna Minnhagen and the managers of associated farms, Mikael Wennström from Åland Government and Gun Lindberg from Västervik municipality.

As indicated above, it should be noted that the operational costs per ton harvested mussels in the given pilot farms were high in all places, actually too high, with the exception of the farm at St. Anna. But it should be noted that these are figures related to first year of operation; it is expected that efficiency will substantially increase when farmers get to know their farm and area resulting in optimized procedures and equipment. The costs for the St Anna farm show what can be expected from well operated submerged longline farms. For mussels to be used for human consumption on the fresh market (50-60 mm, 65 pieces/kg), production costs of up to 0.6-0.7€ per kg may result in a viable business financed through selling the mussels on the normal human consumption food market.

As shown in the financial report for the St. Anna farm, however, for small mussels, which can only be used for feed, fertilizers or other purposes, production costs cannot exceed max 0,1€ per kg unless somebody pays for the ecosystem goods and services provided by these mussel farms .

5.1.2 *Amount of Nutrient uptake by mussels*

Looking at estimations of nutrient reduction in the Baltic Sea and elsewhere, numbers differ depending on calculation and location. Table 8 shows the various ranges on nitrogen and phosphorous reductions provided by various types and locations of farms as described in literature so far.

Table 7: Nitrogen and phosphorous uptake by mussels, overview of several studies.

Author	Area of Study	Nitrogen uptake	Phosphorous uptake	Setting of the study
Lindahl et al. (2005) [98]	Gullmarn Fjord (Swedish West Coast)	28 tons	----------	2.800 tons of mussels
Gren et al. (2009) [99]	Not indicated	8,5-12 grams	0.8 grams	1kg harvested live mussels
Lindahl (2012) [100]	Kalmarsound, Swedish East Coast	1.8 tons / year	0.12 tons / year	1 ha
Orbicon (2018) [101]	Danish fjords	71 tons / year	4,7 tons / year	5 farms, 86,7 ha

The five farms analysed within the BBG project showed the following results (see BBG report XXX):

- The pattern of biomass yield of mussels was driven by salinity at the regional scale and food availability at the local scale. Higher growth values were predicted at higher salinities and/or better food regimes i.e. the outer and central Baltic Sea. Together with the reduction of salinity in the entrance region biomass yield decreased 7 times, from 15 down to 2 kg ww m-1 2yr-1. In the central Baltic Sea, the variability in the growth yield was small at 1-2 kg ww m-1 2yr-1. In the marginal regions, salinity suppresses mussel growth to the extent that the biomass yield never exceeded 1 kg ww m-1 2yr 1.

- However, under real farm conditions differences in the biomass yield were much smaller between oceanic and brackish water than in models based on the environmental conditions only. In brackish water substrate limitation among mussels and consequently the losses of mussels in the farm area are very low. Measurements taken on the mussel growth and nutrient removal during the BBG project showed that the central Baltic Sea farm at a salinity of 6 PSU (St Anna) removes a minimum of 1.1 t N and 0.045 t P per hectare over one harvest cycle (16 months). Typical figures from near-oceanic waters in Denmark are around 1.9 t N and 0.1 t P per hectare. This is only a 36% larger yield in the marine conditions compared to the typical salinity of the Baltic Sea. In consequence, the effectiveness of low salinity farms in view of nutrient removal service is almost as high as those farms operating in high salinity levels. This in turn means that cost differences for the nutrient removal service are not as high as expected and indicated in literature so far (see below).

[98] Lindahl et al. (2005)
[99] Gren et al. (2009)
[100] Lindahl (2012)
[101] Presentation – Orbico, Malmö March 2018

- Furthermore, the tests on the chemical and biological water properties carried out by Orbicon around the BBG project mussel farms showed a reduction of 41-44% in microalgae concentration and a 30-54% reduction in bacteria concentration; thus proving the important additional ecosystem services provided by mussel farms.

5.1.3 *The relationship between mussel farms costs and ecosystem services provided (cost-benefit analysis)*

Almost 10 years ago GREN ET AL. (2009) had put together a table with all costs for mussel farming in different parts of the Baltic Sea (see table 7).[102]

Table 8: Costs related to mussel farming in different areas of the Baltic Sea (GREN ET AL., 2009).

	Kattegat		The Sound		North Baltic Proper	South Baltic Proper
	Human	Industry	Human	Industry	Industry	Industry
Production cost (Euro kg^{-1})[a,b]	0.28–0.32	0.08–0.10	0.64–0.72	0.16–0.19	0.33–0.54	0.18–0.21
Marginal cost (Euro kg^{-1} N)	23.3–37.7	10–16.5	26.7–42.4	13.3–22.4	27.5–63.5	15–24.7
Marginal cost (Euro kg^{-1} P)	350–533	150–233	400–600	200–317	413–900	225–350
Sales price (Euro kg^{-1})	0.35	0.08	0.35	0.08	0.08	0.08
Net cost (Euro kg)	0	0–0.02	0.29–0.37	0.08–0.11	0.25–0.48	0.1–0.13
Marginal net cost (Euro kg^{-1} N)	0	0–4.3	24–31	6.7–13	21–57	8.3–15
Marginal cost (Euro kg^{-1} P)	0	0–60	363–454	100–183	312–800	125–216

In the SUBMARINER compendium published in 2012, this data was then used to show the different marginal costs for removing nitrogen and phosphorous in different parts of the Baltic Sea.

Table 9: Estimated marginal costs using mussel farming for nitrogen and phosphorous harvest along the Swedish coasts. Data from GREN ET AL. (2009). (US-$ converted into €) (SCHULTZ-ZEHDEN & MATCZAK, 2012).

	Salinity level	€/kg nitrogen	€/kg phosphorous
Skagerak/ Kattegat		0-32	0-323
Öresund Strait		0-36	0-361
Southern Baltic		6-34	61-338
Northern Baltic		13-77	131-769

At that time the data indicated a clear correlation between salinity levels and cost of nutrient reduction: the higher the salinity level, the lower the cost. When the mussels were sold as food on the Swedish west coast, there was no marginal costs, increasing to about 23 euro when the mussels were sold as feed and averaging about 35 euro per kg when only the nutrient removal aspect was valued.[103]

As shown above the measurements undertaken within the BBG project, point to a less dramatic correlation; as lower salinity farms are only 36% less effective in regards to nutrient or phosphor removal than those based in higher salinity parts.[104]

Nevertheless price ranges or rather calculations showing the total 'cost' for nutrient removal still vary substantially:

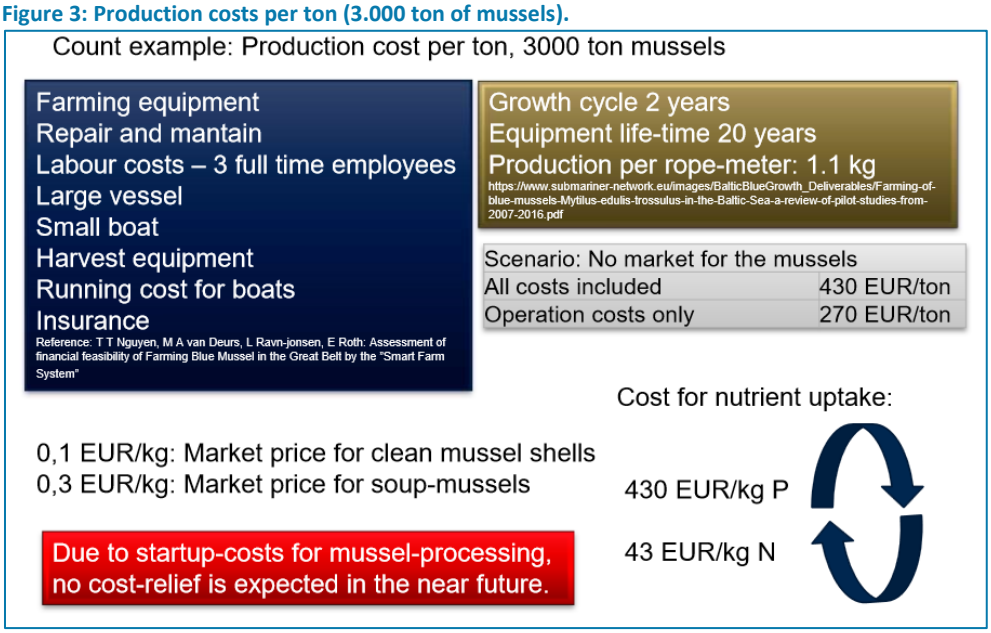
- One study conducted in the Danish fjords calculated the costs of **14,8 EUR/kg N**.[105]

- Another study conducted by the Kalmar municipality in Sweden, which was based on the production costs of their mussel farms situated in the Kalmarsound, concluded that for a farm

[102] Gren et al. (2009)
[103] Schultz-Zehden & Matczak (2012)
[104] Holmer et al. (2015)
[105] Petersen et al. (2014)

producing 3,000 tons of mussels every two years (1,500 tons per year), the costs would be around **43 EUR/kg N** and 430 EUR/kg P uptake (see Figure 3).[106]

Figure 3: Production costs per ton (3.000 ton of mussels).



- The following BBG report XXX, which was based on the operational costs of the test farm in St. Anna (see above), however, indicated lower costs showing a payment need of **19-25 EUR/kg N** and 250-500 EUR/kg P uptake to the respective mussel farm operator to be financially viable. The range of figures derives from different scenarios assuming either no further support; some start-up support and finally a growing market for mussels to be used in the feed industry.

5.1.4 Challenges in terms of calculating costs/ benefits of ES in mussel farming

Challenges should be considered when attempting to calculate the value of ES provided by mussel farms. Standard economic valuation assumes relatively intact and stable ecosystems; however, ecosystems (and their services) are dynamic systems being able to shift to completely new states of equilibrium.[107] Specifically, production costs are highly variable, and the cost effectiveness depends on productivity, labour intensity and equipment. The outcome depends on the overall yield of mussels, which can vary significantly. Limiting factors include spat supply, predation by eider ducks and other mussel predators, which influence both yield and production costs.[108] All in all, these factors limit the value of the ecosystem service. **With less mussels produced, the nutrient uptake is equally lower**. This is particularly relevant when discussing mussel farming in terms of agri-environmental services under CAP. As discussed in chapter 4.3.1, the payment in this case is paid per hectare and thus 'income foregone' by the farmer rather than an average price/calculation on how much nutrient inflow is reduced. In the case of mussel farming, the ecosystem payment is, however, assumed to be based on the actual amount of nutrient uptake, and thus the mussel harvest.

