A NUTRIENT TRADING SYSTEM FOR THE BALTIC SEA REGION

EXAMINING THE POSSIBILITIES OF IMPLEMENTATION

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EXECUTIVE SUMMARY

Eutrophication – an oversupply of organic matter or nutrients to an ecosystem – is regarded as one of the most intricate problems facing the Baltic Sea, resulting in massive algal blooms, extensive oxygen depletion, and recurrent incidences of fish kills. The sources of nutrients in the Baltic Sea arise from a variety of sources, including natural outflow from land, up-welling of phosphorus-rich deep water, atmospheric deposition of nitrogen, and, most importantly, anthropogenic sources (municipal and single household wastewater, agriculture, and industry).

The Water Framework Directive obliges all EU member states to prevent deterioration of the status of all water bodies and to ensure all water bodies achieve "good status" by 2027. "Good status" should originally have been reached by 2015 but has been postponed twice, each time by six years. Despite this, several studies suggest that current approaches for addressing eutrophication are too slow in delivering results. One estimate suggests that, when following the current plan, the first basin in the Baltic Sea to achieve a non-eutrophication status will do so between 2030 and 2040 and the last basins are not expected to reach this status before 2200 (two basins are not likely to meet targets at all).

Recovery of the Baltic Sea requires that we re-evaluate existing policy instruments and consider new ones. There are several types of policy instruments that can address nutrient pollution from man-made sources, including regulation, information, and economic instruments. An example of the latter is a trading system where the quantity of pollution allowed is linked to an emissions permit (credit) allocated by the government. These permits (credits) can be bought and sold by actors in the market. By controlling the total number of permits the government can regulate the total amount of pollution allowed. Trading systems have the potential to distribute more efficiently the total costs of pollution abatement across society by directing nutrient reduction measures to actors with the lowest marginal costs of abatement. Although nutrient trading systems for the Baltic Sea region have been proposed earlier and are popular around the world, they have not yet been implemented.

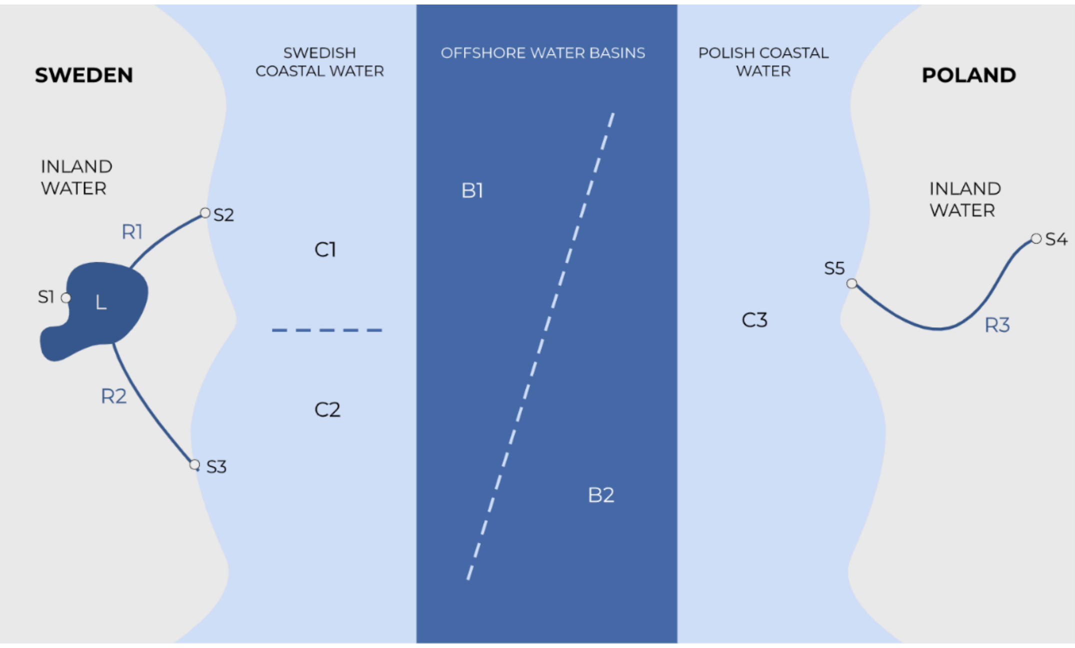
The Swedish government has given the Swedish Agency for Marine and Water Management, in collaboration with the Swedish Board of Agriculture and other relevant authorities, the assignment of investigating the conditions for increased cooperation between Baltic Sea countries, including the possibility of an international emissions trading system. To support this government assignment, the Swedish Agency for Marine and Water Management has assigned a consortium led by WSP to examine the possibilities of implementing a nutrient trading system in the Baltic Sea region. The result of this assignment is presented in this report.

OUTLINE OF A NUTRIENT TRADING SYSTEM (PART A)

We conclude that the trading system should be an ambient trading system. To our knowledge, no full-scale ambient trading system for nutrients has been implemented in practice. One reason is that, despite being discussed in research circles since 1972, ambient trading systems have not been widely known to practitioners and policymakers. A second reason – particular to this case – is that other trading systems have not successfully dealt with the fine mesh of environmental objectives in water bodies and basins under the Water Framework Directive and the Marine Strategy Framework Directive. This report discusses how this is in fact possible with an ambient trading system.

In an ambient trading system sources buy and sell portfolios of permits (or credits) in several markets, one market for each receiving water that its emissions affect, where each market has its own price determined by demand and supply. What makes this easier in the ambient trading system, compared to the emission permit system, is the use of fixed parameters (describing average retention and nutrient transport) rather than computer-simulated trade-ratios that change between each transaction. Therefore, no computer simulations are needed while transactions take place in ambient trading system. Moreover, sources face single prices that are simply the weighted averages of the permits (or credits) in their specified portfolios.

The figure below illustrates how an ambient trading system works with respect to trade in portfolios. Each water body, coastal water and offshore water basin has a market with permits (or credits) connected to the inflow of pollutants. The specified portfolio of each source contains permits (or credits) in all the receiving waters of the source. For example, source S1 (found adjacent to an inland water in Sweden) needs to buy a specified portfolio containing permits (or credits) from the Swedish rivers R1 and R2, Swedish coastal waters C1 and C2, offshore water basins B1 and B2 and perhaps also Polish coastal water C3. The sizes of shares in the portfolio are determined by the retention and nutrient transport between the source S1 and the receiving waters in the portfolio. Accordingly, the portfolio for source S1 will contain high shares of Swedish rivers R1 and R2 and likely low shares of Polish coastal water C3.



An ambient trading system can be designed in two ways: First, it could be an ambient cap-and-trade system for trading inflow loads to water bodies, coastal waters or offshore water basins. This is referred to as an ambient permit system since inflow loads are traded via permits, based on an overall cap. Second, it could be an ambient baseline-and-credit system for trading reductions in inflow loads in these waters. This is referred to as an ambient credit system because reductions in inflow loads are traded via credits, based on an overall baseline. An ambient trading system that trades with load permits works by the same principles as the EU ETS, but with two exceptions. First, traded units are inflow of loads (kg/year) to each water body, coastal water or offshore water basin rather than pollution load to the atmosphere. Second, each actor trades a specified portfolio of load permits based on the water areas it affects, rather than a common trading area. The key steps for implementing an ambient permit system are:

1. The regulator decides the maximum annual nutrient inflow load (kg/year) for each water body. These loads set the cap, i.e. maximum number of load permits for each inland water body, coastal water body or offshore basin.
2. The regulator allocates the load permits to operators either by auctions or following an allocation rule (e.g. in proportion to last year's inflow of loads).
3. Each source must submit a portfolio of load permits corresponding to its verified inflow of loads (kg/year) to water bodes, coastal waters or basins.
4. Failure to submit load permits that correspond to verified loads may result in penalty fees and/or prosecution.
5. The regulated number of permits to be submitted for each water body or trading area is decreased annually according to an announced plan towards a target year, when the environmental quality standard is to be fulfilled.

An ambient credit system conducts trade in credits and functions according to the same basic principles as the Swedish electricity certificates. A difference is that traded units and quotas are reductions (kg/year) in the inflow loads to each water bodies, coastal waters or offshore water basins. Each actor trades a specified portfolio of reductions in the waters it affects. The key steps for implementing an ambient credit system are:

1. The regulator decides the minimum reduction of inflow of load (kg/year) to each water body or trading area during the year. These reductions set the floors, i.e. the minimum number of credits for each inland water body, coastal water body or off shore basin that should be submitted by sources each year.
2. The regulator allocates duties to submit credits among sources in terms of individual quotas. The sum of Individual quotas in each water body, coastal water or basin equals the floor in each of these waters.
3. Each source must submit its individual quotas for each water area, by the end of each year. Each source may submit its quotas as credits either generated by own verified reductions, bought from other actors with verified reductions during the same trading period or bought at an auction held by the regulator.
4. Failure to submit the individual quotas may be followed by penalty fees and/or prosecution.
5. The floors, that is the regulated number of credits to be submitted for each water body or trading area is increased annually according to an announced plan towards the target year when the environmental quality standard is to be fulfilled.

Since ambient credit trade takes place in reductions of loads (rather than emissions), non-point sources can be involved in trade, as long as they can implement verified measures that reduce emissions. A second feature is that it has distributional effects that mimic freely allocated permits, which most likely increases acceptance among potential participants. External actors generating credits by voluntarily making verified measures to reduce the nutrient emissions (and getting paid for it), can help attract external capital financing measures, primarily reductions at non-point sources. To be able to report such ambient offset measures, these need to be accounted for in the same way as load reduction credits.

Since the largest anthropogenic sources of nutrient emissions to the Baltic Sea come from agriculture, sewage facilities, forestry, fishery and certain industries, these represent the potential actors to include in a future trading system. Further, a large share of the nutrient load (particularly nitrogen) stems from deposition of air emissions from transports and combustion sources. We do not recommend that air sources are included in the trading system because it requires an extended modelling approach to identify the relationship between these sources and their impact on relevant water bodies.

Non-point sources such as agriculture can be included as in an ambient credit system provided there are verified methods for connecting measures and reductions per year. However, agricultural activities cannot be included in an ambient permit system that focuses on total emissions because these are difficult to monitor. Therefore, if agriculture is to be included, the trading system must be an ambient credit system. There is a risk that costs affect farmers, causing a structural change within the sector. Therefore, a trading system could be used as infrastructure for existing subsidies by public bodies earmarking a specified budget for purchasing permits or credits tied to a verified set of measures that reduce emissions from e.g. agricultural non-point sources. For other possible actors in a trading system (e.g., public wastewater treatment plants, industries etc.), trading can give incentives to decrease the amount of pollutants more than what is required in the environmental permits, leading to *additional* improvement. To increase the number of actors buying permits, the trading system can include actors who are required to hold an environmental permit – especially public wastewater treatment plants who face relatively high costs for treating effluents.

There are two ways that external actors can be involved (external actors are actors that do not generate emissions themselves). First, pro-environmental actors may want to voluntary buy credits that generate external capital inflows. In this case the sources that have fulfilled common obligations through their own measures will then receive external financing for these. In the Baltic Sea region, there are already actors with such types of incentives that are active in combating eutrophication. Second, and perhaps more importantly in an ambient credit system, external actors can voluntarily implement verified measures to reduce the nutrient emissions and get paid for this by selling their generated credits on the market. This will be a new way of attracting external actors who voluntarily implement measures for reductions in e.g. the agricultural and forestry sectors.

The tradable unit should be based on a physical quantity that corresponds to the expected environmental impacts from the emissions of nutrients. Since the geographical location is so important for the environmental impacts associated with eutrophication, simply using nitrogen or phosphorus emissions “at the source” as a basis for the tradable units would not be appropriate.

Among the available trading systems, the ambient trading system takes the simplest regulatory approach by letting the environmental authorities specify a cap (or baseline) for each receiving water with an environmental quality standard and then create water-specific ambient permits for the maximum load (or ambient credits for the minimum load reduction) to each water body. The caps (baselines) would increase in stringency every year until the final year when the targets are to be reached in each water body. The same principle also works for ensuring non-deterioration under the Water Framework Directive.

The key data needed for operating an ambient trading system are:

- Estimates from water quality modelling of average retention and nutrient transport between each emission source and the receiving water bodies (or group of water bodies), coastal waters and offshore water basins. These estimates are the fixed parameters (describing average retention and nutrient transport) between each emission source and receiving water.

- Maximum allowed nutrient loads per year for each water body (or group of water bodies), coastal waters and offshore water basins, based on the target indicators for nutrients needed to fulfil environmental objective.
- For non-point sources, verified measures with result-indicators that describe "reductions per unit of measure undertaken".

The proposed ambient systems can be implemented and operated with existing water quality models for Sweden. Importantly, it is not necessary to have a perfect model before starting a trading system; a better strategy is to start with a system that covers reductions in inland and coastal waters (where water quality modelling already exists) and then plan for future extensions or upgrades between trading periods (e.g., adding offshore water basins as those models are improved or become available).

An ambient trading system can generate a cost-efficient allocation for attaining any predetermined levels of nutrient loads to receiving water bodes and for any initial allocation of permits (credits) among sources in the system. This means that the authority can choose initial allocations of permits (or credits) to achieve distributional targets without affecting cost-efficiency.

An important consideration for any trading system designed with multiple caps is the magnitude of transaction costs (e.g., time spent on registering and reporting). Several authors have anticipated high transaction costs, but empirical analyses suggest otherwise. Furthermore, the ambient trading system uses transfer coefficients, which provides more certainty and precludes the need for computer simulations before each transaction. In addition, since each source faces a single price represented by the weighted average of the prices in the specified portfolio, transaction costs imposed on sources are unlikely to differ much from a single-cap and single price systems, such as EU ETS. Similarly, this reduces administrative costs for the environmental authorities.