As indicated before, **it is therefore important that one can calculate an average amount of how many mussels can be taken up by a given farm over the course of years justifying an average amount to be paid for the related nutrient uptake.** To properly assess the risks and opportunities, each farm should be evaluated on an individual basis. Whatever indicators are used, these should be

[106] Presentation by Susanna Minnhagen at KLSA mussel meeting, Stockholm 2018
[107] United Nations Economic Commission for Europe (2007)
[108] Food and Agriculture Organization of the United Nations (no date)

quantifiable, transparent and easy to understand for practitioners. When monitoring a specific area, or in the case of the BBG project farms, these indicators should be the same.

Monitoring however is outside the scope of this study and it is crucial to keep in mind that numbers and even general assumptions concerning the effects and costs of other measures can vary greatly in the different regions. The benefits and costs of reducing the nutrient load are unevenly distributed across different countries, regions, economic sectors and stakeholders. The aggregated benefits are often the highest in densely populated regions, because more beneficiaries of clear water are located there, such as citizens, industry, tourism etc. The aggregated costs however are highest in regions that drain into waterbodies that are in an alarming ecological state, like the Baltic Sea. The target of reducing nutrition in those sub-basins is most challenging and costly.[109] However one should consider, that mussel farms do not only reduce nutrients in the Baltic Sea, but also provide other direct and indirect benefits such as better visibility and thus better benthic macroalgal communities, higher biological diversity, better fish spawning areas etc. These effects should also be regarded when developing payment schemes.

5.2 Comparative advantages of ES from mussels

The WFD specifies that the most cost-effective measures should be selected to reach the good status objective. For mussel farming, this would mean that mussel farming only becomes relevant as a measure to reduce nutrient load when the "marginal costs are lower than those of other abatement measures". However, cost effectiveness only considers the contribution to a certain goal (in this case mitigating eutrophication) but it fails to consider the other benefits of an activity (in the case of mussel farming this includes inter alia, clearer water, regional development and food/ feed production). Furthermore it should be stressed, that the goal of removing nutrients cannot be reached by using external measures only[110]. All possible measures to reach this goal need to be combined, to reach the best solution possible. Consequently, to understand how mussel farming contributes to social welfare, it is relevant to consider the generated direct and indirect benefits as well as costs. Hence, **the cost-effectiveness of mussel farming ought to be assessed according to all associated wider societal as well as potential costs**.

5.2.1 Costs of alternative measures to mitigate eutrophication

The total cost of achieving the remaining BSAP targets are estimated to be around EUR 3.1 billion, only considering land-based measures. An evaluation of mussel farming as mitigation measure (part of the HELCOM BSAP) conclude that including mussel farming would decrease total abatement costs by around 5% (equally to EUR 20-138 million).[111]

The BalticStern report[112] compares figures for costs of different land-based measures for nitrogen and phosphorous uptake (see Table 9). It should be noted that the two underlying studies are Ahlvik et al. (2012) and Hasler et al. (2012), which are by now somehow dated.

Table 10: Costs of different land-based measures based on N/P uptake.

	Ahlvik et al. 2012		Hasler et al. 2012	
	€/kg Nitrogen	€/KG Phosphorous	€/Kg Nitrogen	€/Kg Phosphorous
Reduced fertilization	2-158	0-463	0.5-8	
Catch crops	4-133	433-3,670	0.3-9.7	
Livestock reduction	16-512	950-150,000	0-328	0-14,688

[109] Hyytiäinen et al. (2014)
[110] Savchuk (2018)
[111] Gren et al. (2009)
[112] BalticSTERN Secretariat (2013)

Restoring wetlands	2-332	239-3,105	1.6-93	1.6-1,647
Constructing phosphorus ponds		18-867		
Improving wastewater treatment	2-642	10-2,772	14.6-13,898	57-537
Banning phosphorus in detergents		22-373		

Importantly the table illustrates the vast range of costs for different measures. This discrepancy results from differences in country, region, location, and availability of the different measures. Reducing the use of fertilisers remains the most effective measure for achieving a reduction of nitrogen input. Improving wastewater treatment is responsible for 60% of phosphorous mitigation.[113]

Two Danish studies (see Table 10) calculated the costs for different land-based measures to reduce nitrogen inflow. The comparison shows that costs per kg nitrogen reduction differ significantly among the measures but also between the different approaches used in the studies. According to the studies, costs for mussel farming are on a medium level.

Table 11: Calculated costs for various land-based measures in € / kg nitrogen reduction

Measure	Petersen et al. (2014)[114]	Other Danish Study (XXX)
Catch crops	3.5-10.5	0.3-41.6
Fertilization below optimum	8.1-32.2	15.7-27.1
Increased use of manure	11.4-12.8	
Energy crops	10.9-25.1	
Buffer strips and wetlands	10.9-25.1	9.9-34.9
Intercrops		7.5-13.7
Straw incorporation		0-44.7
Set aside farmland		20-69.7
Mussels		13.42

In chapter XXX we gave an overview of how much payment is given to farmers for growing catch crops and other measures in the context of the Common Agricultural Policy and the European Agricultural Fund for Rural Development. The payments range from EUR 50/ha for cultivating / building embankments to EUR 400/ha for taking care of wetland and dams.

According to a study by LINDAHL based on payment rates from 2006, the average price per kg retained nitrogen was EUR 11. If the same price was given to nitrogen taken up by mussels, then the payment should be **EUR 0.11** per kg live mussels.[115] This is less, but relatively close to the lower price ranges indicated above necessary for mussel farmers to receive as ES payment based on the different cost calculations.

5.2.2 *Replacement Cost Method*

To determine the value of the ES provided by mussels and other shellfish, some studies have employed the so-called replacement cost method. The method calculates the costs that would incur when replacing the industry's services with the next best alternative, for example (theoretically) replacing a wastewater treatment plant with mussel cultivation.

[113] BalticSTERN Secretariat (2013)
[114] PETERSEN ET AL. (2014)
[115] LINDAHL & KOLLBERG (2009)

The town of Mashpee, Massachusetts introduced a Watershed Nitrogen Management Plan in order to stay below total maximum daily loads of nitrogen. An evaluation of the plan revealed that in some bays, shellfish can remove all of the required nitrogen and that shellfish aquaculture can contribute to a total of 12.59 tons out of the required 17.13 tons of nitrogen removed annually in two affected bays. The required harvest to achieve this is 2,518 tons of shellfish annually. ***In terms of costs, the evaluation showed that substantial savings were to be made when including shellfish into the mix of abatement measures: with the shellfish, the total cost of keeping within the daily limit would reach 160 million USD, without shellfish the costs would increase to 250 million USD. The reason why these savings are so high is because wastewater treatment plant upgrades are the only viable option in the area, which has barely any agriculture.*** *Moreover, wastewater collection and treatment are highly fragmented and decentralised, which makes upgrades expensive.*[116]

Cost-effectiveness is not the only factor determining what measures should be implemented. The **assessment hinges greatly upon the variable "land availability**". Agricultural land is not everywhere available and opportunity costs might be too high to implement land-based measures such as wetlands. Furthermore, **costs and benefits of nutrient abatement cannot be considered linear**. As shown in the graphs below, costs for land-based measures used to reduce nitrogen and phosphorous increase exponentially the closer one gets towards achieving the BSAP goal.[117]

Figure 4: Cost curve and P reductions in Baltic Proper by measure (HYYTIÄINEN ET AL., 2014).

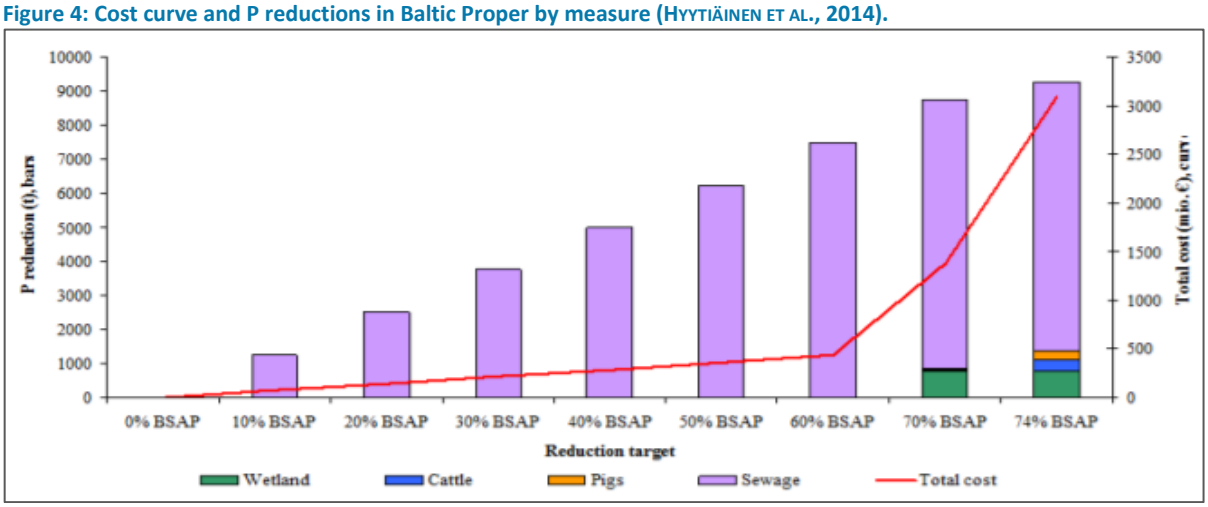
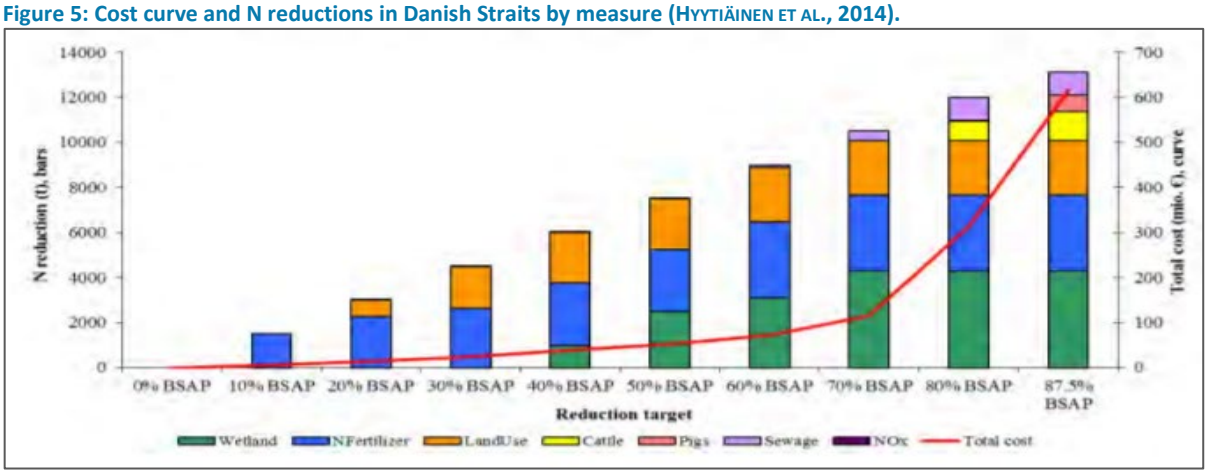


Figure 5: Cost curve and N reductions in Danish Straits by measure (HYYTIÄINEN ET AL., 2014).



[116] GHD INC. (2015)
[117] Hyytiäinen et al. (2014)

Even though mainly understood as an additional measure, mussel cultivation can also play a bigger role as it becomes relatively cheaper in case of increasing costs of land-based measures. However, costs for mussel farming are not linear either. As the best locations are taken by the first farms, costs of future farms may also go up in case of less suitable, cost-effective locations. At same time; for the near future it would be mainly expected that cost efficiency of mussel farms will increase due to two factors: 1) With the quantity of mussels increasing, the more cost-effective mussels become as a possible resource for the feed sector resulting in higher income from mussel sales. 2) The more Baltic Region mussel farms being operational, the more standardised operations and equipment leading to lower costs.

5.2.3 *Comparison with other sea based nutrient extraction methods*

As mentioned, mussel farming should, however, most importantly be compared with other forms of sea based nutrient extraction. However, all current nutrient extraction measures are experimental and not implemented on a regular basis yet. Moreover, as the nutrient content reduction measures in the table below have not been tested on a large scale, and some are invasive on the ecosystem, it is important to consider the potential negative pressures that these measures could have on natural ecosystems. Table 12 shows the measures currently being discussed and an estimation of their price per kg phosphorous.[118]

Table 12: Cost of phosphorous reduction (VAITIEKŪNIENĖ & SEMĖNIENĖ, 2017).

Measure	Cost (EUR/kg P)
Artificial oxygenation of bottom sediments	2 - 75
Adsorption on fine-particulate marl	3
Anoxic bottom treatment with aluminium	50 - 275
Mussel farming	67 - 6300
Reducing the amount of plankton eating fish	No estimates yet
Harvesting and cultivation of algae	60
Density sorting dredging	32
	Cost (EUR/kg N)
Nitrogen removal	2-35

5.3 Conclusion: How much to pay for the ES of mussel farms

As shown, it is currently not possible to indicate one single Baltic Sea Region wide figure on how much a mussel farmer operator needs to be paid for the provision of the ecosystem services. This is, however, no exception. The same applies to any water treatment charges or agri-environmental payments. None of them are the same across the various countries in the Baltic Sea region and actually often also show regional variations.

Nevertheless it is important that the costs identified in the literature review as well as within the BBG project – even though they vary - remain somehow in a similar range. Thus they give an indication of how much ES payment for mussel farms would be necessary for a mussel farmers being able to operate as an ES service provider.

Compared to other land-based measures, mussel farming might not be the cheapest measure from a strict economic point of view but it is also not the most expensive one. Moreover – even though mussel farming should not replace any kind of point source reduction solution – it may in some cases be the only remaining financially viable option. As shown, the actual costs calculated and resulting necessary payments to mussel farmers are already by now in the range of what is paid on average for other nutrient reduction measures per kg nitrogen retained.

[118] Vaitiekūnienė & Semėnienė (2017)

Alternative sea-based measures seem to be cheaper, but are still experimental and not yet implemented on a regular basis. Furthermore, negative impacts of those measures are not yet fully known.

For the time being, mussel farming as an additional measure for nutrient extraction seems reasonable, comparing different measures.

6 Possible ES payment scheme for mussel farming in the BSR

The analysis of the legal framework, existing funding schemes, approaches on ecosystem service payments and specific features of mussel farming has provided a sound fundament of knowledge. However, the study has also proved, that there is not yet a ready-made singular ES payment scheme in place, which could be used one to one for mussel farming. The related ES payment scheme therefore needs to be developed based on experiences from other fields.

As part of the Baltic Blue Growth project, the insights of this study have been discussed and ideas on how to design an ES payment scheme for mussel farming in the BSR have been collected. Based on the findings of the chapters 2-4, the following section summarises what needs to be considered and how could a possible payment scheme, tailored to the needs of the region look like.

6.1 Responsibility – choosing the right policy level

Public policy involves authorities from all levels, from EU policy down to municipal strategies. The EU and national legislation may have a greater legislative authority concerning transnational and national matters. **Local and regional governments, however, invest relatively more money in environmental protection and are often the ones carrying out environmental policies. They would be best suitable to host an ES payment scheme for mussel farms.**

Getting public authorities involved in ecosystem service payment schemes is complicated though, because of legal restraints and justification issues. However, **such schemes are potentially on a much larger scale than the schemes relying on single beneficiaries. Moreover, there is a bigger chance that ongoing payments would be guaranteed and not dependent on the whims of givers or firms**. As shown in the study, **the main motivation behind a public policy-driven scheme are actually the regulatory measures and strategies, which await implementation and for which the legal framework is established**. All legislation and strategies mentioned in chapter 2 (including the WFD, MSFD, HELCOM BSAP) as well as national legislation play a key role in paving the way for public funding. IN case of mussel farms being used as compensation for fish farms (IMTA system) other motivation may come in, which are more driven by sustainable regional blue economy development considerations.

The choice of policy tool should depend on the dimensions, to what extent the policy is viable in a specific context and how effective it is in achieving a satisfactory level of ecosystem service provision. The policy tool should also include some important characteristics, including:

1. **Transparency:** the costs and benefits of the policy should be visible to both providers and beneficiaries;
2. **Automaticity:** to what extent existing institutional structures can be used to carry out an ecosystem service payment scheme. The more structures are already in place, the lower the transaction costs will be.
3. **Coerciveness:** in the sense that a tool restricts behaviour rather than just encouraging or discouraging it.
4. **Effectiveness**: The tool should be cost-effective;
5. **Feasibility**: Implementation should be feasible within the near future.

6.2 Early mover issues

The study has shown, that there are still knowledge gaps concerning costs and benefits of mussel farming, ecosystem services in general and the best possible payment schemes in specific. Most of

them are still linked to the fact, that with only a few sites being fully operational, mussel farming in the Baltic is far from being standardised and experiences the problem of a 'lack of critical mass'.

When designing and testing an ES payment scheme for mussel farming in the BSR, uncertainties of various dimensions are therefore still to be expected:

- **Environmental:** e.g. uncertainty concerning the actual retention, the correlation between the activity or measure (e.g. mussel farming) and nutrient load and between the load and its effect on eutrophication, weather-related uncertainties;
- **Economic:** e.g. uncertainty regarding actual costs of mussel farming; the monetary benefit of reduced nutrient load and the efficiency effects to be gained from having more mussel farms in the vicinity and the resulting possible opening of new markets (e.g. such as feed market);
- **Technological:** Current mussel farming technology only works efficiently in sheltered bays, while offshore mussel farming is still experiencing "teething" problems.[119]

As shown in the various business plans developed for the BBG pilot farms, mussel farming in general is far from being 'big' business. Thus, in case mussel farming is wanted and desired to become a normal 'blue economy' service within the Baltic Sea region, public or private support is required to share the responsibility and financial burden of these uncertainties with the given mussel farm operators.

6.3 Combining action with outcome based payments

From our point of view, the ecosystem service payment scheme should be used as a reward instrument for providing ecosystem services. As shown in the chapter before mussel farms provide a variety of ES linked to the uptake of phosphorous and nitrogen. **The payment should be linked to the actual amount of nutrients taken out of the sea.** After all, we aim to design a scheme supporting action rather than inaction. Therefore, payment should only be given to mussel farms in areas where positive effects occur. This holds true for areas with sufficient oxygen, salinity, and chlorophyll levels.

When deciding on a value for the ecosystem service, or in other words, how much the farmers should be paid for their service, one can either look at the outcomes or the actions to achieve nutrient reductions. In terms of actions, the relevant mussel farming activity would be harvesting. This would be the more straightforward approach as only the weight of the harvested mussels is important for valuation with no analysis of the actual uptake of nitrogen and phosphorous being necessary. To base the evaluation on outcomes, i.e. the amount of extracted nutrients or water clarity, further monitoring is needed.

The best option is to combine outcome-based and action-based payments to limit the risks for farmers in case of a loss of harvest, but at the same time ensure the provision of ES.

In practice, it could look like the following: Suppose that the appropriate payment would be EUR 20 per mussel unit. This payment can be divided into two parts, the first EUR 5 would be paid out for setting up the farm. An established farm already guarantees some ES provision (e.g. increase in water transparency even if the mussels are not harvested). The rest of the EUR 15 would be paid when the outcome is produced (i.e. when the mussels are harvested and the nutrients extracted).

Such a scheme would also correspond with the various sources of funding. As has been shown, some funding is more 'investment' and/or project oriented; thus allowing for the financing of the initial investment in setting up the farm; the further development of appropriate equipment as well as the related monitoring. The further ongoing payment scheme would therefore then only need to finance the actual running costs related to the actual growing and subsequent harvesting of mussels.