Finally, there are several challenges and risks when introducing a trading system, not the least being the pedagogical challenge of explaining the benefits and purpose among potentially skeptical actors. Input from previous studies, as well as interviews conducted as part of this report, suggests that this represents a communication challenge, as it requires simple and easy-to-understand language to combat misinformation and misperceptions about market-based instruments.

CURRENT INSTRUMENTS AND POSSIBLE ROLE FOR A NUTRIENT TRADING SYSTEM (PART B)

Countries have cooperated to address eutrophication through agreement on common goals and establishment of national/regional strategies. For example, the Baltic Sea Action Plan sets nutrient reduction targets, with the overall goal of reaching "good" environmental status of the Baltic Sea. Further, the Water Framework Directive and the Marine Strategy Framework Directive set high requirements on the quality of fresh waters and marine waters in EU countries. In response, all coastal countries of the Baltic Sea have developed strategies to achieve common goals.

The nine countries around the Baltic Sea rely on slightly different types of policy instruments, with a tendency toward subsidies and regulation for the agricultural sector and regulation for the wastewater sector. The wide use of regulation is probably due to the long history of this approach, while the use of agricultural subsidies is mainly an effect of the agri-environmental subsidies of the EU's Common Agricultural Policy. Information instruments are somewhat more common among wealthier countries, which could be due to stricter regulations, or perhaps to a broad acceptance of information instruments. Five countries tax nutrient pollution in wastewater, but the use of taxes/fees in agriculture is more limited. Few countries rely on economic instruments and none rely on markets specifically.

The wide use of command-and-control instruments suggests that environmental goal achievement is more expensive than necessary. Administration of subsidies and lengthy processes to renew environmental permits are significant drivers of high transaction costs. Additionally, subsidies to farmers for reducing nutrients fail to consider where such measures are likely to have the greatest environmental effect, partly because the information required is costly.

We analyzed qualitatively the effectiveness of existing policy instruments in order to draw general conclusions about whether new instruments may be warranted. We identified several economic challenges (e.g., costly implementation, lack of financing, high transaction costs), as well as other policy challenges (e.g., lack of adequate or sufficient instruments, poor implementation of existing instruments, skewed distributional effects, etc). Many of these challenges can be addressed through a nutrient trading system – in particular the high costs and uneven distribution of burden across countries and sectors – but another approach is to improve existing instruments. For example, increasing the level of nutrient taxes could improve efficiency and cost-effectiveness, as would equal treatment of point and non-point sources. Another alternative could be to re-design current subsidies to farmers by basing payments on results rather than costs, thus achieving better environmental outcomes.

Building upon existing collaboration to address eutrophication among the nine Baltic Sea countries may be a path forward since it has the potential to lead to increased net benefits on the aggregate level. However, expanding this cooperation to include a trading system that is robust and effective requires that all participating countries expect to receive those benefits. The nine Baltic Sea countries have diverging national interests and thus different incentives to increase existing collaboration. We map nine factors that affect incentives including environmental aspects (e.g., public support for reducing pollution), economic aspects (a country's economic reliance on the Baltic Sea as a resource) and others (e.g., competition between environmental and other policy goals). Our analysis suggests two groups of countries: a more affluent group (Denmark, Finland, Germany, Sweden) and a less affluent group (Latvia, Lithuania, Poland, Russia, Estonia), where the former shows a higher willingness to pay for new initiatives to reduce eutrophication, are richer (more resources available for pollution control) and are better able to compensate their own farmers for reduction of pollution.

Full collaboration among all nine countries is unlikely according to our analysis, which suggests that compensatory payments or issue-linkage may be needed to entice cooperation from reluctant countries. A more limited scheme of collaboration among affluent countries with strong incentives to reduce Baltic Sea eutrophication would probably be easier to establish but may lead to smaller efficiency gains (since marginal abatement costs across countries are similar). Thus, a suggested path forward referred to as "gradual enlargement" could be the most promising. This path would focus on countries that (1) are likely to join a coalition and (2) have variation in marginal costs of abatement. For example, limited compensatory payments from Sweden and/or Finland to either Poland and/or Lithuania could be a start.

LEGAL CONTEXT (PART C)

The main purpose of the Water Framework Directive is to achieve “good” status or potential of all waters concerning human health, water supply, natural ecosystems and biodiversity. It enacts two main obligations on EU Member States (to be reached by 2027):

- to prevent deterioration of the status of all surface and groundwater bodies
- to protect, enhance and restore all water bodies in order to achieve “good” water status.

A national legislative act cannot go against an EU legislative act, meaning a proposed trading system must be in line with the EU *acquis* related to the Water Framework Directive (acquis refers to the accumulated legislation, legal acts and court decisions that constitute the body of European Union law). The objectives of the Water Framework Directive are not legally binding for individuals in Sweden; rather responsibility lies with the competent authorities who have an obligation to deny environmental permits to projects that lead to deterioration or jeopardize the achievement of environmental objectives. This obligation was clarified in the *Weser Case* 2015, in which the Court of Justice of the European Union addressed how the environmental objectives in Water Framework Directive shall be interpreted. In short, there is deterioration of the status of a body of surface water as soon as the status of at least one of the quality elements declines by one class, even if that decline does not result in the decline in classification of the whole body of surface water. Further, the Court stated that if the quality element concerned is already in the lowest class, any deterioration of that element constitutes a “deterioration of the status” of a body of surface water. In doing so the Court linked deterioration itself to individual quality elements, instead of the overall water quality status. The Court also clarified that the environmental objectives of the Water Framework Directive are legally binding on the Member States when permitting new developments and that a drop in any quality element is considered an infringement of the Directive.

If a Member State fails to ensure compliance with EU law, the Commission may decide to refer the Member State to the Court of Justice. If the Court rules against a Member State, the Member State must take the necessary measures to comply with the judgment. The legally binding character of the Water Framework Directive restrains the available leeway for a trading system. If the system is decoupled from direct physical actions required to fulfil Water Framework Directive to a system allocating emissions/loads and with the prerequisite that every operator must reduce its emissions/loads (or by permits) in the water bodies, it should be regarded as aligned with the Water Framework Directive. There can be no deterioration with an ambient trading system since it is based on maximal allowable loads for the actual water body. Instead the system would induce actions which will lead to the accomplishment of the environmental objective in the Directive. An important perspective is that when the ambient trading system was developed in the 1970s, is was designed to fulfil a non-deterioration condition which later also became an objective in the Water Framework Directive.

There are a large number of water bodies. Fewer water bodies would mean thicker markets and increased possibilities to trade. However, the scope for adjusting existing water bodies into significantly larger entities is most likely very limited.

POSSIBLE PLAN FOR INTRODUCTION OF A NUTRIENT TRADING SYSTEM (PART D)

Effective government processes will be critical for guiding a Swedish national ambient trading system proposal from design to legislation to implementation. We outline a proposed strategy for implementing and designing an ambient trading system for the Baltic Sea region, which can be applied for either an ambient credit system or an ambient permit system. This strategy suggests a 10-step process (see the table below) that starts with building support and includes consideration of key design features. The strategy emphasizes the importance of, among other things, educating policymakers, lawmakers, regulated entities and the public about the pros and cons of an ambient trading system, and facilitating the building of knowledge and capacity needed in the public bodies entrusted with operating the trading system.

1. Build political support

- Allocate budget resources for outreach and communication with e.g., policymakers, lawmakers, regulated entities, the public and media
- Emphasize five attractive features of an ambient trading system
- Make use of Sweden's domestic experience for trading systems on greenhouse gas emissions and electricity certificates.

2. Decide the scope

- Consider including agriculture, public sewage treatment plants, industries, forestry
- Consider including external actors who buy permits for pro-environmental reasons
- Consider Including external actors generating credits by implementing verified measures

3. Decide ambient trading unit

- Consider the following options:
  - For point sources: trade in loads using permits or trade in load reductions using credits
  - For non-point sources: trade in load reductions using credits for non-point sources based on methods for connecting measures by non-point sources and load reductions

4. Decide on ambient offsets

- Include ambient offsets in the system which will attract external actors as well as sources in the system that provide both influx of capital financing and also the possibilities for implementing verified measures beyond what is mandatory in the system.

5. Set the ambient caps

- Target levels should be set in accordance with indicators for environmental objective in the Water Framework Directive and Marine Strategy Framework Directive, rather than those established by the Baltic Sea Action Plan.

6. Define the size of ambient markets

- The default is one market with a local cap for each receiving water with a target indicator.
- Upsizing markets in sparsely populated areas is possible without increasing administrative costs, loss of load control or loss of cost-efficiency in allocations. Still, the optimal scope of individual trading areas should include water bodies that have less than good status and are affected by many emission sources.
- Allow for intermediaries and brokers to be active in the system to increase transparency

7. Define an efficient geographical area

- Focus on geographic areas with many sources, high total load and poor status.
- In areas where sources are few and needs for reduction are small an ambient trading system may bring larger costs than benefits

8. Set up institutional arrangements

- Five key responsibilities:
  - establish number of permits/credits for each receiving water
  - require submission of annual permits/credits by operators.
  - operator submits permits/credits corresponding to own reductions or purchase of permits/credits
  - enforce penalties for non-compliance
  - adjust the caps annually according to an announced plan.

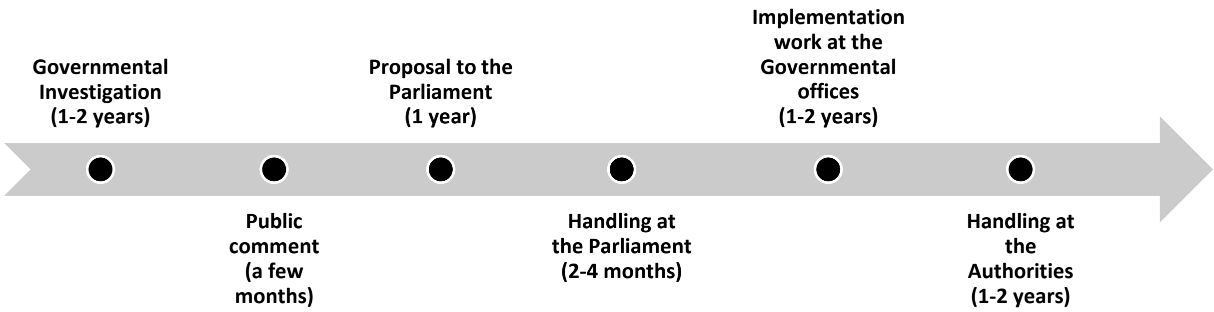
9. Generate verified data for operating the system

- Verified measures for non-point sources with corresponding result-indicators from approved models or methods
- Estimates of average retention and nutrient transport from water quality modelling
- Maximum allowed nutrient loads per year for each water body from the water and marine managements
- Reduction paths for the maximum allowed nutrient loads per year until the target year

10. Expand internationally

- Expand the system gradually, maybe in this order: 1 Sweden, 2 Finland, 3 Poland/Lithuania
- Rely on initial allocations of permits/credits as compensatory payments to entice participation

Full implementation of a trading system that accomplishes the objectives in the Water Framework Directive is not possible by 2027, due in part to the Swedish legislative time frame: appointing a governmental investigator, establishing and enforcing new laws, implementing the necessary measures, etc. In this complicated case, it could take between 6-7 years before a trading system is functioning. We emphasize, however, a trading system that accomplishes the objectives of the Water Framework Directive is of great value, especially if an infringement case would be brought against Sweden in the future. Note that Sweden must comply with the Water Framework Directive, even if full implementation is delayed beyond 2027. The necessary legislative steps for implementing the trading system are shown in the figure below.



This report describes a trading system that would comply with the Water Framework Directive, while also being aligned with the Baltic Sea Action Plan at HELCOM. Given the limited time frame, we recommend that governmental offices begin immediately in formulating the directive for a governmental investigation. Importantly, this report provides a key basis for such an investigation, since several of the necessary topics are addressed herein. Other input may be needed can be gathered by different authorities or during the process of the investigation itself. The necessary legislation is not possible without this type of investigation and time lags will affect when the trading system can be in place. If an investigation is not possible, due e.g., lack of information on a crucial topic or any other reason, an alternative could be to create a governmental assignment for an authority that can continue the work, which can then be included in a future investigation.

CONCLUSIONS

A nutrient trading system has many potential advantages. Efficiency gains from choosing cost-effective instruments occur across time and space and are likely to decrease the costs of achieving water quality goals drastically. Further, a trading system increases the precision of achieving these goals, while the transfer of responsibility from authorities to polluters helps to speed environmental recovery. The system can be designed to allow for influx of private capital to fund reduction measures.

Design of the trading system is critical for its success. Since the system must guarantee good ecological status of each individual water body, it precludes explicit trade between water bodies (although there is implicit trade between water bodies since the ambient markets are linked with each other). Our proposed solution is to introduce an ambient system, which focuses on the ambient conditions of the impacted waterbody rather than the quantity of pollution emitted at the source. Each emission source would have a retention and nutrient transport rate determined by a biophysical model and would purchase a portfolio of emission rights that includes all affected (downstream) water bodies. The distribution of emission reduction is determined by trade within the system, while the path of reduction is based on how best to reduce the total load of pollutants.