[119] Swedish Environmental Protection Agency (2009)

Any further costs related to the 'use of mussels' in mussel meal for feed products would then in turn need to be covered by the actual purchaser of the mussels. Any higher price related to the purchase of mussels as opposed to any other sources for feed would need to be justified by the corresponding higher price to be achieved by gaining a more sustainable 'eco' feed product.

6.4 Providing support to optimal site selection

Sites having optimal conditions for mussels to grow shall be carefully considered in maritime spatial plans in order to secure – as far as possible - their use for the farms. In order to do so, sectoral 'mussel cultivation site' plans, should in first instance be prepared, which are integrated into the overall aquaculture plans (see BBG Report XXX). As optimal siting may differ, depending on the purpose of the mussel farm (e.g. mussels for human consumption; mussels as nutrient uptake measure; mussel farming as compensation for fish farms) plans have to based on the given national or regional targets, which may be driven by different stakeholders (e.g. Ministry of Environment; Ministry for Agriculture). Moreover, thorough environmental monitoring should take place regularly at the mussel farms to check the impact and allow for quick reaction in case of undesirable effects.

6.5 Funding for investments, monitoring programmes and testing of payment schemes

The EMFF as a public funding tool is dedicated to fund projects in aquaculture and even stresses the need for nutrient uptake. Furthermore, the EU has recently introduced the Natural Capital Financing Facility (NCFF), a funding mechanism that mixes grants with loans from the European Investment Bank. The NCFF can co-finance investments to set up and implement projects to restore and manage ecosystems. The NCFF also funds projects developing payment mechanisms that could repay any investments as the project carries on.

Especially through the EMFF an important support scheme can be offered by EU Member States, which reduces the total production costs of mussel farms by providing support for investments related to establishing a mussel farms as well as the related equipment (e.g. harvesting, storing, processing).

Moreover it can, however, also be used to provide support to the establishment and operational testing of payment schemes (and related monitoring programmes needed). Given the above described uncertainties, it is important that such burdens are not only placed on the individual mussel farms, but that this is supported by public funding programmes. Therefore, the project oriented public funding schemes described in chapter 4.1.1 provide useful opportunities.

6.6 Nutribute – crowd-funding for Baltic mussel farms?

In chapter XXX we introduced the existing crowd-funding platform Nutribute, which can already by now function as a crowd-funding tools for supporting investments related to the establishment of mussel farms and thus function in similar way as EMFF / NCFF funds (see above).

6.7 Subsidies and reverse auctions

There are a few different ways to pay out for farmers. The most commonly used and simplest form of payment is a **general subsidy**. A subsidy is defined by OECD as "any measures that keeps prices for consumers below market levels, or for producers above market levels, or that reduces costs for consumers and producers".[120] For a subsidy, the funding agency determines the maximum amount each farmer can receive and the two parties settle on a funding protocol. For some subsidies, like the

Randers fjord survey (200

agri-environmental fund, the farmers have to commit to certain land-use measures in order to receive a payment.

Other, possibly more nuanced options could be a "**scored subsidy**" or a "**reverse auction**". Scored subsidies, indexes or other assessment methodologies are used to provide scores for various characteristics such as location, biodiversity and growth rate. The service providers who scored the best are then offered a payment for their services.

A similar idea is provided by a 'reverse auction'. Reverse auction essentially means that whoever offers the best service provision at the lowest costs is funded first, and so it goes on until the funds are exhausted. In other words: In a reverse auction with a fixed cap potential sellers of mussel related ecosystem services are invited to bid on a per unit price for, e.g. phosphorus removal, with a maximum payable amount determined by the buyer of the services. This may be easier to implement than a full cost effectiveness analysis and spreads the risk of ecosystem service non-delivery between the buyer and the seller.

6.8 Voluntary emission offsetting and nutrient trading[121]

Another approach is rather suitable to motivate polluters to pay and should therefore be considered in light of what has been said before regarding risks of polluter pay principles:

A nutrient trading scheme is a market-based instrument that is premised on the fact that the costs to reduce nutrient pollution vary among individual entities. It is a scheme whereby participating parties such as businesses, farmers, wastewater treatment plants and municipalities can meet their discharge allowance by trading with each other. Hence, cost-inefficient discharges can buy nutrient credits from cost-efficient dischargers that have already reduced pollution more than required. Trading becomes attractive when the dischargers face substantially different pollutant reduction costs. A party facing relatively high pollutant reduction costs, such as a wastewater treatment plant, can pay another party, such as a mussel farm, to achieve a better than equivalent nutrient reduction at a lower cost. By trading credits, the overall cost of achieving nutrient reduction is minimised. In an efficient market, the trading scheme leads to the lowest-cost nutrient reduction.[122]

A nutrient trading scheme requires a comprehensive regulatory framework backed up by strong actors such as national, regional and local public entities, however, non-regularly drivers such as private businesses are equally important to create a demand for the nutrient trading credits.[123,124]

There is still a lot of scepticism regarding nutrient trading: No reliable all-encompassing, comparable monitoring data is available, neither for point nor for non-point sources. Furthermore, there are certain legal obstacles that need to be addressed. Especially the issue on whether nutrient trading schemes comply with the Water Framework Directive as well as other national regulation needs to be investigated. Like all schemes based on the polluters pay principle, trading schemes increase the risk, of missing the aim of reducing nutrient emission and combatting eutrophication. Polluters just pay themselves free without changing their behaviour. Thus, some agencies and regional authorities oppose nutrient trading since they even fear an exacerbation of eutrophication or localised hotspots.

Measures tend to be carried out in places where production is cheapest and conditions for cultivation are most favorable. These sites might not correspond with the optimal locational choice

[121] For different examples of nutrient trading systems see the Annex at the end of this report
[122] Cherry et al. (2007)
[123] SELMAN ET AL. (2009)
[124] STANTON (2009)

for the environment. Another issue regarding BSR-wide trading is the varying and sometimes conflicting goals, motivation and willingness to make polluters pay. Different emission levels between the different BSR countries might be another topic for discussion. Therefore, these schemes are likely to remain on a local and regional level, despite the advantage of schemes with a broader geographical scope.[125] However, changes in legislation (e.g. wastewater treatment) is also necessary to make nutrient trading possible even on local or regional scale.

6.8.1 Nutribute 2.0 – a feasible option?

Despite the scepticism described, it may be considered to expand the current Nutribute platform to provide ongoing support to mussel farms. **Some kind of certification as well as some kind of formal proof that nutrient reduction has taken place is a prerequisite for such scheme to become successful.** Another option could be creating a similar or additional label to the Aquaculture Stewardship Council label for mussel farms that provide ES, independently or as part of an IMTA.

Taking these aspects into account a potential future offsetting scheme for nutrient emission in the Baltic Sea could look like the following:

- A foundation is needed, that is in charge of a platform for voluntary emission offsetting, which includes the three elements nutrient-neutrality, emission calculation and offsets;
- A proof that the measures are working is needed to ensure that nutrients are being reduced and that there is a common standard by which third party auditors, validators and verifiers work to ensure clear standards (additionality, monitoring, verification, performance) and comparability among projects;
- Certification in the form of a label or otherwise is needed for profit-driven contributions for marketing reasons.

Moreover, the offsetting scheme has to:[126]

- Contribute to eutrophication protection by resulting in real, additional and verifiable nutrient reduction, whilst limiting negative consequences;
- Reduce nutrient emissions in an economically efficient way;
- Enhance the social and environmental benefits of the project to its hosts;
- Stimulate social and technological innovation and participation by involving new actors, sectors and groups;
- Create and build a legislative and policy framework for more effective and comprehensive national and international solutions;
- Avoid initiatives that could hamper broader eutrophication protection actions and policies; Create synergies with other eutrophication measures.

There is potential for a scheme such as Nutribute to expand into becoming a fully-fledged voluntary offsetting scheme. Nevertheless, this requires a large quantity of political will and an innovative policy framework with a certification standard that applies across the Baltic Sea Region.

6.9 Conclusion: Who should / could pay for what and how?

The collection of ideas and first components of a possible ES payment scheme for mussel farms in the BSR shows, that this endeavour is realistic, but that it cannot be left to individual mussel farmers on their own. It requires the joint effort of the entire 'mussel community' at least within a given region to provide the optimal framework for allowing the given first mover mussel farms to continue their operations and expand to more such mussel farms:

[125] Swedish Environmental Protection Agency (2009)
[126] Kollmuss et al. (2008)

- Most importantly mussel farms have to be accepted as an appropriate measure at given sites to reduce nutrient load and thus being part of the accepted mix of supported abatement measures. To this end also an accepted and easy to run monitoring scheme has to be established, which shows the ecosystem service effect provided by each mussel farm.

- Establishment of future mussel farms shall be support by site selection plans; driven by optimal site choice for given outcome targets (e.g. nutrient reduction targets in given regions; sustainable blue economy targets – e.g. expansion of fish farms)

- First mover mussel farms should receive public support (e.g. by EMFF) as a reflection of the higher costs related to the fact that mussel farms are far from standardised, while also lacking the critical mass necessary to produce the quantities necessary to be an accepted supplier to the feed industry

- Public funding programmes may also be used as to support the system design of payment schemes based also on donations from companies or foundations; which are in turn linked to benefits gained by those in view of showing corporate or regional social responsibility.

- Last but not least, however, also the mussel farm operators have to learn to organise themselves as to speak with one voice as

7 Conclusion and Recommendations

7.1 Conclusions

The main premise of this report is, that existing land-based measures to combat nutrient input and the reduction of eutrophication are without any question very important. Efforts in this direction should be maintained and even expanded.

However, to ensure good environmental status in the Baltic Sea, we highly recommend to consider mussel farming as an additional measure and that mussel farms established to this end are receiving a payment for this ecosystem service provided. As shown in other BBG reports based on the assessment of the given five pilot farms, mussel farming does provide important ecosystem services. Therefore, we argue that sea-based measures protecting and promoting marine ecosystems should receive support for providing ecosystem services just like farmers for their land-based measures.

Mussel farming should not be understood as an alternative for other measures; in case that those are feasible. GES is only possible when applying all appropriate instruments.

Our study on the current legislative framework has shown, that **existing international or EU directives and regulations do not prohibit mussel farming. However, they do not directly support mussel farming for nutrient update either**. They rather function as guidelines to be filled by **national legislation**. This **is by far the more interesting level of legislation for supporting ecosystem services provided by mussel farming**.

To design a possible ES payment scheme for mussel farming we first discussed the question who should pay for it. The analysis of existing public funding sources identifies the EMFF as most promising fund so far. However, the national operational programs decide for what measures the funding will be used, so again the actual support for mussel farming needs to be decided on a national/ regional level. Furthermore, the EMFF rather provides project funding and no institutional funding, which would be advantageous in the case of mussel farms. **The EMFF may be the right source to be used for further investments into mussel farms and related equipment as well as testing of payment schemes**. Further sources for payment are the polluter pays principle, which however is in danger of counteracting the aim of reducing nutrient emission. Therefore, **a scheme based on payments by beneficiaries seems more appropriate to safeguard ongoing ES payments.** Different sources such as private foundations, crowdfunding, companies or even sectors or public authorities are discussed. However, this form of payment needs a mechanism to reduce free-riding, to motivate potential payers and to raise awareness for the need of mussel farms providing important ecosystem services.
In the report we discuss three different approaches for motivation. One possibility to motivate beneficiaries to pay, is to **install ecolabelling or certificates to buy the products produced in the mussel farm**. Another means to raise awareness is the **nutrient emission calculator, to make the user aware of his/her own nutrient footprint** and to **suggest paying for ecosystem services afterwards**. An example to motivate polluters to pay is given by the voluntary emission offsetting or nutrient trading. However, as mentioned before, the polluter pays principle holds the risk of supporting nutrient emission, which is definitely not our intention.

The **payment should be based on the effective ecosystem service that mussel cultivation and harvest provide.** This is first and foremost filtering the water by feeding on phytoplankton, thereby taking up nutrients. However, it is difficult to determine an exact prize for the ecosystem service. Two approaches seem possible. Either a rather objective approach by calculating costs and benefits.

However, the monetarising of an ecosystem service is rather difficult and highly complex. The other option is to use the more qualitative and subjective approach of willingness to pay. Asking people about their willingness to pay, gives a clear message to the politics on the priorities of the society.

Furthermore we discussed to what extend mussel farming is competitive compared to other possible measures to combat eutrophication. It should be stressed that **mussel farming is currently the only existing measure to tackle uptake of nutrient content**. At the same time **our comparison even with nutrient inflow measures shows, that the efficiency of mussel farming for nutrient uptake is on a medium level concerning the cost-benefit ratio**. Taking the fact into account, that single measures are not enough to reach the goal of GES and that the cost-efficiency of each measure highly depends on local conditions, it is reasonable to argue, that mussel farming could and should be part of a mix of measures.

Our overview and discussion of several approaches to nominate payers, to motivate them, to calculate the prize and to design a scheme on how this payment could look like shows, that even though general principle are clear; a one size fits all scheme does not seem realistic. Rather, **local solutions tailored to the specific region or farm need to be developed**. But therefore, more specific research on site would be necessary to include specific characteristics. In chapter 5 we listed some ideas derived from the report on **what a payment scheme needs to consider** and which are the **best suitable approaches**, analysed so far.

In the following section we conclude with rather general policy recommendations on how to proceed regarding using ecosystem services by mussel farms and how to support them. The recommendations hinges upon on the following basic assumption:

Mussel farming is proven to reduce eutrophication (locally) by taking up nutrients from the water. Reducing nutrient inflow has to be complemented with a reduction in nutrient content. Mussel production is not in competition with other measures to improve water quality but a possibility to combine food production and a living sea/coast.

The set up of ES payments to mussel farms is realistic, but that it cannot be left to individual mussel farmers on their own to create it. It requires the joint effort of the entire 'mussel community' at least within a given region to provide the optimal framework for allowing the given first mover mussel farms to continue their operations and expand to more such mussel farms.

7.2 Recommendations

Currently there is a good time to induce policy change – showcase BBG results

- Policies should refer to UN SDG 14 "Conserve and sustainably use the oceans, seas and marine resources for sustainable development" and explicitly mention that mussel farms are a contribution to both living seas and coasts.
- Some EU-wide operational programmes are currently under revision: now is the time to influence decision-makers and for them to take actions. This does not only relate to the Directives such as the WFD or MFSD, but also the funding programmes. Here not only the EMFF is relevant, but also the restructuring of the European Agricultural Fund for Rural Development.
- Also the current HELCOM Baltic Sea Action plan as well as the EU Strategy for the Baltic Sea region is currently reviewed and updated; sea-based e.g. measures dealing with nutrient content are considered to be included. It is now for the BBG and resulting mussel community to communicate the projects' results and lobby for such measures to be included, accepted and highlighted. HELCOM and its EU Member States should then in turn lobby on a European level.

Examine the financial instruments, which are already available in the region / country.

- The EMFF may already be possible to be used for mussel farming or may be easily restructured in such way.
- Mussel farms should receive public support (e.g. by EMFF) as a reflection of the higher costs related to the fact that mussel farms are still first movers and thus being far from standardised.
- The EMFF can be used to lower the overall production costs by providing support to the investments related to the establishment of the farm; but also other supporting activities.

Provide support to overcome 'first movers' to reach critical mass

- Currently mussel farms lack the critical mass necessary to produce the quantities necessary to be an accepted supplier to the feed industry. The more mussel farms are established, the lower their cost and the higher the additional positive effects and ecosystem services provided by the mussels produced – as they can then provide an alternative protein source for the feed industry. Thus any future public or private support schemes should also provide support and forum to mussel farms to set up cooperative solutions for joint use of infrastructure and collective supplier to a given feed industry.
- Public funding programmes may also be used as to support the system design of payment schemes based also on donations from companies or foundations; which are in turn linked to benefits gained by those in view of showing corporate or regional social responsibility.

Ensure that incentives to reduce nutrient are not impeded

- Nutrient trading as a scheme is worth considering: But any scheme involving offsetting has to ensure that restrictions on nutrient polluters such as agriculture and waste-water plants remains as strict as before

Mussel farms need to be officially accepted as an additional measure at given sites to reduce nutrient load and thus being part of the accepted mix of supported abatement measures.

- To this end they need support for being 'certified' in that they indeed provide the ecosystem services promised.
- While payments should be based on quantifiable parameters such as P/N uptake or water clarity; a clear, easy, common and cost-efficient monitoring & evaluation scheme should be adopted to showcase these positive impacts to the public.
- The payment would primarily cover the mussel production costs. Investment / set up costs are separate costs that could be covered by grants
- Payments should be at least equal to that given to land-based measures and should consider that mussel production accumulate more carbon and nutrients than it releases

Mussel farming should always be included in a cost-effective abatement mix

- It is currently the only existing measure, which can currently deal with nutrient content.
- Nevertheless it also is in the mid-range in terms of costs, but has positive externalities
- In some instances, land-based measures are not possible or too costly due to e.g. lack of land. This strengthens the case for mussel farming as a mitigation measure

Support establishment of future mussel farms through target oriented site selection plans

- driven by optimal site choice for given **outcome targets** (e.g. nutrient reduction targets in given regions; sustainable blue economy targets – e.g. expansion of fish farms)

A scheme in which the benefactor pays is a good alternative for short- and long-term success.

- There is a clear willingness to pay for clearer water among the population in Baltic Sea countries, which politically justifies payment scheme for mussel farming
- Benefactors may be individuals, private foundations, enterprises as well as regional authorities.

- Beach house owner / hotels / tourism benefit from clearer water and could pay a small tax or fee for the ecosystem service provided by mussel farmers.
- Alternatively also other enterprises see the funding of a mussel farm as part of their Corporate Social Responsibility programme.
- For success in the short-term, the scheme can start of as local or regional with the potential to become a national scheme
- Payments may be organised through reverse auctions, where those providing the best 'offer' for the ecosystem service provision are funded.

Implement local (or regional) backed by national support

- There is a much higher possibility to be implemented on a local / regional level, particularly when involving local stakeholders such as fishermen in a coordinated effort to influence national policy
- Anyhow, it is a case by case decision, on whether a mussel farm is best additional measure in a given place depending on how effective and feasible any other land-based measures would be
- A Baltic-wide approach is theoretically desirable but very difficult to implement
- EU-funding: Reforms are happening but very slowly and outcome is uncertain. Do have a look at regional development funds, here the decision is taken on a national level

Let the beneficiary be the owner or the buyer of the services of the mussel farm

- Set up a scheme where the municipality / region and/or private foundation is the owner but a private company or organization is the operator, responsible for running the farm and for marketing

Last but not least, mussel farm operators have to organise themselves as to speak with one voice

Annex: Further examples of offsetting schemes

REDD+ and PLANVIVO – how to design a voluntary offsetting scheme

By comparing these two carbon offsetting schemes, we can start to put together a potential voluntary nutrient offsetting scheme for the Baltic Sea. Countries are unlikely to offset as long as the caps are too high, and stakeholders in a Baltic Sea scheme would rather be companies than smallholders and individuals. Moreover, it is important that the effort to improve the environment in the Baltic Sea Region is shown to clients.

REDD+

REDD+ is a mechanism under the UN-REDD programme which aims at conserving forests in developing nations. The basic idea was to design a performance-based payment system for measurable and verifiable emission reductions through forest conservation measures. So far, the mechanism has encountered several problems and is still at the preparation stage, acting more as an inefficient aid programme than an offsetting scheme.[127] Even if the general consensus is that REDD+, "although troubled, is not dead",[128] there are other similar schemes that are closer to a scheme that would suit the Baltic Sea better.