This means that in sparsely populated river basins, each ambient market will cover a large number of water bodies with few sources, saving significant administrative costs at no loss of pollution control or loss of cost-efficient allocation between sources. An ambient trading system that covers all geographical areas in Sweden is unlikely to be effective since the administrative burden becomes too great in relation to the social and environmental benefits. The optimal scope of individual trading areas would include water bodies that have less than good status and are affected by many emission sources. For Sweden, these conditions are met for the water bodies in the Baltic Sea, along the coasts and in the southern agricultural districts. Although no environmental or efficiency arguments exist for including *all* water bodies, there may be legal constraints that force water bodies to be included in the system, which should be investigated.

Each source would report load permits (or credits) corresponding to the emissions after each trading period, making the proposed system compatible with the Water Framework Directive. Further the system would be agile in the sense that it can integrate new sources of emissions, countries, buyers and sectors over time.

We recommend an ambient credit system that regulates load reductions to receiving waters. This is the only ambient system that can handle non-point sources such as agriculture and forestry, while also easily handling point sources. An alternative is an ambient trading system that uses ambient credits for non-point sources, and ambient permits for point sources (where credits and permits are traded at a one-to-one ratio).

It is unlikely that all countries will perceive benefits from participating in a nutrient trading system. Even a smaller regional system will require proactive efforts such as transfers from countries with strong incentives to participate to countries with weaker incentives – and this may be costly. The most realistic approach would be to start with a national system in Sweden and then expand it incrementally based on other countries' preparedness and incentives. The initial expansion could include Finland, which has previously investigated a nutrient trading system and faces similar incentives to Sweden. Subsequent expansion could include other countries with high emissions and, relative to Sweden and Finland, lower abatement costs (e.g., Poland and Lithuania), thus increasing opportunities for efficiency gains (although relatively few water bodies are affected by countries with very different abatement cost levels).

Before transactions can take place between market actors' key decisions are required with respect to integration of existing instruments. Our preliminary analysis suggests that information can be integrated but should be reoriented; regulation cannot be replaced, and integration would require that the trading system is binding. Economic instruments should either be removed or reoriented; taxes could help control price volatility in a trading system while subsidies could address one of the future risks, namely thin markets.

Introducing an ambient trading system in Sweden may take 6-7 years as it must follow several legislative steps: governmental investigation, public comment, proposal to the parliament, and then comment from parliament, governmental offices, and authorities. Even if the process can be expedited, a trading system that achieves the requirements of the Water Framework

Directive by 2027 is unlikely. Nonetheless we recommend that the proposed trading system is implemented for several reasons:

1. Our assessment is that existing policy instruments are insufficient to achieve the requirements by 2027.
2. Even if current instruments are tightened, they suffer from time lags that are many times longer than the time lags of market-based measures.
3. A trading system represents an environmentally effective and cost-efficient instrument.
4. A trading system that accomplishes the objectives of the Water Framework Directive is critical, especially if an infringement case would be brought against Sweden in the future. Sweden must comply with the Water Framework Directive, even if full implementation is delayed beyond 2027.

Ensuring acceptance is a challenge when introducing a trading system – by the public, market actors, and other countries. Successful systems are those that stimulate active engagement of market participants and garner a sense of inclusion. The initial allocation of permits represents an important negotiation tool. We recommend that Sweden "owns" the implementation process but engage in early discussions with other countries – both bilateral and within the HELCOM collaboration.

INTRODUCTION

Man-made eutrophication of lakes, coastal waters, and oceans occurs in practically all populated parts of the world. The ecological effects of excessive input of nutrients include massive algal blooms, extensive oxygen depletion, and recurrent incidences of fish kills. As such, nutrient pollution of marine waters is addressed in the UN Sustainable Development Goals (see SDG 14 "Life below water"). Target 14.1 of this Goal aims to prevent, and significantly reduce by 2025, all types of marine pollution including debris and nutrient pollution. The target also recognizes the impact of land-based activities on marine pollution (Grimvall, et al., 2017).

The sources of nutrients currently found in the Baltic arise from both natural and man-made sources, including natural outflow from land, up-welling of phosphorus-rich deep water, atmospheric deposition of nitrogen, and, most importantly, anthropogenic sources (municipal and single household wastewater, agriculture, and industry) (HELCOM, 2009). Eutrophication of the Baltic Sea is regarded as one of the most intricate problems facing this inland sea (Wulff, et al., 2007); (HELCOM, 2009).

Several studies – as well as the interviews conducted as part of this report – suggest that current approaches for addressing eutrophication are too slow in delivering results. For example, the eutrophication status in the Baltic Sea is far from the objectives agreed upon in the Baltic Sea Action Plan, even if there is a slow trend of recovery (HELCOM, 2013). According to Murray et al. (2019), best-case estimates suggest that the first basin to achieve a non-eutrophication status will do so between 2030 and 2040, when following the current Plan (the last basins are not expected to reach this status before 2200 and two basins are not likely to meet targets at all). Part of the problem are substantial delays between implementation of measures and subsequent effects on water quality, which are amplified due to climate change impacts and concurrent stress on ecosystems from human activities. In short, recovery of the Baltic Sea requires that we re-evaluate existing policy instruments and consider new ones.

There are several types of policy instruments that can address nutrient pollution from man-made sources, including regulation, information, and economic policy instruments. An example of the latter is a trading system where the right to pollute is linked to an emissions permit that is allocated by the government. These permits can be bought and sold by actors in the market (e.g., companies that emit nutrients, companies that sequester nutrients, or organizations wishing to finance reduction measures). By controlling the total number of permits the government can regulate the total amount of pollution allowed. Trading systems have the potential to distribute *more efficiently* the total costs of pollution abatement across society by directing nutrient reduction measures to actors with the lowest marginal costs of abatement (Schmalensee & Stavins, 2015; Tietenberg, 2010). The idea was originally proposed by economists Crocker (1966) and Dales (1968) and has been implemented in practice through e.g. the U.S. Acid Rain program for sulphur emissions and the EU's Emission Trading Scheme for carbon emissions. Although nutrient trading systems for the Baltic Sea region have been proposed earlier, they have not yet been implemented.

The Swedish government has given the Swedish Agency for Marine and Water Management, in collaboration with the Swedish Board of Agriculture and other relevant authorities, the assignment of investigating the conditions for increased cooperation between Baltic Sea countries, including the possibility of an international emissions trading system. To support this government assignment, the Swedish Agency for Marine and Water Management has assigned a consortium led by WSP to examine the possibilities of implementing a nutrient trading system in the Baltic Sea region. The result of this assignment is presented in this report.

The report is divided into the following sections:

- Background. Provides the context in which this trading system is being proposed and gives the economic theory behind.
- Part A. Discusses preconditions for a nutrient trading system in the Baltic Sea region from a theoretical, empirical and practical point of view. Part A concludes by suggesting a trading system design for further investigation.
- Part B. Assesses current instruments and possible role for a nutrient trading system in the Baltic Sea region.
- Part C. Reviews the legal context that will impact the design of the trading system.
- Part D. Presents a concrete suggestion for a trading system and a strategy for how to implement it.
- Conclusions. Synthesizes the major conclusions from each part of the report and recommends a path forward.

Importantly, the report's conclusions represent on-going work to develop the necessary ideas and infrastructure to support a future trading system. As such, the report proposes a theoretically sound market structure and a stepwise implementation that considers the political process. Nonetheless, additional decisions and analyses will be required before market transactions between polluters can take place.

BACKGROUND

This part of the report provides background knowledge for the reader to understand the context in which this trading system is being proposed. After a short description of relevant international policies, we review previous proposals for nutrient trading systems in the Baltic Sea and go through the economics of water quality management.

For context, we strongly recommend reading Chapters 1 (international policies) and 2 (previous investigations on trading systems in the Baltic sea area) before reading the rest of the report. However, Chapter 4 (economics of water quality management) is of a different character – it deepens the understanding of the theoretical underpinnings of the proposed system – and therefore is not necessary for full understanding of the report.

1 INTERNATIONAL POLICIES

There are several relevant policies addressing eutrophication in the Baltic Sea, both at the EU level and through international collaboration. Note that eight of the nine countries bordering the Baltic Sea are EU members (Russia being the exception), which means that these countries are obliged to follow EU Directives and thus have somewhat similar instruments. Part C will develop the legal context for trading system. The major policies and agreements include the following, which are detailed below.

- The Water Framework Directive (WFD) The Water Framework Directive with the objective to reach good status of waters covers all waters, including inland waters (surface water and groundwater) and transitional and coastal waters up to one sea mile (in terms of monitoring ecological status and hence eutrophication – and for the chemical status also territorial waters which may extend up to 12 sea miles) from the territorial baseline of a Member State, independent of the size and the characteristics.
- The Marine Strategy Framework Directive (MSFD) is aimed at the protection of the marine environment, creating a framework for the sustainable use of marine waters.
- Nitrates Directive (ND) addresses pollution caused by nitrates from agricultural sources.
- Urban Wastewater Treatment Directive (UWWTD) addresses pollution from urban wastewater discharges.
- HELCOM is an international agreement between the Baltic Sea countries aimed at reducing nutrient loads in the region and is separate from the above-mentioned EU polies.
- The Common Agricultural Policy (CAP) implements a system of agricultural subsidies and other programmes within the EU.
- The Groundwater Directive establishes specific measures to prevent and control groundwater pollution within the EU.
- Industrial Pollution Prevention and Control Directive provides limits for N and P emissions as well as best practices for manure management.

1.1 WATER FRAMEWORK DIRECTIVE

The main Environmental objective of the Water Framework Directive (WFD, 2000/60/EC) is according to Article 4 to achieve good surface and groundwater water status. Good surface water status means the status achieved by a surface water body when both its ecological status and its chemical status are at least good. There are two main obligations on the EU member states: 1) to prevent deterioration of the status of all surface waters and groundwater within the EU, and 2) to protect, enhance and restore all water bodies to achieve “good status” at latest 2027.

The Water Framework Directive requires countries to define geographical or administrative units, in particular the river basin, the river basin district, and the “water body”. One key purpose of the Directive is to prevent further deterioration of, and to protect and enhance the status of all waters. The success of achieving this purpose and its related objectives will be mainly measured by the status of “water bodies”. “Water bodies” are therefore the units that will be used for reporting and assessing compliance with the Directive’s principal environmental objectives.

The classification of water bodies is based on an assessment of different quality elements. Biological as well as supporting hydromorphological and physico-chemical quality elements are to be used by Member States in the assessment of ecological status/potential. When considering the physico-chemical quality elements for High Status nutrient concentrations shall remain within the range normally associated with undisturbed conditions.

Good surface water chemical status means the chemical status required to meet the environmental objectives for surface waters established in Article 4(1)(a), that is the chemical status achieved by a body of surface water in which concentrations of pollutants do not exceed the environmental quality standards established in Annex IX and under Article 16(7), and under other relevant Community legislation setting environmental quality standards at Community level. Since neither nitrogen nor phosphorus is regarded as a pollutant they are not regulated under this part or by the environmental quality standards directive (2008/105/EC).

In the *Weser case* (2015), the European Court of Justice explained how the environmental objectives of the directive should be interpreted and applied in individual authorization processes. The court established that all environmental objectives of the Water Framework Directive are legally binding and equally important to follow (Weser Case, 2015). The consequence is that the level of water quality must not be reduced in any water body.

The water bodies and environmental quality elements are determined on a national basis. For instance, there are around 23,800 surface water bodies in Sweden of which 66 percent are rivers, 31 percent are lakes and 3 percent are coastal waters. Information on all water bodies in Sweden can be found in a database (VISS, 2021a), which contains information on environmental monitoring as well as status classifications and the parameters on which the assessment is based.

Ek and Persson (2016) evaluate the implementation of the Water Framework Directive in Sweden and find that cost-effectiveness is challenged by the complexities of water management. While the directive emphasizes the role of economic tools, the goals are not based on economic efficiency. Flexibility is a key issue for cost-effectiveness and, since the Swedish water management mainly consists of command-and-control instruments, the cost effectiveness is likely to be limited.

In the following text there will be multiple references to the "Environmental objective." This refers to the obligation for the EU Member states to fulfil the obligations of Article 4 in the Water Framework Directive and it will also include the method to assess the status by monitoring the environmental quality elements.

1.2 MARINE STRATEGY FRAMEWORK DIRECTIVE

The Marine Strategy Framework Directive (MSFD, 2008/56/EC) aims to achieve Good Environmental Status (GES) of the EU's marine waters by 2020. For those HELCOM Contracting Parties also being EU member states, the EU Marine Strategy Framework Directive establishes a framework within which the member states shall take the necessary measures to achieve or maintain Good Environmental Status of the marine environment by the year 2020 (Article 1). The environmental targets of human-induced eutrophication use indicators of nutrient levels, chlorophyll and dissolved oxygen. Member states are required to follow a common approach that involves the following in six-year cycles:

1. Assessing the current state of the marine environment
2. Determining good environmental status

3. Establishing environmental targets and associated indicators to guide progress towards achieving good environmental status
4. Establishing monitoring programmes for ongoing assessment and regular updating of targets
5. Developing programmes of measures to achieve or maintain good environmental status

In 2015, Sweden's programme of measures to achieve or maintain Good Environmental Status of the marine environment by the year 2020 was developed. This programme will be updated every sixth year. During 2021 the programme of measures will be updated and be valid for the second period 2022-2027.

For those HELCOM Contracting States (see Section 1.5) who are also being EU-Member States, HELCOM is the coordinating platform for the regional implementation of the Marine Strategy Framework Directive in the Baltic Sea.

For Russia, the delivery of good environmental status is to be met by the Maritime Doctrine of the Russian Federation. The principles of the national maritime policy include integrated marine scientific research, the development of systems for monitoring the marine environment and coastal areas, and the protection and conservation of the marine environment in the interests of the Russian Federation. Compliance with international obligations and possibilities for international cooperation are important elements for achieving the goals of the Doctrine.