PLANVIVO

Although working on a much smaller scale, PLANVIVO is a more promising offsetting scheme than REDD+. It is a foundation bringing together offset buyers and providers by certifying projects, including PES for carbon sequestration and issuing certifications for contributing to these projects. The offset standard "Plan Vivo Standard" is itself developed for use in community-based projects using a PES-approach. Hence, the community or small-holders directly undertake the activities and are in charge of the project. As such, the projects are highly additional as they involve communities that otherwise would lack the financial, technical and social capacities to implement such projects. Moreover, the projects must pass an additionality test, ensuring that they are not a direct result of legislation, or commercially viable in their own right.[129]

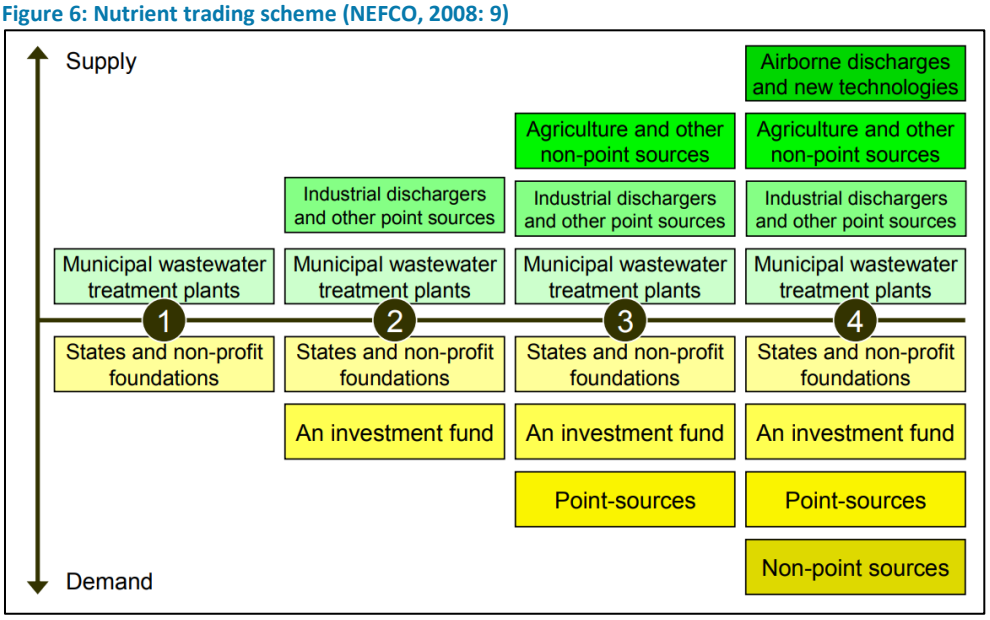
NEFCO

The nutrient trading scheme proposed by NEFCO in 2008 proposes a step-by-step approach with four phases (see figure 6), with a later phase building upon the outcomes of the previous phase:[130]

- Phase 1: Introducing the concept of nutrient trading;
- Phase 2: Establishing a fund for pooling voluntary investments;
- Phase 3: Allowing point-sources the flexibility of using nutrient credits for compliance;
- Phase 4: full-scale nutrient trading.

[127] Fletcher et al. (2016)
[128] Angelsen et al. (2017)
[129] For more information on PlanVivo see: http://www.planvivo.org/
[130] NEFCO (2008)

Figure 6: Nutrient trading scheme (NEFCO, 2008: 9)



However, the NEFCO proposition was never piloted due to political opposition at the time. However, 10 years later, some national governments such as Sweden used the idea by establishing mussel farms as an ecosystem service payment measure to comply with regulation. Politically the BSR might be warming up to the idea of a future nutrient trading scheme.

CEASAR – Certificates for Allocation of Shares Adjusted to Retention

To achieve the reduction targets Sweden committed to under the BSAP, the Swedish environmental protection agency – Naturvårdsverket – developed a nitrogen trading programme. It is a system of tradable nitrogen certificates with a "nitrogen removal floor" for the three marine basins the Baltic Proper, the Sound and the Kattegatt. The main focus is municipal wastewater treatment plants, as these are the biggest nitrogen emitters in Sweden. Before CEASAR was to be introduced, an adequate legal and regulative system to implement the programme was planned. It included, for example, a law on nitrogen certificates for municipal wastewater treatment plants together with new regulation for retention, accredited measurements of nitrogen and guidance to regional regulative authorities. The regulatory framework was propped up by new data on retention and hydrological networks as well as a rigid enforcement, monitoring and reporting system.

The basic idea is similar to other emission trading schemes currently in place. A wastewater treatment plant generates one nitrogen certificate for each kg of nitrogen load that is reduced. The nitrogen removal floor – i.e. the minimum number of nitrogen certificates to be generated by the industry – is based on the Swedish industry target set by the BSAP in 2007, 3000 tons reduction in the annual load of nitrogen. At the beginning of the scheme, the nitrogen removal floor will start at the current industry equilibrium level of nitrogen and will then take an annual percentage increase until the target is achieved.

Wastewater treatment plants can obtain nitrogen certificates in the two following ways: Either the plant implements measures to reduce its own emissions, or the plant can buy nitrogen certificates on the market. These certificates will come from other treatment plants that have already achieved their targets and are selling off their remaining quotas.

Trading nitrogen certificates has several advantages. First of all, trading with certificates will create a price on nitrogen load to the three marine basins, which in turn will create an incentive for treatment plants in Sweden to implement the necessary nitrogen load reductions. As a certificate is a verification that one unit of nitrogen load has been reduced rather than the right to add another unit of load, the scheme creates a sense of common responsibility to the meet the commitment of the wastewater treatment industry. This in turn raises awareness among private actors of their responsibility to mitigate eutrophication.

CEASAR focuses on nitrogen as the Swedish commitments to BSAP to reduce phosphorous has already been achieved. However, the CEASAR scheme could still be useful for regulating the agricultural and industry sector to ensure that adequate measures are taken in order to meet the environmental quality objective "No Eutrophication". Moreover, as the nitrogen certificate is verification for a one kg reduction in a nutrient emission and is therefore directly linked to emissions reductions linked to actions rather than total emissions. This is crucial to justify such a scheme as non-point sources cannot be attributed to individual actors. A trading with certificates scheme can therefore control both point and non-point pollution and provide a flexible solution without burdening the agricultural sector with taxes.[131]

Unfortunately, the CEASAR nutrient trading scheme was never realised. The Swedish government asked the Swedish Environmental Protection Agency whether a nutrient trading scheme would be feasible for the Baltic Proper, the Sound and Kattegatt. The report concluded that trading with nutrient certificates is in line with the Water Framework Directive, however in 2014, elections took place and a new government and parliament were installed. The new parliamentary committee on the environment and agriculture deemed the nutrient trading scheme incompatible with current environmental regulation and decided that there are other more cost-efficient measures to reduce the nutrient inflow into the Baltic Sea.[132]

[131] Natur Vårds Verket (2012)

[132] For more information see: https://data.riksdagen.se/fil/022D51DA-8083-4C43-AA9B-0C2217C7B3E8

8 Literature

Ahtiainen, H. et al. (2014): Benefits of meeting nutrient reduction targets for the Baltic Sea – a contingent valuation study in the nine coastal states. In: Journal of Environmental Economics and Policy 3 (3), pp. 278-305.

Allen, W. & Jacobson, C. (2009). Learning about the social elements of adaptive management in the South Island tussock grasslands of New Zealand. In: Allan, C. & Stansky, G. Adaptive environmental management: a practitioner's guide. Springer in association with CSIRO, pp.95–114.

Andersson, M. (2007): Region branding: The case of the Baltic Sea Region. In: Place and Branding and Public Diplomacy 3 (2), pp. 120-130.

Andreoni, J. (1990): Impure Altruism and Donations to Public Goods: A Theory of Warm-Glow Giving. In: The Economic Journal 100 (401), pp. 464-477.

Angelsen, A., Brockhaus, M., Duchelle, A., Larson, A., Martius, Ch., Sunderlin, W., Verchot, L., Wong, G., Wunder, S. (2017): Learning from REDD+: a response to Fletcher et al. In: Conservation Biology 31 (3), pp.718-720.

Atkins, J., Burdon, D. (2006): An initial economic evaluation of water quality improvements in the Randers Fjord, Denmark. In: Maritime Pollution Bulletin 53 (1-4), pp. 195–204.

BalticSTERN Secretariat (2013): The Baltic Sea –Our Common Treasure, Economics of Saving the Sea. Rapport 2013:4 commissioned by the Swedish Agency for Marine and Water Management. Available online:
http://stockholmresilience.org/download/18.4531be2013cd58e844853b/BalticSTERN_The+Baltic+Sea+-+Our+Common+Treasure.+Economics+of+Saving+the+Sea_0314.pdf (27.11.2018).

Bartnicki, J., Benedictow, A. (2017): Contributions of emissions from different countries and sectors to atmospheric nitrogen input to the Baltic Sea basin and its sub-basins. In: EMEP/MSC-W Report for HELCOM, Oslo. Available online: https://bit.ly/2Q0OwLX (19.11.2018).

Blankenship, K. (2008): Bay Stakeholders Look to Offset Nutrient Footprints. Ecosystem Marketplace . A forest trends initiative. Available online: http://www.ecosystemmarketplace.com/articles/bay-stakeholders-look-to-offset-nutrient-footprints/ (27.11.2018).

Chesapeake Bay Foundation (2013): Chesapeake Nutrient Neutral Fund. Final Prgrammatic report. Available online: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1100752.pdf (27.11.2018).

Chislock, M. (2013): Eutrophication: Causes, Consequences, and Controls in Aquatic Ecosystems. In: Nature Education Knowledge 4 (4), p. 10.

Clark, Ch., Kotchen, M., Moore, M. (2003): Internal and external influences on pro-environmental behavior: Participation in a green electricity program. In: Journal of Environmental Psychology 23, pp. 237-246.

Costanza, R., D'Arge, R., de Groot,R., Farber, St., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R., Paruelo, J., Raskin, R., Sutton, P., van den Belt, M. (1997): The value of the world's ecosystem services and natural capital. In: Nature 387, pp. 253-260.

Elofsson K., Gren, I-M. (2004): Cost-effectiveness in Swedish environmental policy – an evaluation. In: Ekonomisk Debatt 3, pp. 57-68.

EMFF (2014a): Operational Programme 2014-2020 for Sweden. Available online:
https://ec.europa.eu/fisheries/sites/fisheries/files/docs/body/op-sweden_sv.pdf (27.11.2018).