The Marine Strategy Framework Directive covers the sea area of the North Sea and the Baltic Sea, i.e. both coastal waters and offshore waters including each member state's economic zone. This means that it overlaps geographically with the Water Framework Directive in the area that extends from the shoreline to 1 nautical mile outside the baseline. However, the Marine Strategy Framework Directive only covers those aspects of coastal water quality that are not covered by the Water Framework Directive. According to the Navigation Groups for the two directives, good environmental status (GES) in coastal water bodies should be delivered largely or entirely through the measures to be taken under the Water Framework Directive (The European WFD Navigation Task Group and the Marine Strategy Navigation Group, 2010).

1.3 NITRATES DIRECTIVE

The Nitrates Directive (ND, 91/676/EEC) aims to protect the water quality across Europe by preventing nitrates from agricultural sources polluting both ground and surface waters as well as promoting the use of good farming practices. The Nitrates Directive is seen as an integral part of the Water Framework Directive and as a key instrument in the protection of waters from agricultural pressures.

The implementation of the directive contains six elements.

1. Identifying waters polluted and exceeds a certain limit of nitrates
2. Point out areas of land which drain into polluted waters
3. Establish Codes of Good Agricultural Practice to be implemented by farmers to reduce nitrate pollution
4. Establish action programmes to be implemented by farmers on a compulsory basis
5. Limit the application of nitrogen from manure

6. Member States are required to report on nitrate concentrations, eutrophication, action programme results, future trends and revisions on a four-year basis.

It is important to highlight that the Nitrates Directive at present only sets limits to the use of nitrogen, not of phosphorus. Within agriculture, to meet crop N requirements, farmers end up applying onto soils 5–10 times the crop P requirements, eventually leading to losses through seasonal runoff. Thus, the EU Nitrates Directive does not regulate phosphorus and many EU countries lack national phosphorus legislation that restrict its application. Thus, there is a lack of regional harmonization on the use of phosphorus in agriculture.

1.4 URBAN WASTEWATER TREATMENT DIRECTIVE (UWWTD)

The Urban Wastewater Treatment Directive (UWWTD, 91/271/EEC) aims to protect the environment from negative effects of urban wastewater discharges as well as discharges from certain industrial sectors. Specifically, it regulates the collection, treatment, and discharge of domestic wastewater, mixture of wastewater, and wastewater from certain industrial sectors It also requires pre-authorisation of all discharges of urban wastewater, monitoring of the performance of treatment plants and receiving waters, as well as controls of sewage sludge disposal and re-use, and treated wastewater re-use whenever it is appropriate.

1.5 THE HELCOM BALTIC SEA ACTION PLAN

In 1974, the Baltic Sea coastal countries signed the Convention on the Protection of the Marine Environment of the Baltic Sea Area (1974 Helsinki Convention). A new Helsinki Convention was signed in the beginning of the 1990's by the coastal countries and the EU. The agreement of the new Helsinki Convention entered into force in 2000 with the objective of establishing a framework of regional cooperation in the Baltic Sea to reduce and prevent pollution in this region. The Helsinki Commission (HELCOM) is an intergovernmental organization consisting of ten contracting parties: Denmark, Estonia, the European Union, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden. The Convention was concluded through EU Council Decision and the competence is mixed/shared between EU and the Member States. HELCOM is responsible for implementing the convention, making recommendations to the parties, defining pollution control criteria and objectives and promoting additional measures in cooperation with governmental bodies.

The HELCOM Baltic Sea Action Plan (BSAP), adopted in 2007, is a regional programme of measures and action for a healthy marine environment. The plan includes a nutrient reduction system with two main components:

- Maximum Allowable Inputs (MAI) of nutrients, indicating the maximal level of inputs of water- and airborne nitrogen and phosphorus to Baltic Sea sub-basins that can be allowed to fulfil the targets for non-eutrophicated sea; and
- Country-Allocated Reduction Targets (CART), indicating how much nutrient inputs each HELCOM countries need to reduce compared to a reference period (1997-2003).

In the coming Baltic Sea Action Plan 2021, HELCOM will go from using Country-Allocated Reduction Targets (CART) to Nutrient Input Ceilings (NIC). The advantage of the new system is that the reduction targets are consistent with Maximum Allowable Inputs (MAI) instead of being compared to the reference period (which means there can be changes when historical data are updated).

Although the overall goal of the current action plan to reach good environmental status of the Baltic Sea by 2021 will not be reached, the plan has delivered unprecedented results. In 2018, the HELCOM Ministers have therefore decided to update the plan by the end of 2021 at the latest, offering the possibility to adjust it and consider previously unaddressed challenges.

1.6 THE COMMON AGRICULTURAL POLICY (CAP)

The renewed EU Common Agricultural Policy (CAP) for 2020–2027 (European Commission, 2018), includes an obligatory nutrient management tool to improve water quality. To promote this, an app for farmers (Farm Sustainability Tool for Nutrients, FaST) has been developed (European Commission, 2019a). In addition, each member state will develop Eco-schemes to support and/or incentivize farmers to observe agricultural practices beneficial for the climate and the environment, beyond their mandatory requirements.

1.7 THE GROUNDWATER DIRECTIVE

The Groundwater Directive (GWD, 2006/118/EC) specifies measures to prevent and control groundwater pollutions. Specifically, it outlines: (a) criteria for the assessment of good groundwater chemical status; and (b) criteria for the identification and reversal of significant and sustained upward trends and for the definition of starting points for trend reversals.

Threshold values for achieving good chemical status of groundwater should be based on the protection of the body of groundwater and keeping in mind its impact on, and interrelationship with, associated surface waters and directly dependent terrestrial ecosystems and wetlands. Practically, this means that thresholds can be established at the national level, at the level of the river basin district or the part of the international river basin district falling within the territory of a Member State, or at the level of a body or a group of bodies of groundwater.

Nitrates are one of the two sets of groundwater quality standards used to assess groundwater chemical status. The other set are pesticides. When it comes to assessing nitrates, consistency should be ensured with the protection of waters against pollution caused by nitrates from agricultural sources. In some cases, the protection of groundwater may require a change in farming or forestry practices, which could entail a loss of income. However, it is left to each Member state to decide on the priorities and projects for ensuring groundwater protection measures. But in any case, criteria should be established for monitoring trends in pollutant concentrations and for defining the starting point for trend reversal. These criteria should take into account the likelihood of adverse effects on associated aquatic ecosystems or dependent terrestrial ecosystems.

2 PREVIOUS INVESTIGATIONS ON TRADING SYSTEMS IN THE BALTIC SEA

This chapter reviews two previous investigations on trading systems: a Swedish effort that evaluated the potential of a domestic trading system and a broader effort by HELCOM that considered opportunities for an international trading system. The purpose is to provide a context for the current analysis and to identify lessons learned from previous attempts. The four most important lessons are:

1. There are gains in environmental effectiveness and economic efficiency to be obtained from better allocation of nutrient abatement efforts around the Baltic Sea;
2. Although there are numerous legal issues to be solved before implementation is possible, the legal challenges do not prevent implementation of some form of nutrient trading;
3. The regional character of nutrient pollution and the local environmental quality requirements call for a design of a nutrient trading program that can deal with local environmental targets; and
4. Stakeholders in different regions and sectors tend to have strong opinions about the distributional effects of instruments for nutrient reduction, which may challenge national as well as international political acceptability. A successful trading system needs to be designed to advance distributional effects that can gain common acceptability.

2.1 PREVIOUS SWEDISH ANALYSES OF TRADING SYSTEMS

Between 2007 and 2013 there were several Swedish-led efforts to develop a new policy instrument based on emissions permit trading. For example, after signing the Baltic Sea Action Plan, the Swedish Environmental Protection Agency proposed a national fee system for nitrogen and phosphorus in Sweden (Swedish EPA, 2008) to address eutrophication of the Baltic Sea and the North Sea. The proposal focused on municipal wastewater treatment and the forest sector and required actors that exceeded emissions limits for nitrogen and phosphorus to choose between (1) reducing their emissions below the limit or (2) paying a fee per unit of emissions exceeding the limit. The revenue would be used to finance compensatory measures in other sectors not regulated by the emissions limits (e.g., measures by non-point sources in agriculture and aquaculture like wetlands restoration or algae harvesting). The net distributive effects of the fee-subsidy system would, in practice, imply transfers from sectors with point sources to sectors with non-point sources.

In a second assignment, Swedish EPA (2010) further developed the fee system to a tradable permit-fee system allowing for trade in permits between point sources with emissions limits. Swedish EPA (2010) judged that allowable nitrogen and phosphorus loads in environmental permits must be removed from the assessment process in environmental courts in order not to undermine the potential of cost efficiency in the tradable permit-fee system. Moreover, Swedish EPA (2010) concluded that it is unclear how a trading system could operate with environmental objectives in the Water Framework Directive and suggested a need for further investigation into this topic.

In 2010, the proposed tradable permit-fee system was opposed by Swedish Water, the industry association of municipal wastewater treatment plants in Sweden. The association initiated an alternative investigation (co-funded by the State) and implemented by IVL Swedish Environmental Research Institute. It proposed a refunded emissions payment system for nitrogen and phosphorus (Olshammar, et al., 2012), which was similar to the nitrogen oxide charges (NO_X charge) for NO_X air emissions in the Swedish industry sector but adjusted to fit nutrient emissions from wastewater treatment plants. The system implied that plants with higher than average emission intensities in the sector would pay a fee per unit of nutrient pollution, which would then be used to fund plants with lower than average emission intensities. Thus, the system implied that payments stayed within the sector.

In 2010, the Swedish government followed the initiative by Swedish Water and assigned a third mission to the Swedish Environmental Protection Agency to investigate several economic instruments for reducing nitrogen from Swedish municipal wastewater treatment plants, of which one must be the refund system proposed by the Swedish Water investigation (Olshammar, et al., 2012).

Swedish EPA (2012) designed and compared five different economic instruments for nutrient emissions from municipal wastewater treatment plants in Sweden; taxes, tradable permits, tradable credits (or certificates) in a baseline-and-credit system, tax-subsidy hybrid and refunded emissions payments. All instruments were developed and designed to correct for retention (retention refers to how much of a source's emission actually reaches a given downstream water body). Further, they included economic incentives to help achieve the sector's Baltic Sea Action Plan target in coastal waters within a maximum of six years after implementation. In economic modelling, tradable permits and tradable credits were the only two economic instruments in the investigation that were predicted to fulfil the BSAP target by 2021 with sufficient certainty. The reason was that both were trading systems with maximum allowed loads, rather than price-based instruments such as taxes or subsidies.

Moreover, trade in reduction of loads was finally favoured over trade in loads. This is because trade in reductions is in better harmony with the emissions limit values set by the permit assessment process in environmental courts, as well as the environmental quality elements under the Water Framework Directive.[1] In addition, trade in reductions implied that non-point sources could more easily be included in the future (Swedish EPA, 2012).

In 2012, Swedish Water announced that they would abolish their earlier proposal of refund emissions payment system from 2010 and instead support the tradable credit system by Swedish EPA (2012). The Swedish government then had the intention to implement the tradable credit system in Sweden. However, in the 2013 Baltic Sea Action Plan negotiations, the Country-Allocated Reduction Targets for nitrogen were significantly reduced compared to the preliminary targets from 2007 (for which the nutrient trading system was designed). It was then judged that a nutrient trading system was not needed in Sweden as the new reduction target could be achieved by the existing policy instruments.

1 Sweden did not set environmental quality elements for nitrogen in inland waters under the Water Framework Directive. Thus, the trading system was only facing targets in Coastal water.

2.2 THE 2008 STUDY ON NUTRIENT TRADING FOR HELCOM COUNTRIES

The Swedish effort to consider a national flexible permitting system (as described above) to meet the Baltic Sea Action Plan targets was rather unique. On a Baltic Sea scale, the Nordic Environment Finance Corporation studied the possibilities for a framework of a nutrient quota and a credits trading system for the contracting parties of HELCOM. The work started in 2007 and was coordinated by the Green Stream Network. The objectives were 1) to develop a conceptual outline for a nutrient quota and credits trading system and 2) to identify the main barriers and further development needs for such a system to become operative nationally and internationally in the Baltic Sea region.

All legal aspects were analysed in the first phase of the study, including coexistence with the Water Framework Directive, the Urban Waste Water Directive and the Nitrates Directive. The final report concluded that there is a need to create flexible policy tools for controlling eutrophication in the Baltic Sea and that, despite their complexity, the set of national laws and environmental agreements do not prevent such a system from being developed, particularly for point-sources (NEFCO, 2008). The report notes the possibility for net benefits from a well-designed, environmentally and economically efficient, nutrient trading system that helps the contracting parties achieve their reduction targets. However, the report also identified issues that need to be addressed before developing such a system:

- Initial allocation of permits can be utilized to even out the benefits from improved water quality (highest in Sweden and Finland) and the abatement efforts (most intensive in the Baltic States and Poland). By allocating more permits to the poorer countries, the incidence of benefits and costs could be made more equitable. (This issue is discussed in Part A of this report).
- The subsidiarity principle of the EU which provides guidelines for bringing regulation to EU level, and the role of EU legislation must be analysed.
- Importance of considering the impact of state aid jurisprudence between all Member States.
- The need to find or create an appropriate legal forum for Russia as the only non-EU State.
- A need to agree on the scope of the market, which may be affected by heterogeneity of abatement costs and existing legal frameworks for point sources (e.g., Emission Limit Values and Best Available Technology).

The report was presented to HELCOM and discussed at a meeting in March 2008. It was reported that Sweden was favourable towards the idea, but Germany and the European Commission were not. While Germany welcomed discussion of the topic, it also noted that no national work would be initiated in Germany to develop a nutrient trading framework (HELCOM, 2008). Germany argued, among other things, that the trading system would not be able to address eutrophication hot spots and that it might be in violation of the legal requirements of the Water Framework Directive and the Marine Strategy Framework Directive. Both issues are discussed thoroughly in this report, including a specific trading system proposal that was developed to avoid the problems that Germany identified, without weakening the potential for efficiency gains provided by a market.

As such the system proposed in the NEFCO report remained a desk top study until 2015 when it was addressed in a project led by the John Nurminen Foundation and financed by the Central Baltic Programme 2014-2020[2]. That project analysed the possibilities to take the first steps in the Finnish context, which included actual pilot activities to remove nutrient loading. The project was able to establish a system of neutralizing nutrient footprints using two tools – the Nutribute crowdfunding tool and network of The John Nurminen Foundation to connect investors who wish to finance pollution control with actors seeking funding for abatement technology.[3]

3 ECONOMICS OF WATER QUALITY MANAGEMENT

This chapter is designed to better understand the technical aspects of nutrient trading systems and is targeted specifically toward economists. This chapter is not necessary for understanding the report or its major conclusions.

Marine water is a common-pool resource. This leads to environmental problems typical for public goods. Marine areas have been used as deposits for nutrients and other wastes. For individuals, firms and communities generating and emitting the pollutants, these deposits are referred to as externalities. They impose environmental damage costs on society, but these costs are not borne by the polluting firms and thus not taken into account in their operational decisions. This leads to excessive quantities of pollutants being generated and emitted. The resulting inefficiency is a known as a “market failure”.

In a market solution without regulation, a polluting firm that minimize its costs will not abate anything. This is because the costs from its abatement are often large in comparison to the environmental damage that the firm faces. Abatement costs are minimized when there is no abatement at all. But what is cost minimizing for the firm is not cost minimizing for society. Further, firms that attempt unilaterally to control their pollution are placed at a competitive disadvantage due to the higher cost of production they face relative to their less conscientious competitors that may be located in countries with more lax environmental regulations. Thus, the free market solution not only fails to generate an efficient level of pollution control, but also penalizes those firms that might attempt to control an efficient amount. This conclusion justifies some sort of government intervention to ensure adequate pollution control.

This chapter explains the cost-effective way of allocating targets for pollution abatement between firms with differing abatement costs. It also discusses alternative policy instruments that can be implemented to achieve the allocations and how they differ in terms of costs and environmental improvements. Finally, it discusses how instruments can deal with changes in the environmental, economic and technological environment.

[2] The Central Baltic Programme 2014-2020 is an EU cross-border cooperation programme which finances results orientated cross-border cooperation projects in Estonia, Finland (incl Åland), Latvia and Sweden.
3 The Nutribute tool can be found at: http://www.nutribute.org/. It has financed various nutrient abatement activities in Finland. The list of active crowdfunding sources can be found in http://www.nutribute.org/#archive-tab.

3.1 COST-EFFECTIVENESS

Pollution control efforts should be divided between the polluters such that the selected environmental target is achieved at the lowest possible total costs to society, i.e. cost-effectively. Failing to achieve cost-effectiveness means that either the total costs could be lowered by maintaining the environmental target or a higher environmental quality could be achieved at the same cost. Let us discuss the concept with the help of a graph depicting the marginal abatement cost curves for two firms (sources) (Figure 3.1).

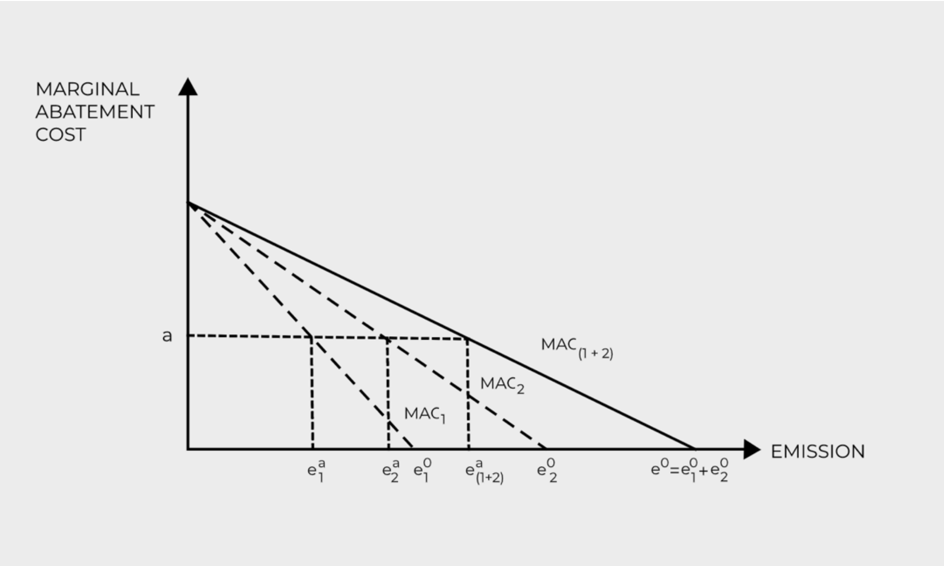


Figure 3.1 Cost-effective allocation of pollution and pollution abatement between two sources with different marginal abatement costs (MAC).

The dotted curves (MAC_1 and MAC_2) represent firm-specific cost curves, while $MAC_{(1+2)}$ represents the aggregate cost. The horizontal axis denotes the level of emissions and the vertical axis denotes the marginal abatement costs. They can equally well be understood as marginal savings from averted abatement efforts (full emission level = all abatement costs avoided = marginal abatement cost equals zero).

The two firms in Figure 3.1 have different options for controlling the amount of pollution they emit and hence have different marginal abatement costs. This is reflected by the different slopes of the marginal abatement costs curves MAC_1 and MAC_2. The aggregate marginal abatement cost curve ($MAC_{(1+2)}$) indicates the marginal abatement costs associated with any given total pollution levels for the two-firms.

The least cost choice for firm 1 is to emit the amount e_1^0. That is, not to do any abatement. Similarly, the least cost amount of emissions for firm 2 is e_2^0. In a nonregulated market solution, the total pollution generated by the two firms is $e^0 = e_1^0 + e_2^0$.

Now suppose that society acknowledges the environmental damages and realizes that by decreasing the total pollution to level $e_{(1+2)}^a$ an environmental target will be achieved. What is the least cost way of allocating the abatement targets to the two firms? The allocation is found by equalizing the marginal abatement costs of the two firms. This is done by allowing firm 1 to emit e_1^a and firm 2 to emit e_2^a. Any shift in the emission shares that maintained the total pollution at this level would increase the abatement costs of one firm more than they decrease those of the other. Alternatively, any shift that maintained the total emission level would increase the total costs. This is a graphical representation of the general rule for cost-effectiveness: The cost of achieving a given reduction in emissions will be minimized if and only if the marginal costs of control are equalized for all emitters. The rule extends to multiple sources.

It is important to recognise that the cost-efficient solution may not be considered a “fair” distribution of responsibility between actors. However, the issues of fairness only arise if there is no mechanism that ensures that the ones doing the abatement are compensated. In other words, a firm with high abatement costs is better off financing cheaper measures in another sector/firm rather than abating the same amount of pollution at a higher cost at their own facility.

3.2 POLICIES TO ACHIEVE COST-EFFECTIVE ALLOCATIONS

There are several ways authorities can try to induce the desired abatement levels. In principle, they can be divided in two types: command-and-control regulations and economic instruments. Command-and-control is the direct regulation of an industry or activity by legislation that states what is permitted and what is illegal. This may include requirements of using best available technologies or setting precise pollution limits. Economic instruments, such as taxes or trading systems, incorporate environmental costs and benefits into the budgets of households and firms to provide incentives for reducing emissions.

Whereas air pollution control has experienced a wave of recent reforms that has improved the process and made it more cost-effective, little parallel exists for water pollution control. Policies toward cleaning up rivers and lakes has mainly been based upon command-and-control regulation of municipal wastewater treatment facilities and industrial sources, an approach that has been hampered by delays and high costs. Emission charges and tradeable permits are more flexible and cost effective in both the dynamic and static sense. Further, new watershed-based trading programs are now gaining attention.

The cheapest control measure (per unit of emission) will differ widely, not only among industries but also among plants in the same industry. The selection of the cheapest method requires detailed information on the potential pollution control techniques and their associated costs. Generally, plant managers can acquire this information when it is in their interest to do so. However, the government authorities responsible for meeting pollution targets are not likely to have this information, making it difficult to equalize the marginal costs of control for all emitters.

One solution to this problem is to impose a legal limit on the amount of pollution allowed by each source. If the limit were chosen precisely at the level of emission where marginal control costs are equal for all sources, efficiency will be achieved for those sources. If the abatement costs curves are not known, however, such an allocation cannot be achieved.

Therefore, an alternative approach is to set a price on pollution, either by imposing a tax/charge on emissions or by creating a market for pollution. The latter generates the price automatically, driven by the scarcity of the supply of pollution permits compared to their demand. The firms operating in the market for pollution permits responds to any price level yielding a cost-effective market allocation of emissions (and thus abatement). A tax would require a trial-and-error process before the right level of pollution can be found.

The following figures analyse how command-and-control (Figure 3.2), pollution tax (Figure 3.3) and emission trading succeed in mitigating pollution and keeping the costs down, when the regulator has the wrong information about firms’ abatement cost curves. In each of the figures, the left panel represents the marginal abatement cost curves the regulator anticipates, and according to which the instruments are set. The panels on the right represent the actual marginal abatement cost curves according to which the firms make their abatement decisions.

Figure 3.2 thus presents the case for command-and-control regulation. Again, there are two polluting firms. The left panel shows the regulator's perception of the marginal abatement costs and the right shows actual costs, known only by the firms. After careful analysis, political struggle or both, the government comes up with the conclusion that the desirable level of pollution in society is $e = e_1 + e_2$. Coincidently, it turns out that the cost-effective allocation is to allow both firms to emit an equal amount: $e_1 = e_2$. That is, they are both required to reduce pollution from its initial level up to this point. Because the initial emission of firm 2 is higher, it does more abatement. The total costs of abatement are denoted by the light and dark triangles underneath the marginal abatement cost curves.

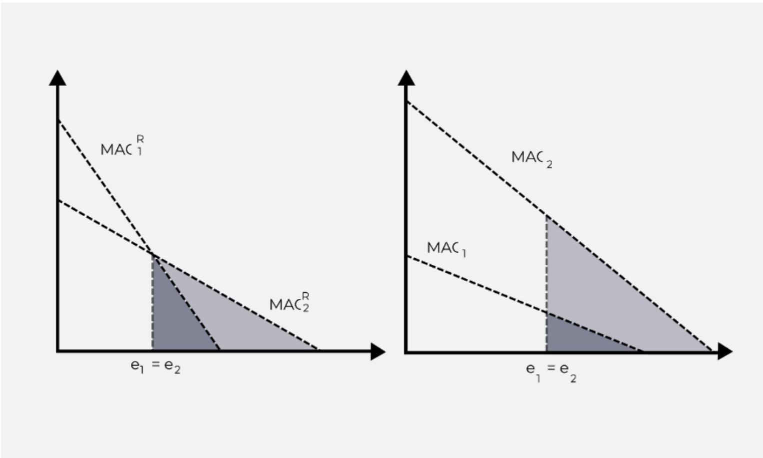


Figure 3.2 The effect of imperfect information on total abatement costs when command-and-control instruments are used. Uniform emission standards are set according to perceived MAC curves on the left, the firms' actual curves on the right. Emission targets are reached but the costs are unnecessarily high.

The regulator issues environmental permits, allowing pollution only up to level $e_1 = e_2$, regardless of the control costs. This will also be the level at which the cost-minimizing firms will pollute, i.e. they will not do any extra abatement.

The right panel shows that the command-and-control regulation achieves the desired total pollution level. The total abatement costs, however, differ from the intended ones. If the regulator's perception of marginal abatement costs were correct (the left panel), the solution would be cost-effective. Because the perception is false, the sum of total abatement costs for the two firms is much higher than in a cost-effective solution.

Figure 3.3 presents the same situation, but the regulator's choice is to issue a pollution tax. Working on the perceived marginal abatement cost curves on the left, the regulator sets the tax at τ. If the information were correct, the outcome would be identical to the command-and-control solution. But the actual responses to the tax rate will differ from the command-and-control scenario: Firm 1 finds it cheaper to push all the emissions to zero than to pay any pollution tax. Firm 2 emits more than under command-and-control. Two typical observations associated with such a tax are: 1) The total costs of abatement are smaller than under command-and-control and 2) The total emissions are not what the regulator expected. In this case the total emissions are lower than under command-and-control. If the regulator would err in the other direction, the emissions levels could be excessively high. In any case, the total emission/abatement level is uncertain. Of course, the regulator could correct the tax once he/she had noticed the undesired outcome.