EMFF (2014b): Operational Programme 2014-2020 for Denmark. Available online:
https://ec.europa.eu/fisheries/sites/fisheries/files/docs/body/op-denmark_da.pdf (27.11.2018).

European Commission (2000): Water Framework Directive (2000/60/EC). Available online:
https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32000L0060 (19.11.2018).

European Commission (2016a): Introduction to the new EU Water Framework Directive. Available online: http://ec.europa.eu/environment/water/water-framework/info/intro_en.htm (26.11.2018).

European Commission (2016b): On the application of the Water Framework Directive (WFD) and the Marine Strategy Framework Directive (MSFD) in relation to aquaculture (SWD(2016) 178 final). Available online: http://ec.europa.eu/environment/marine/pdf/SWD_2016_178.pdf (26.11.2018).
European Commission (2016c): European Maritime and Fisheries Fund. Available online: https://ec.europa.eu/fisheries/sites/fisheries/files/docs/body/op-overview-fact-sheet_en.pdf (27.11.2018).
European Council (1991): Nitrates Directive (91/676/EEC). Available online: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31991L0676&from=EN (19.11.2018).
European Investment Bank (2018): Successful roll-out of EUR 400m natural capital initiative supporting conservation across Europe. Available online: http://www.eib.org/en/infocentre/press/releases/all/2018/2018-128-successful-roll-out-of-eur-400m-natural-capital-initiative-supporting-conservation-across-europe.htm (27.11.2018).
European Parliament, European Council (2000): Water Framework Directive (2000/60/EC). Available online: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32000L0060 (26.11.2018).
European Parliament, European Council (2008): Marine Strategy Framework Directive (2008/56/EC). Available online: https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:164:0019:0040:EN:PDF (19.11.2018).
European Parliament, European Council (2014): Regulation on the European Maritime and Fisheries Fund (No 508/2014): Available online: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R0508&from=EN (18.12.2018).
European Parliament, European Council (2016): Groundwater Directive (2006/118j/EC). Available online: https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:372:0019:0031:EN:PDF (19.11.2018).
Eurostat (2018): Agri-environmental indicator-gross nitrogen balance. Available online: https://ec.europa.eu/eurostat/statistics-explained/index.php/Agri-environmental_indicator_-_gross_nitrogen_balance (19.11.2018).
Fletcher, R., Dressler, W., Büscher, B., Anderson, Z. (2016): Questioning REDD+ and the future of market-based conservation. In: Conservation Biology 30 (3), pp. 673-675.
For more information see: http://www.fao.org/3/a-i5555e.pdf
Fripp, E. (2014): Payments for Ecosystem Services (PES): a practical guide to assessing the feasibility of PES projects. Bogor, Indonesia: CIFOR. Available online: http://www.cifor.org/publications/pdf_files/Books/BFripp1401.pdf (28.11.2018).
Graneli, E., Wallström, K., Larsson, U., Graneli, W., Elmgren, R. (1990): Nutrient limitation of primary production in the Baltic Sea area. In: AMBIO 19 (3), pp. 142–151.
Gren, I-M., Lindahl, O., Lindquist, M. (2009): Values of mussel farming for combating eutrophication: An application to the Baltic Sea. In: Ecological Engineering 35 (5), pp. 935-945.
Gundersen, H., Bryan, T., Chen, W., Moy, F. E., Sandman, A. N., Sundblad, G., Schneider, S., Andersen, J. H., Langaas, S., and Walday, M. G. (2016) Ecosystem services in the coastal zone of the Nordic countries. Nordic Council of Ministers. Rosendahls Schultz Grafisk: Denmark.
Haines-Young, R., Potschin, M.(2018): Common International Classification of Ecosystem Services (CICES) V5.1 – Guidance on the Application of the Revised Structure. Available online: https://cices.eu/content/uploads/sites/8/2018/01/Guidance-V51-01012018.pdf (27.11.2018).
Hansen, R., Frantzeskaki, N., McPhearson, T., Rall, T., Kabisch, N., Kaczorowska, A., Kain, J., Artmann, M., Pauleit, S. (2015): The uptake of the ecosystem services concept in planning discourses of European and American cities. In: Ecosystem Services 12, pp. 228-246.
HELCOM (2007): Baltic Sea Action Plan. Available online: http://www.helcom.fi/Documents/Baltic%20sea%20action%20plan/BSAP_Final.pdf (19.11.2018).
HELCOM (2009) Guidelines for sampling and determination of nitrate. Online at: http://www.helcom.fi/Documents/Action%20areas/Monitoring%20and%20assessment/Manuals%20and%20Guidelines/Guidelines%20for%20sampling%20and%20determination%20of%20nitrate.pdf

HELCOM (2014): Eutrophication status of the Baltic Sea 2007-2011 - A concise thematic assessment. In: Baltic Sea Environment Proceedings No. 143. Available online: http://www.helcom.fi/Lists/Publications/BSEP143.pdf (19.11.2018).
HELCOM (2016): Shipping sector cuts nitrogen loads to the Baltic Sea. Press release. Available online: http://www.helcom.fi/news/Pages/Shipping-sector-cuts-Nitrogen-loads-to-the-Baltic-Sea.aspx (26.11.2018).
HELCOM (2017): HELCOM Indicators – Dissolved inorganic phosphorous (DIP). HELCOM core indicator report, July 2017. Available online: http://www.helcom.fi/Core%20Indicators/DIP%20-%20HELCOM%20core%20indicator%20report%20-%20HOLAS%20II%20component.pdf (26.11.2018).
Hökby, St., Söderquist, T. (2003): Elasticities of Demand and Willingness to Pay for Environmental Services in Sweden. In: Environmental and Resource Economics 26 (3), pp. 361-383.
Holmer, M., Thorsen, S.W., Carlsson, M.S. and Kjerulf, P.J. (2015): Pelagic and benthic nutrient regeneration processes in mussel cultures (Mytilus edulis) in a eutrophic coastal area (Skive Fjord, Denmark). In: Estuaries and coasts, 38(5), pp.1629-1641.
https://www.raceforthebaltic.com/foundation
Hyytiäinen, K., Blyh, K., Hasler, B., Ahlvik, L., Ahtiainen, H., Artell, J., Ericsdotter, S. (2014): Environmental economic research as a tool in the protection of the Baltic Sea – Costs and benefits of reducing eutrophication. In: TemaNord 2014: 504. Available online: http://norden.diva-portal.org/smash/get/diva2:707748/FULLTEXT01.pdf (26.11.2018).
International Maritime Organisation (2018): International Convention for the Prevention of Pollution from Ships (MARPOL). Available online: http://www.imo.org/en/about/conventions/listofconventions/pages/international-convention-for-the-prevention-of-pollution-from-ships-(marpol).aspx (26.11.2018).
Jacquet, J., Sebo, J. and Elder, M. (2017) Seafood in the Future: Bivalves Are Better. The Solutions Journal. 8(1), pp. 27-32.
Jeffery, K., Vivian, C., Painting, S., Hyder, K., Vemer-Jeffreys, S. Walker, R. Ellis, T., Rae, L., Judd, A., Collingridge, K., Arkell, S., Kershaw, S., Kirby, D., Watts, S. Kershaw, P., Auchterlonie, N. (2014): Background information for sustainable aquaculture development, addressing environmental protection in particular - Sustainable Aquaculture Development in the context of the Water Framework Directive and the Marine Strategy Framework Directive. Cefas contract report <C6078>. Available online: http://ec.europa.eu/environment/enveco/water/pdf/SUSAQ%20Final%20Report%20Part%201.pdf (26.11.2018).
Jordbruks Verket (2019) Remuneration levels for environmental compensation and compensation for organic production. Online at: http://www.jordbruksverket.se/amnesomraden/stod/jordbrukarstod/miljoersattningar/ersattningsnivaer.4.613fbaa714bedd0f2d319ee8.html, 1 SEK = 0,1 EUR.g
Kemkes, R., Farley, J., Koliba, Ch. (2010): Determining when payments are an effective policy approach to ecosystem service provision. In: Ecological Economics 69, pp. 2069-2074.
Kollmuss, A., Zink, H., Polycarp, C. (2008): Making Sense of the Voluntary Carbon Market: A Comparison of Carbon Offset Standards. Available online: https://mediamanager.sei.org/documents/Publications/SEI-Report-WWF-ComparisonCarbonOffset-08.pdf (28.11.2018).
Le Goffe, P. (2013) The Nitrates Directive, Incompatible with Livestock Farming? – The case of France and Northern European Countries. Jacques Delors Institute. Online at: http://www.institutdelors.eu/wp-content/uploads/2018/01/nitratesdirective-legoffe-ne-jdi-may13.pdf
Lillebø et al. (2016): Assessment of Marine Ecosystem Service Indicators: Experiences and Lessons Learned from 14 European Case Studies. In: Integrated Environmental Assessment and Management 12 (4): pp. 726-734.
Lindahl, O., Kollberg, S. (2009): Can the EU agri-environmental aid program be extended into the coastal zone to combat eutrophication? In: Hydrobiologia 629 (1), pp. 59-64.