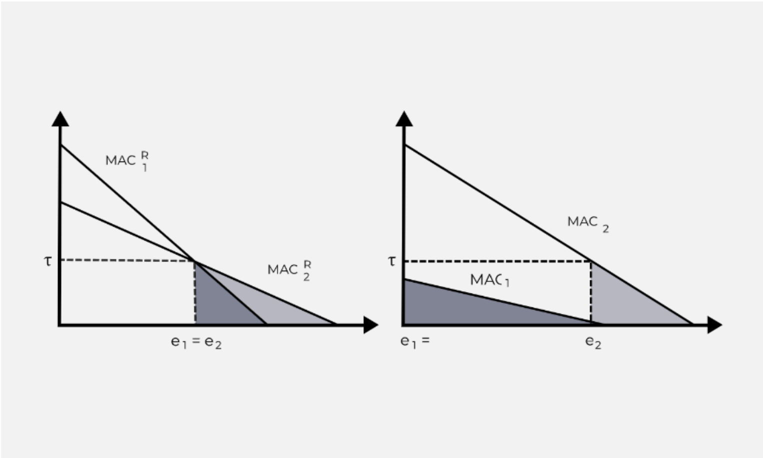


Figure 3.3 The effect of imperfect information on total abatement costs when taxes are used. Tax is set according to perceived MAC curves on the left, the firms' reactions follow the actual curves on the right. Emission targets are not reached but the costs are lower than under command-and-control.

Figure 3.4 presents how a trading system would react to false information on abatement costs. First, the regulator would issue a total of E emission permits and allocate them to firms 1 and 2. Note that the initial permit allocation (i.e., how many permits to give out and which firms get them) does not matter, as long as trading is allowed. Again, the left panel shows how the regulator thought it would go and the right panel shows how it actually went.

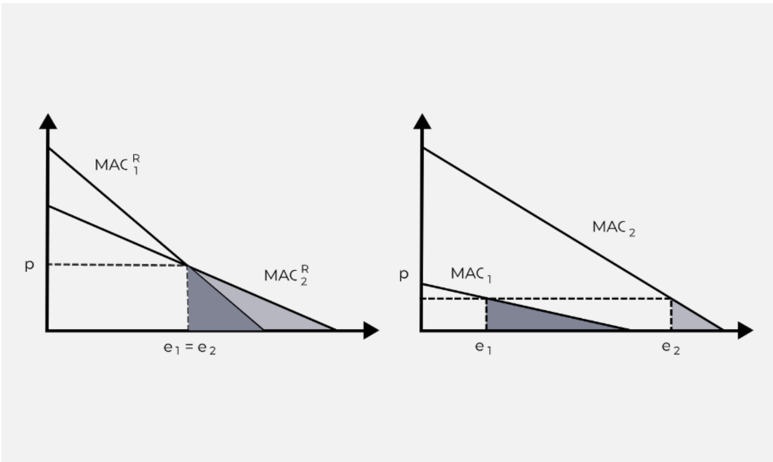


Figure 3.4 The effect of imperfect information on total abatement costs and emissions when a trading system is used. Total permits are chosen by the regulator (utilizing the perceived MAC curves on the left), the firms' reactions generate a market price p and the firms' emissions follow the price. Emission targets are reached at the lowest possible costs.

The equilibrium price of a permit is denoted by p. It is an outcome of the transactions of the two firms and not set by the regulator. It is the price of the last transaction. The left panel is identical with the above cases. The right panel, however, shows the two most important features of a trading system: 1) $E = e_1 + e_2$ and 2) this total emission level is achieved at the lowest possible total abatement costs. These two conditions hold generally for trading and are the main justification for why economists favour trading systems in pollution control.

In practice, there is no way for a control authority to know the optimal tax level before trying it. Thus, a trading system represents an alternative that finds the cost-minimizing allocation without going through a trial-and-error process.

The following results (which summarize the figures above) hold for any number of firms, as long as the pollution is homogenous in its environmental damages and enforcement is perfect: (1) command-and-control will result in certain amount of pollution but potentially higher costs than any other instrument; (2) a tax (or subsidy) will result in the lowest cost solution for a given total amount of pollution which is uncertain 3) pollution permits that can be traded between regulated parties will result in the least cost solution and a known amount of total pollution.

A major difference between taxes/charges and a trading system of permits is the way these two systems react to changes in external factors. This is important because bureaucratic procedures are often sluggish and changes in policies are usually rendered slowly. Three circumstances are worth considering:

- Number of pollution sources. If the number of pollution sources were to increase in a trading system, the demand for permits would also increase. Given a fixed supply of permits, the price would rise, but the amount of emissions would remain the same. On the other hand, the level of taxes/charges would not change under this scenario of new sources (in the absence of changes in the level of taxes/charges by the control authority), which implies that total pollution will rise as a result of economic growth. Therefore, the arrival of new sources would result in environmental deterioration due to the added emissions by these new sources. The costs of abatement would rise, since the cost of control paid by the new sources must be considered, but by a lesser amount than with a trading system, because of the lower amount of pollution being controlled. Thus, if the economy is growing, the permit system ensures that emissions will not rise, given that new permits are not issued to new sources.

- Inflation would automatically result in higher permit prices in a trading system, but with a taxes/charges system it would result in lower pollution control. Essentially, the real charge (the nominal charge adjusted for inflation) declines with inflation if the nominal charge remains the same. In order to solve the problem, the tax level needs to be adjusted annually for inflation.

- Technological progress. We should not, however, conclude that taxes/charges will always result in less pollution control than tradable permits. Suppose, for example, technological progress in designing pollution control equipment were to cause the marginal cost of abatement to fall. With a trading system this would result in lower prices and lower abatement costs, but the same aggregate degree of pollution control. With a taxes/charges system, the amount of abatement would increase and, therefore, would result in more pollution control than a trading system.

PART A: PRECONDITIONS FOR A NUTRIENT TRADING SYSTEM IN THE BALTIC SEA REGION - THEORY, EXPERIENCE AND LESSONS LEARNED

This part of the report examines preconditions for a nutrient trading system in the Baltic Sea region from a theoretical point of view. It also includes empirical experiences from existing systems around the world. It concludes by suggesting a trading system design for further investigation.

- Chapter 4 presents the benefits and challenges of a nutrient trading system in the Baltic Sea
- Chapter 5 describes what a trading system is and highlights different types of systems
- Chapter 6 discusses general considerations for designing a nutrient trading system
- Chapter 7 discusses geographical targets in a nutrient trading system that are aligned with the Water Framework Directive
- Chapter 8 gives an international overview of existing nutrient trading systems
- Chapter 9 identifies and describes potential buyers and sellers in the Baltic Sea region
- Chapter 10 concludes with a list of preconditions for implementing a nutrient trading system in the Baltic Sea

4 THE BENEFITS AND CHALLENGES OF A NUTRIENT TRADING SYSTEM

The purpose of a nutrient trading system is to improve environmental effectiveness and economic efficiency in policies addressing eutrophication. Below we highlight the benefits and challenges of a nutrient trading system.

4.1 BENEFITS OF A NUTRIENT TRADING SYSTEM

First, a trading system may help address two intractable problems in implementing the BSAP: high total costs and reducing emissions from the agricultural sector. Current cost estimates of achieving water quality goals are significant: implementation of the renewed Swedish River Basin Management Plan 2021-2027, as part of the Water Framework Directive, is estimated at 4.8 billion euro (The Water Authorities, 2020a). Other countries like Estonia have also projected significant costs for achieving water quality goals with existing approaches. A trading system is a more efficient instrument compared to regulation as it can achieve reductions with higher target precision and at a lower total abatement cost to society. The system is more efficient because sources facing relatively lower costs of abatement can generate emission, or load, permits (or credits, see Section 5) by exceeding reduction targets and then selling these permits to actors that face relatively higher costs of abatement. Moreover, the system can be designed to allow for non-polluting actors to join the market and provide financing for nutrient reduction, e.g., firms with technology to sequester and/or reduce emissions, or other organizations wishing to finance pollution reduction. Further, a trading system can address pollution consistently across all polluting sectors. Until recently, the focus (and most of the gains) has been in controlling point sources (e.g., wastewater plants), while non-point sources (primarily agriculture) have received relatively little legislative attention. Today, non-point sources represent over half of the anthropogenic nutrient load from the Baltic Sea countries, which means reducing non-point source emissions is more cost-effective than *further* reducing emissions from point sources (Gyllström, et al., 2016, pp. 68-). A trading system provides a mechanism for distributing pollution reduction (including the costs of doing so) across both the wastewater and agriculture sectors, which is important since the Water Framework Directive lacks the instruments to directly intervene in countries' relevant agricultural policies.

Second, disagreements among HELCOM-countries often involve discussions of fairness in how to distribute the financial burden of nutrient reduction measures. While the BSAP's allocation of country-specific targets for reducing nutrients allows for flexible implementation of measures, they do not explicitly account for economic disparities across countries. For example, two countries with relatively lower GDP per capita levels, Russia and Poland, actually bear the largest nutrient reduction targets and hence largest financial burdens. A trading system can address this by providing a mechanism for countries to share the financial burden – across both time and space – and thus provide more flexibility for countries to achieve their allocated targets. In fact, Savitri (2019) note the importance of considering economic disparities when developing policy instruments to address nutrient pollution and explicitly suggests the use of a nutrient trading system to reduce implementation costs for less affluent countries.

Finally, as an economic policy instrument, a trading system puts a price on emissions which makes it expensive to pollute and creates an incentive to reverse the negative impacts of emissions. This, in turn, can lead to several positive spin-off effects. For example, creating incentives for actors to sell technology or processes that reduce emissions. Furthermore, although a tax on nutrient emissions also puts a price on emissions, a trading system offers the opportunity to invite actors from other sectors via offset projects, if designed correctly (see Sections 6.2 and 10.5). Including offset projects is a way to allow external parties to help meet emissions reduction goals. Offset projects may be linked to either a production process that requires nutrients as inputs (e.g., economically viable aquaculture production such as blue mussels) or environmental measures such as algae farming. By incentivizing these other actors to join the market and purchase emission permits – including environmental organizations or start-up firms developing nutrient sequestration technology – a trading system provides opportunities for the influx of financial capital that can relieve the overstrained public budgets that often subsidize nutrient reduction today. It also generates new economic activities and employment opportunities. It should be noted, however, that similar incentives could be generated with separate instruments by, for instance, channelling tax revenues to nutrient uptake subsidies. But trading is a superior generator of offsetting activities, assuming they are incorporated in the trading system.

4.2 CHALLENGES OF A NUTRIENT TRADING SYSTEM

There are, of course, several challenges and risks involved in establishing a future trading system. We highlight four challenges below, which are addressed in more detail in Part A.

First, the administrative costs of establishing a trading system may be significant. These costs stem in part from the fact the nine Baltic Sea countries have independent jurisdictions and from the additional regulatory layer provided by the EU Directives (relevant for eight of the countries). As the example from Sweden shows, establishing a trading system for a single nation is challenging and costly (e.g., the revision of legislation is a time consuming and costly affair). Therefore, the efficiency gains from a future trading system must outweigh these total administrative costs (it is worth distinguishing, however, between the administrative costs of setting up the system and those for running the system – there is no reason to believe that running the system will be any more burdensome than running existing systems).

Second, it is important to create a future trading system that includes agricultural sources, particularly the large animal facilities and their manure management. HELCOM EU countries alone have about 21 million livestock units in the Baltic Sea basin (Niskanen, et al., 2020). Imposing new regulations on agriculture is difficult because of the overarching Common Agricultural Policy (CAP) support system, which funds agri-environmental measures. Since funding to farmers cannot be compensated from sources other than the CAP, this raises the question of whether actors ("buyers") in a future trading system can fund environmental measures. On the other hand, the Dutch phosphate trading system shows that it is possible to generate effective trading systems even under the CAP umbrella.

The third potential challenge when designing the trading system is the problem of thin markets. There are programs where the regulated parties have chosen a self-sufficiency approach, i.e. undertaking required abatement measures while staying away from the trading markets (see e.g. the Lake Dillon trading program). On the other hand, the Long Island Sound program shows that by proper design of the trading rules one can generate a vibrant marketplace. However, there is also the risk of strategic behaviour by regulated entities: will they rely on permit markets when making their investment decisions, whose timing and scope eventually determine the supply and demand of permits any given year? If the regulated entities anticipate a risk of having low (or non-existent) trading activity in the market they might simply choose self-sufficiency – i.e., optimize investments in their own abatement without generating extra credits to sell or postponing investments to generate demand. This could be described as the endogenous or strategic risk of ending up with too thin markets. The economic literature offers little help in this matter. A precautionary approach would perhaps over-emphasize the need to generate a thick permit market by design.

Finally, there is the challenge of political acceptability, in particular resistance from sectors that are currently 'protected/insulated' from the polluter pays principle or receive subsidies for their activity. Significant resources will be needed to conduct ambitious outreach and communication activities to combat misinformation, as the lack of understanding of an ambient trading system is likely to increase resistance.

The rest of Part A considers these risks in light of the advantages a trading system may provide for achieving Baltic Sea Action Plan goals. The following chapters define a trading system, explain how it works, and discuss other critical design aspects, including the geographical scope and extent of the market.

5 WHAT IS A TRADING SYSTEM?

Emissions trading systems, such as the EU Emissions Trading System (EU ETS), are market-based instruments that create incentives to reduce emissions where these are most cost-effective. In most trading systems, the regulator sets the maximum allowable amount of emissions in a region or in one or more sectors – the so-called cap. An equal number of permits is issued by the regulator which are then allocated or auctioned to the sources covered. Sources are then allowed to trade emissions permits with the result that the maximum allowable amount of emissions – the cap - is reached by reducing emissions where these are most cost-effective.

A trading system automatically allocates the abatement to the most inexpensive sources. However, all sources contribute equally to the last abatement units, either by incurring the marginal abatement costs or by financing other sources' abatement by buying permits. Every source within the same area thus eventually pays a market price for the last abatement measures. This ensures that the emissions reductions will be done with the lowest possible costs. The quantity limit (the cap) ensures that the sum of emissions from all actors remains below the target level.

The other obvious advantage of a trading system is that it supports innovations. Abatement technologies are not predetermined. On the contrary, any means to come up with more effective and inexpensive pollution abatement are reflected directly to firm's profits. The incentive for innovation is constantly present with a trading system. Innovation is also driven in the science-policy nexus as modelling requirements are intensified. With diffuse pollution in particular – if included in the system – models to quantify abatement measures' impact on eventual pollution loads must be developed. Such development would benefit any other regulatory instrument as well, but the trading system generates most transparent incentives to actually develop and improve the models. Trading system unleashes the innovative skills of those possessing the best know-how on their systems.

In general, there are mainly two types of trading systems: *cap and trade* and *baseline and credit*. In a cap-and-trade system, there is a limit/cap on total emissions from regulated sources. Each source gets a number of permits to emit, which can be sold or used. In a baseline-and-credit system, there is no cap, but the polluters follow a baseline level of emissions. Sources reducing their emissions more than the baseline path earn "credits" that can be sold to polluters that exceed their baselines.

This chapter describes how these systems work when there is a single cap or baseline for all sources in the system as, for instance, in the cap-and-trade system of EU ETS. In Chapter 7, trading systems with several local environmental targets (determining local caps or baselines) are described, which is needed for a nutrient trading system.

5.1 CAP-AND-TRADE

In a cap-and-trade system, all sources face a collective limit on their emissions (the cap) and they are allocated (or sold) permits to emit. Each permit authorizes a specific amount of emissions (e.g. 1 tonne or 1 kg). The regulator issues the total number of permits needed to produce the desired emissions level. These can be distributed among the sources either by auctioning them off or by granting them directly to sources free of charge, an allocation referred to as "gifting" or "grandfathering". Regardless of the way the permits are initially allocated, they are freely transferable; they can be bought and sold. Sources emitting more than their holdings would buy additional from firms who are emitting less than authorized. Any emissions by a source in excess of those allowed by permit holdings at the end of the year would cause the source to face severe monetary sanctions.

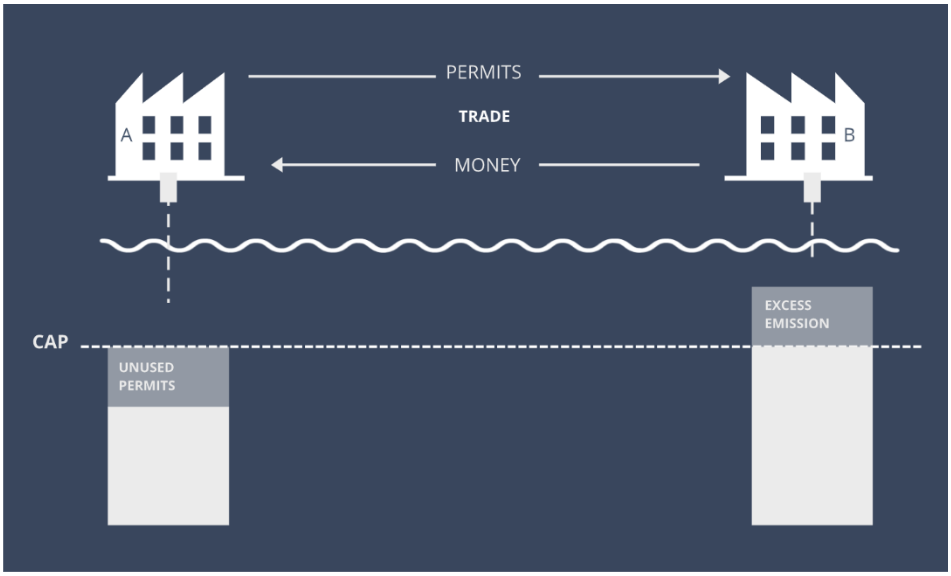


Figure 5.1. Illustration of a cap-and-trade system.

5.1.1 How does cap-and-trade work in practice?

Sources covered by a trading system are registered with the regulator and assigned to an account for the holding of emission permits. One permit gives the right to emit one unit (e.g. 1 kg) of the regulated substance. A point in time is determined when the permits must match the emissions. Usually, by the end of each year, the number of permits possessed by a source must be equal to its accumulated emissions during that year. If a source has emitted more than indicated by the initial allocation, it must buy the missing permits from another source or from a broker at the market price.

Also, a trading system typically sets a tightening cap at the outset of the program, indicating the path of total emissions from period to period until the trading area reaches its final cap. Free allocation of permits works as follows: The sources are allocated a number of permits each year in proportion to an allocation rule. To meet the final cap by the end of the trading program, the allocation will be reduced each year by a predetermined number until the eventual target level is achieved. When introducing a trading system, the regulatory authority needs to issue general rules for accredited measurement methods for emissions.

5.2 BASELINE-AND-CREDIT SYSTEM

The second type of trading system is *baseline-and-credit*. In this system, there is no explicit cap on aggregate emissions. The baseline is sometimes constructed as a ratio by dividing emissions by e.g. production output (or energy input). The implicit cap on aggregate emissions will then vary with the level of aggregate output and becomes a tradable performance standard (Fischer, 2001; 2003). Such varying baseline effectively becomes an implicit subsidy on output. Companies receiving this subsidy will tend to expand their capacity to produce more output. Theory and laboratory experiments suggest that if baselines are proportional to output, aggregate emissions are significantly greater under a baseline-and-credit trading plan than under a comparable cap-and-trade plan because companies produce more output (Buckley, et al., 2004). Since these measures do not regulate emissions quantity directly, and lack fixed aggregate limits, which are important for achieving targets that can fulfil environmental objective, they are not further considered here.

Another type of baseline-and-credit system has a baseline expressed in emissions reductions and therefore a fixed implicit cap as in Figure 5.2. In this system each source faces a certain baseline level of emissions which is reduced over time towards a final target level. Therefore, the implicit cap becomes fixed rather than a variable as in the previous case where the baseline was constructed as a ratio. Sources that reduce their emissions more than the baseline path generate "credits" that can be banked or sold to polluters that exceed their baselines (see Figure 5.2). A credit is a verification that the source has fulfilled its obligation to make an annual reduction in its emissions. Thus, a baseline-and-credit system will then produce equivalent results as a cap-and-trade plan if the implicit cap is fixed and numerically equal to the cap in a cap-and-trade plan.

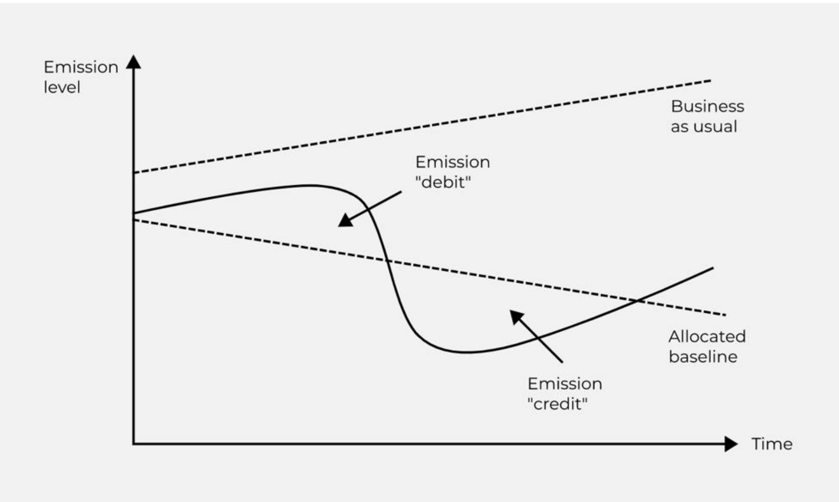


Figure 5.2. Illustration of a baseline-and credit system with a fixed implicit cap.

The dashed line pointing upwards (Business as usual) is the estimated path of emission that would take place without extra abatement efforts. The dashed line pointing downwards (Allocated baseline) is the fixed implicit cap in each trading period. Realized emissions above the implicit cap (Emission "debit") must be offset by purchasing credits. Emissions below the implicit cap (Emission "credit) earn credits for the facility.

5.2.1 How does baseline-and-credit trade with a fixed implicit cap work in practice?

Sources covered by the trading system are registered with the authority and assigned an account of credits. A generated credit certifies that a source has reduced its emissions by one unit compared to the allocated baseline since the starting year. A final year is determined when the total amount of credits in the area must be at least the same as the total reduction target. This amount translates to a reduction target per year.

The reduction target per year determines the minimum number of total credits called "the floor" that the sources are obliged to achieve a certain year compared to the starting year emission level. The floor starts at the initial emissions level and continues with an annual increase in the floor until the final year when the total target reduction is achieved.

The individual obligations derived from the annual floor increase can be distributed to polluters as a reduction from previous year or in proportion to total emissions in the area.

On a specific record date each year, each source must submit to his account at the authority the number of credits required to show that he has fulfilled his obligation quota during the previous year.

There are two ways for a source to obtain credits:

- To generate credits by reducing emissions below its baseline by a certain number. Credits generated are deposited in the source account at the annual reporting and can be sold to another source or a broker at the market price.
- To buy a credit no later than the annual record date. Credits can be transferred directly between sources via the authority or brokers in the credits market.

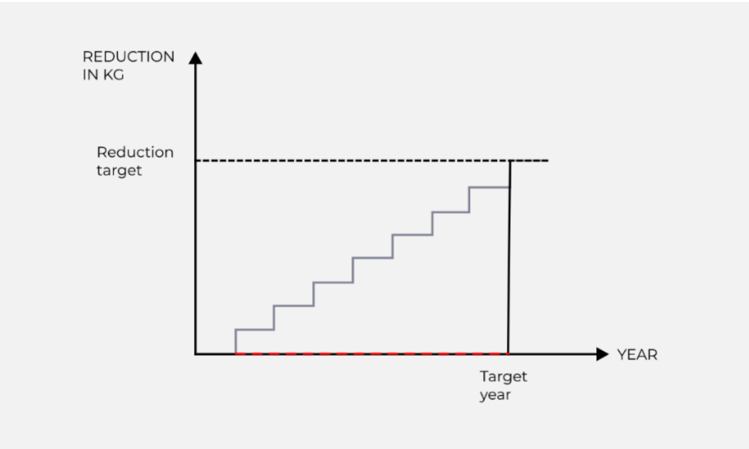


Figure 5.3 The baseline for reductions of a source in a baseline-and-credit with a fixed implicit cap equal to the sum of the individual baselines.

While a baseline-and-credit system with a fixed implicit cap, in principle can use permits as trading units, credits have the appealing feature that they are “duties to reduce” rather than “rights to emit”. Sources who have a mission to promote themselves as pro-environmental, for instance wastewater treatment plants and farming activities, may prefer to trade in credits showing that they have fulfilled their “duties to reduce” rather than trade in permits and “rights to pollute”. Technically, trade is the same with permits and credits, but it may be a semantically essential issue for acceptance among some pro-environmental sectors. An example of a baseline-and-credit system with a fixed implicit cap was used in the proposed CEASAR trading system for nitrogen emissions from Swedish wastewater treatment plants to achieve a reduction target (Swedish EPA, 2012).

6 CONSIDERATIONS WHEN DESIGNING A NUTRIENT TRADING SYSTEM

This chapter focuses on important considerations for designing a nutrient trading system, such as including offset projects, potential for leakage, pollution swapping, how to address air pollution, impacts on low-income countries and retention of nutrients in river basins. These considerations are relevant for all trading system, but nutrient retention and local water quality are particularly relevant for nutrient trading systems.

6.1 INCLUDING OFFSET PROJECTS IN THE SYSTEM

The aim with a trading system is to reduce emissions from capped sources but the program could also allow the use of offset projects in other sectors (such as mussel production or algae farming) to reduce pollution and comply with the requirements. Allowing offset credits is a way to allow parties in the “uncapped economy” to help meet emissions reduction goals while also reducing the costs of phosphorus and nitrogen abatement. The theory behind using offsets as a cost-containment mechanism is that entities in the uncapped economy would otherwise not have incentives to reduce emissions, which means this relatively low-cost abatement option is lost.

A number of standards must be met in order for pollutant reductions from offset projects to be counted in a trading system. The standards must ensure that the projects result in real and permanent reductions in nutrients. The strictness of the standards would affect the cost of the offset projects and thus the quantity and price of offset credits available.

6.2 POTENTIAL FOR LEAKAGE

Any form of policy instrument aiming to reduce nutrients can unintentionally increase emissions outside the area. Such increases are referred to as emissions leakage. For example, under cap-and-trade, the new costs of reducing emissions and the new costs of covering any remaining emissions with compliance instruments, could put commercial entities at a competitive disadvantage relative to competitors in places without analogous costs. If a firm in the Baltic Sea region reduced its production due to these costs, competitors outside this region might increase their production to serve the Baltic Sea market, thus increasing the environmental problem in their outside region. Alternatively, a business located in the Baltic Sea region might relocate outside the region due to competitive pressures, again increasing emissions of nutrients in that outside region. In short, the Baltic sea would export its environmental problems. One way to reduce leakage risks is to allow for free allocation of permits, or to trade emissions reductions by trading in credits (or certificates), in certain sectors.

The potential of leakage is not a characteristic of a trading system per se, but rather the result of increased costs associated with any environmental regulation.

6.3 POLLUTION SWAPPING

Pollution swapping refers to trade-offs between interlinked pollutants. A measure intended to reduce the emissions of one pollutant may unintentionally increase the emission of another. Several examples of pollution swapping have been observed in nitrogen control. For example, following implementation of the Nitrates Directive – which prohibits manure spreading in winter – ammonia emissions increased in the spring. Collins et al. (2018) demonstrate a possible risk for swapping between land and air emissions, i.e. measures aimed at reducing land-based emissions can lead to an increase in gaseous emissions. Even if some measures can result in pollutant swapping, Sutton et al. (2011) suggest that further control of nitrogen to water is nonetheless justified economically.