Lindhout, P., van den Broek, G. (2014): The Polluter Pays Principle: Guidelines for Cost Recovery and Burden Sharing in the Case Law of the European Court of Justice. In: Utrecht Law Review 10 (2), p. 46.
Maracchi, G., Bindi, M., Sirotenko, O. (2005): Impacts of Present and Future Climate Variability on Agriculture and Forestry in the Temperate Regions: Europe. In: Salinger, M., Motha, R., Sivakumar, M. (2005) (eds.): Increasing climate variability and change: Reducing the vulnerability of agriculture and forestry. Springer Publisher: Berlin, Heidelberg. pp. 117-135.
Millennium Ecosystem Assessment (2005): Ecosystems and human well-being: Synthesis. Island Press: Washington, DC. Available online: https://www.millenniumassessment.org/documents/document.356.aspx.pdf (27.11.2018).
Natur Vårds Verket (2012): Styrmedel för ökad rening från kommunala reningsverk: För genomförande av aktionsplanen för Östersjön och Kattegatt samt miljökvalitetsnormer för kväve och fosfor. rapport 6521. Available online: https://www.naturvardsverket.se/Documents/publikationer6400/978-91-620-6521-8.pdf (28.11.2018)
NEFCO (2008): Framework for a Nutrient Quota and Credits' Trading System for the Contracting Parties of HELCOM in order to reduce Eutrophication of the Baltic Sea. Available online: https://www.nefco.org/sites/nefco.org/files/pdf-files/nefco_bs_nts_gsn_final_report_20080229.pdf (28.11.2018).
NEFCO (2015): Polluter pays or voluntary trading of nutrients. Available online: https://www.nefco.org/news-media/topic-issue/polluter-pays-or-voluntary-trading-nutrients (27.11.2018).
Newton, A. & Elliott, M. (2016). A Typology of Stakeholders and Guidelines for Engagement in Transdisciplinary, Participatory Processes, Frontiers in Marine Science, (3)230.
NutriTrade (2018): Nutrient Offsets – a potential tool to reconcile growing economy with strict water quality standards. NutriTrade Policy Brief No. 3. Available online: https://nutritradebaltic.eu/wp-content/uploads/2018/05/NutriTrade-Policy-Brief-3-Nutrient-Offsets.pdf (28.11.2018).
OECD (2014): OECD Environmental Performance Reviews: Sweden 2014. OECD Publishing: Paris. Available online: http://www.oecd.org/environment/country-reviews/oecd-environmental-performance-reviews-sweden-2014-9789264213715-en.htm (28.11.2018).
Olesen, J., Bindi, M. (2002): Consequences of Climate Change for European Agricultural Productivity, Land Use and Policy. In: European Journal of Agronomy 16, pp. 239-262.
Petersen, J., Hasler, B., Timmermann, K., Nielsen, P., Bruunshøj Tørring, D., Mørk Larsen, M. Holmer, M. (2014): Mussels as a tool for mitigation of nutrients in the marine environment. In: Marine Pollution Bulletin 82 (1-2), pp. 137-143.
Porter, M. (1998): The competitive advantage of nations. Macmillan: London.
Porvari, M. (2017): Nutrient management beyond borders? In: Institutional Development, Newsletter. Available online: http://nutritradebaltic.eu/nutrient-management-beyond-borders/ (28.11.2018).
Ressurreição A., Gibbons J.M., Kaiser M.J., Dentinho T.P., Zarzycki T., Bentley C., Austen M., Burdon D., Atkins J., Santos R.S., Edwards-Jones G. (2012): Different cultures, different values: The role of cultural variation in public`s WTP for marine species conservation. In: Biological Conservation, 145(1): pp. 148–159
Rijswick, H., Backes, Ch. (2015): Ground breaking landmark case on environmental quality standards? : The consequences of the CJEU 'Weser-judgment' (C-461/13) for water policy and law and quality standards in EU environmental law. In: Journal for European Environmental and Planning Law 12 (3-4). pp. 363 – 377.
Rose, J., Bricker, S., Ferreira, J. (2015): Comparative analysis of modeled nitrogen removal by shellfish farms. In: Marine Pollution Bulletin 91 (1), pp. 185-190.
Rößner, Y. (2018): Legislation Issues Status Report. Baltic Blue Growth project report. Forthcoming.
Salzman, J. (2005): A "Must Read" on Ecosystem Services. In: Conservation Biology 19 (2), pp. 582-583.

Savchuk, O.P. (2018): Large-Scale Nutrient Dynamics in the Baltic Sea, 1970–2016. In: Frontiers in Marine Science, 5.
Schernewski, G., Sterr, H. (2002): Tourism and Environmental Quality of the German Baltic Coast: Conflict or Chance? In: Schernewski G., Schiewer U. (2002)(eds): Baltic Coastal Ecosystems. Central and Eastern European Development Studies. Springer Publishing: Berlin, Heidelberg.
Schröter, M., van der Zanden, E., van Oudenhoven, A., Remme, R., Serna-Chavez, H., de Groot, R., Opdam, P. (2014): Ecosystem Services as a Contested Concept: a Synthesis of Critique and Counter-Arguments. In: Conservation Letters – A Journal of the Society for Conservation Biology 7 (6), pp. 514-523.
Schultz-Zehden, A., Matczak, M. (2012)(eds.): SUBMARINER Compendium – An Assessment of Innovative and Sustainable Uses of Baltic marine Resources. Available online: https://www.submariner-network.eu/images/downloads/submariner_compendium_web.pdf (27.11.2018).
Sheehy, B. (2014). Defining CSR: Problems and Solutions. Journal of Business Ethics, 131(3), 625–648.doi:10.1007/s10551-014-2281-x
Silvertown, J. (2015): Have Ecosystem Services Been Sold? In: Trends in Ecology & Evolution 30 (11), pp. 641-648.
Smith, M., de Groot, D., Perrot-Maître, D., Bergkamp, G. (2006): Pay – Establishing payments for watershed services. Gland, Switzerland: IUCN. Reprint, Gland, Switzerland: IUCN, 2008. Available online: https://portals.iucn.org/library/sites/library/files/documents/2006-054.pdf (27.11.2018).
Söderqvist, T., Scharin, H. (2000): The regional willingness to pay for a reduced eutrophication in the Stockholm archipelago. Beijer Discussion paper No. 128. Available online: http://www.beijer.kva.se/PDF/22897416_artdisc128.pdf (27.11.2018).
Söderström, S. (2017) Regional Environmental Governance and Avenues for the Ecosystem Approach to Management in the Baltic Sea Area. Linköping University: Department of Thematic Studies – Environmental Change
Srisunont, Ch., Babel, S. (2015): Uptake, release, and absorption of nutrients into the marine environment by the green mussel (Perna viridis). In: Marine Pollution Bulletin 97 (1-2), pp. 285-293.
Stream Green Network (2008): Framework for a Nutrient Quota and Credits' Trading System for the Contracting Parties of HELCOM in order to reduce Eutrophication of the Baltic Sea. Final report. Available online: https://www.nefco.org/sites/nefco.org/files/pdf-files/nefco_bs_nts_gsn_final_report_20080229.pdf (27.11.2018).
Suplicy, F. M. (2018). A review of the multiple benefits of mussel farming. Reviews in Aquaculture. doi:10.1111/raq.12313
Swedish Environmental Protection Agency (2009): Proposal for a Permit Fee System for Nitrogen and Phosphorus. Report 5968. Available online: http://www.naturvardsverket.se/Documents/publikationer/978-91-620-5968-2.pdf (27.11.2018).
Tacconi, L. (2012): Redefining payment for environmental services. In: Ecological Economics 73 (1), pp. 29-36.
ten Kate, K., Treweek, J., Ekstrom, J. (2010): The use of market-based instruments for biodiversity protection – the case of habitat banking. Technical report for European Commission DG Environment. Led by eftec & IEEP. Available online: http://ec.europa.eu/environment/enveco/pdf/eftec_habitat_technical_report.pdf (28.11.2018).
Turner, R. K., Georgiou, S., Gren, I.-M., Wulff, F., Barrett, S., Söderqvist, T., … Markowska, A. (1999). Managing nutrient fluxes and pollution in the Baltic: an interdisciplinary simulation study. Ecological Economics, 30(2), 333–352.doi:10.1016/s0921-8009(99)00046-4
Turnhout, E., Waterton, C., Neves, K., Buizer, M. (2013): Rethinking biodiversity: from foods and services to "living with". In: Conservation Letters 6 (3), pp. 154-161.
Tynkkynen, N., Schönach, P., Pihlajamäki, M., Nechiporuk, D. (2014): The Governance of the Mitigation of the Baltic Sea Eutrophication: Exploring the Challenges of the Formal Governing System. In: AMBIO 43 (1), pp. 105-114.

UNECE (2007): Recommendations on Payments for Ecosystem Services in Integrated Water Resources Management. United Nations: New York and Geneva. Available online: http://www.unece.org/fileadmin/DAM/env/water/publications/documents/PES_Recommendations_web.pdf (28.11.2018).
Vaitiekūnienė, J., Semėnienė, D. (2017): Costs and benefits of the proposed sea based measures - preliminary results of our review. Presentation held at the HELCOM-EUSBSR Workshop on internal nutrient reserves, 28.-29. November 2017, Gothenburg. Available online: https://portal.helcom.fi/meetings/HELCOM-EUSBSR%20WS%201-2017-498/MeetingDocuments/Costs%20and%20benefits%20of%20the%20proposed%20sea%20based%20measures%20-%20preliminary%20results%20of%20our%20review.pdf (27.11.2018).
Vaughn, C. C. (2017). Ecosystem services provided by freshwater mussels. Hydrobiologia, 810(1), 15–27. doi:10.1007/s10750-017-3139-x
WBCSD & IUCN (2007) Business and Ecosystems. Markets for Ecosystem Services – New Challenges and Opportunities for Business and the Environment – A Perspective. Available online: https://cmsdata.iucn.org/downloads/business_and_ecosystems_september2007.pdf (27.11.2018).
Wolters, St., Nett, K., Schindler, H. (2015): Freiwillige Kompensationszahlungen und nachhaltige Lebensstile: Passt das zusammen? Dokumentation der UBA-Tagung am 10. November 2014 in Berlin. Umweltbundesamt. Available online: https://www.umweltbundesamt.de/sites/default/files/medien/378/publikationen/texte_24_2015_freiwillige_kompensationszahlungen.pdf (28.11.2018).
Wunder, S. (2005): Payment for environmental services: Some nuts and bolts. CIFOR Occasional Paper No. 42. Center for International Forestry Research. Available online: https://www.cifor.org/publications/pdf_files/OccPapers/OP-42.pdf (28.11.2018).
Zandersen, M., Grønvik Bråten, K., Lindhejm, H. (2009): Payment for and Management of Ecosystem Services, Issues and Options in the Nordic Context. In: TemaNord 2009 (571). Available online: http://norden.diva-portal.org/smash/get/diva2:701980/FULLTEXT01.pdf (28.11.2018).
Zwick, St. (2017): Can Europe tap the private sector to protect its environment? Ecosystem Marketplace – a forest trends initiative. Available online: http://www.ecosystemmarketplace.com/articles/can-europe-tap-the-private-sector-to-protect-its-environment/ (28.11.2018).