Similar trade-offs exist in agricultural practises in part because, unlike with point sources, it is not practical to separate pollution abatement processes. That is, any change in input use, land use and/or production technology simultaneously affects the entire vector of pollutants. There are even trade-offs in nutrient fractions. Jarvie et al. (2017) show that large scale changes in cultivation practices to no-till and conservation tillage in Lake Erie region have resulted in the desired reduction in particulate (and thus total) phosphorus loading. However, the loading of dissolved phosphorus increased dramatically, which was an unintended consequence of soil conserving practices: soil phosphorus tends to stratify gradually, enriching the topmost layer and thereby elevating the dissolved phosphorus concentration of runoff waters.

The phenomenon is important in any form of environmental regulation, but in the case of Baltic Sea eutrophication management it implies that measures should aim at the loading of eutrophying substances so that eutrophication decreases. This seems trivial but it requires understanding of the joint responses of the marine environment to various loads of fractions of nitrogen and phosphorus, and the joint effects of measures on the loading of these fractions. The challenge and the possibility of a trading system is that the need to decide on a unit of trade makes this choice an explicit one. Trading rules must determine how these substances are weighted to calculate a unit of trade for the regulated sources.

6.4 POINT SOURCES AND NON-POINT SOURCES

A unique element for water pollution control is the distinction between point and non point sources, where the latter are difficult to trace. Point sources generally discharge into the water at a specific location through a pipe or outfall (sewage facilities or industries etc.) and its emission can be traced to the source. Non-point or diffuse sources on the other hand, such as runoff of fertilizers and pesticides from lawns and farms after rainstorms, are hard to monitor and control and vary with weather. Nutrient leakage from agriculture fields depends on several factors, including choice of crop, crop rotation, supply of fertilizers and manure, tilling and natural conditions such as soil, topography, temperature, rainfall and snowfall (Bång, et al., 2018). Non-point sources have received little legislative attention until recently. Because of the gains made in controlling point sources, non-point sources now compose over half of the waste load borne by the Baltic Region countries.

The efficiency of a nutrient trading system rests on the assumption that emissions, or reductions in emissions, can be precisely observed at little or no cost and can be controlled by the polluter. With diffuse pollution, these conditions are violated. The difficulty of observing the emissions makes defining the tradable units difficult, since it must be measured in some way. Second, the emissions cap cannot be strict, but rather must be set in stochastic terms. Most diffuse pollution in a given time is determined by the weather (in particular rainfall) but also other environmental conditions during the entire growing season. In summary, when emissions cannot be properly measured from non-point sources, these sources cannot trade emissions permits since this requires information about total emissions from each verified actor.

However, this monitoring problem can be solved by linking certain actions that are undertaken on a specific field/area with reductions in diffuse nutrient loading. Models can translate certain actions into reductions in pollution which can then be transmitted into credits (sometimes called certificates), which are verifications that a certain amount of reduction in emissions or load was implemented during the year. So called result-based payments to reduce eutrophication from agriculture have been studied by Bång et al. (2018), who suggest reduction calculations at the agricultural field. Data from previous modelling (PLC-6) are found to be accurate to evaluate the effects at the field level for catch crops, spring cultivation and buffer strips. The field-level impact on pollution from structural liming, ponds and wetlands can also be modelled, but need to rely on research-based functional relationships. In order to include these actions in a nutrient trading system (e.g., catch crops, spring cultivation, buffer strips, structural liming, ponds and wetlands), the regulator must define a set of actions or practices whose effects are evaluated according to predetermined rules and measured in term of reductions of kg of nutrients per Ha of implemented measure. Trade can then occur in reductions linked to credits, or certificates, rather than emissions linked to permits.

Several methods are used internationally for water quality trade, including the Dutch dairy manure phosphorus regulation. It relies on the Overseer model to calculate the emission estimates for the Lake Taupo trading program in New Zealand. Perhaps the most involved model is the Nutrient Tracking Tool (NTT) of the U.S. Department of Agriculture's Natural Resource Conservation Service (Saleh, et al., 2015), which combines agri-environmental models with models predicting effects of individual protection practices. The tool is used in the Ohio River trading program.

Choosing between simple or complex models involves trade-offs. A simple model reduces administrative costs and might facilitate trading activity. More complex models are appealing as they may be more accurate, or at least perceived to be more accurate, which may improve the acceptability of such models.

Importantly, the uncertainties and problems discussed here are features of diffuse pollution generally, and not of trading programs specifically. The difference is that trading programs make these problems more visible due to the need for a tradable unit. Therefore, the efficiency improvements of trading programs on diffuse sources should be evaluated against existing instruments, not against ideal command-and-control or other market-based mechanisms.

A key feature to address when deciding whether to include diffuse pollution in a trading programs is the extent to which model estimates of the loads are at least correlated with the actual loads. With complex interactions between nutrients and fractions of nutrients in agriculture, this is not a trivial request. The question of whether the efficiency gains of a trading system outweigh the administrative costs should be considered once a model is established that satisfies the conditions of being correlated with actual loads.

6.5 SHOULD AIR POLLUTION BE INCLUDED?

Air emissions account for 27 percent of the nitrogen loads but only a small share of the phosphorus loads to the Baltic Sea (HELCOM, 2018a). The main sources of nitrogen oxide emissions include transports, power plants, industry and agriculture. The main sources of air emissions of phosphorus are wind erosion of soils and vegetation emissions, ash from biomass burning, and to a lesser extent, industrial and mining emissions (Mahowald, et al., 2008) (Brahney, et al., 2015).

In theory, air borne emissions can be included in a nutrient trading system. However, air emissions ending up in the Baltic Sea originate to a large extent from different sources than the waterborne loads. This implies that trade with air emissions needs to cover other actors than those trading water borne nutrients. The first requirement for including air emissions is that we must be able to measure them; second, we must identify the individual sources of air emissions and their impact on the water body. Individual polluters also need to be able to connect their actions to the number of permits. For stationary sources dispersion and deposition will largely depend on weather. For non-stationary sources, such as ships and cars, the location of deposition changes.

In order to monitor air emissions of nitrogen, HELCOM (2015) applies an emission model called European Monitoring and Evaluation Programme. This model has been designed for monitoring long-range transmission of air pollutants in Europe among countries who are part of the Convention on Long-Range Transboundary Air Pollution. To estimate the contributions from individual sources to nitrogen deposition into the Baltic Sea, the model calculates wet and dry deposition, based on meteorology and land use. Source-receiving water matrices allocate deposition based on annual emissions from each source. The model is calibrated against monitored nitrogen deposition. Phosphorus deposition is not modelled due to a lack of emission data sets, which means the needed link between source and receiving water is missing.

In order to include air emissions in the nutrient trading system, the water quality borne pollution needs expansion. Nitrogen deposition is closer to inclusion in a trading system than phosphorus. However, such an expansion would add new sources and a larger area to a trading system, increasing its complexity. About 40 percent of the total nitrogen deposition to the Baltic Sea originates from emissions outside the HELCOM countries (HELCOM, 2015).

Another complication concerns nitrogen emissions from transport. Including transport in a trading system would be a challenge as the number of vehicles and vessels in the Baltic Sea region most likely exceeds 50 million. Ships larger than 12 meters are included in the Automatic Identification System (AIS), which could be used as the basis for measuring and linking emissions from vessels to nitrogen deposition in the Baltic Sea. Road traffic is much more challenging. A system similar to the AIS would be needed, but for road traffic. Ideally, the driver or vehicle operator receives information in advance about how the choice of route affects the number of permits. This would provide incentives to choose a route where the smallest number of permits is needed for any specific trip. Since providing such information to drivers necessitates estimates on the eutrophication potential for all water bodies, the costs of producing this information would most likely exceed the benefits. Requirements on permits could instead be based on standard values for the address of each registered vehicle. However, in many cases the use of vehicles deviates from the registration address, making such standard values too rough. Another option would be to assign permits to fuel suppliers depending on fuel mix and the region of the country to which they deliver their product. But this option is also problematic since emissions of nitrogen dioxide and particulate matter depends on engines rather than on fuel.

In short, it is possible to include air emissions in a nutrient trading system, but the empirical challenges are substantial which means creating such a system is practically infeasible.

6.6 RETENTION OF NUTRIENTS IN RIVER BASINS

Retention is the amount of nitrogen and phosphorus "lost" while water and pollutants are carried from the source to the receiving water, which occurs through sedimentation, biological uptake, and degradation in the river basin (and, for nitrogen, through denitrification to nitrogen gas that reaches the atmosphere). The discharge that remains in the receiving water is called net load or load.

When targets are formulated for load reductions to coastal waters (as in the case of the Baltic Sea Action Plan, the Environmental Objective under the Marine Strategy Framework Directive and the Environmental Objective for coastal waters and under the Water Framework Directive), measures at inland sources with high retention become less effective. A high retention value between the source and receiving water means that large emission reductions are required at the source to achieve a small change at the receiving water, in this case coastal waters. Figure 6.1 shows the exponential relationship between the amount of the substance that must be reduced at the source in order to achieve a tonne reduction in load to coastal water.

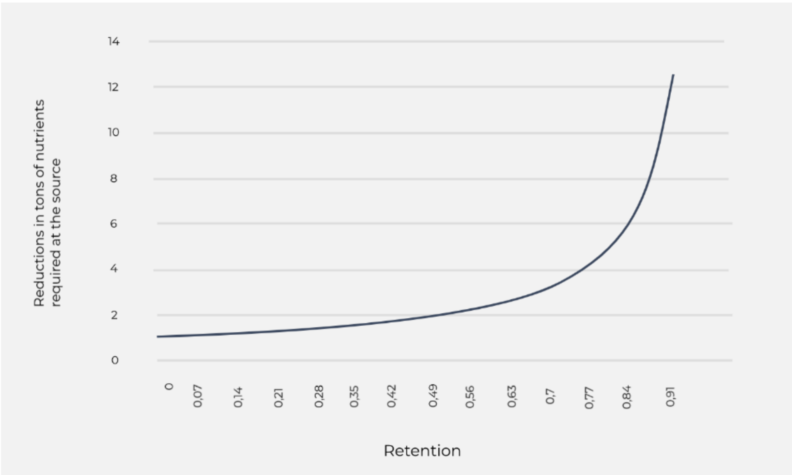


Figure 6.1 The graph depicts how much pollution at the emissions source must be reduced to obtain 1 ton of reduction at the receiving water. The horizontal axis denotes the retention. With zero retention, one ton of abatement also results in one ton of reduction at the emissions source. The larger the retention, the higher the abatement required to obtain 1 tonne reduction at the receiving water.

As seen in Figure 6.1, a source with e.g. 90 percent retention to the receiving water must reduce its emissions about 10 times more than a source at the receiving water to achieve the same reduction at the receiving water. If a load reduction target for a receiving water (e.g., coastal waters) is to be reached early and effectively, one must consider retention. In practice, this means that measures at inland sources with high retention will be cost-ineffective in terms of load reduction at the coast, compared to measures undertaken by sources that are closer to the coast.

Retention will affect the optimal design of trading system. For instance, for an inland source with 80 percent retention to achieve a reduction on the coast of 1 ton, the emissions at the source must be reduced by 5 tons. If a source on the coast then wants to buy an emission permit from this inland source, they must buy 5 permits (and pay 5 times more than a neighbour inland source) compared to buying one emission permit from a coastal source. On the other hand, if the inland source wants to buy an emission permit from a coastal source, they would only need to buy one-fifth of an emission permit from the latter. Thus, the retention-adjusted "exchange rates" for emission permits vary depending on the retention of each source.

In theory this could lead to high transaction costs, but an electronic trading system can automatically calculate retention-adjusting "exchanges rates" so that each actor observes the price in their "own currency" and/or the number of available permits on the market expressed in the retention-adjusted number of permits for that actor.

7 GEOGRAPHICAL TARGETS IN A NUTRIENT TRADING SYSTEM

An important boundary condition for a nutrient trading system in the Baltic Sea region is the need for geographically differentiated targets and measures established within existing international collaborations and legislation, such as the Water Framework Directive, the Marine Strategy Framework Directive and Baltic Sea Action Plan. This chapter discusses how to design a trading system to ensure such targets can be met.

7.1 GEOGRAPHICAL TARGETS

For political acceptance of a trading system it is important that a trading system considers established international treaties and the national implementation of EU Directives. The Water Framework Directive requires each member state to set out quality elements for the classification of ecological status in its inland and coastal waters. The Marine Strategy Framework Directive requires member states to set out basin-specific environmental targets for coastal and offshore waters based on good environmental status. The Marine Strategy Framework Directive covers both coastal waters and offshore waters of each member state's economic zone. Finally, the Baltic Sea Action Plan provides national reduction targets per basin to share the burden of nutrient reductions.

A summary of the targets is illustrated in the Table 7.1. Note that in addition to these, there are various national, regional and local rules that affect water protection policies. Table 7.1 captures the most central targets common to littoral countries (except Russia) for designing a trading program in the Baltic Sea.

Table 7.1. Overview of targets and geographical differentiations in the Baltic Sea.

Policy	Geographical Area	Substance	Geographical Differentiation
The HELCOM Baltic Sea Action Plan (BSAP)	BSAP basins, the North Sea (including Kattegat), the North Baltic (parts of the Baltic Proper) and the Southern Baltic (parts of the Baltic Proper and the Sound).	Nitrogen and Phosphorus	Target differentiation between sea basins and countries' burden sharing
Marine Strategy Framework Directive	Coastal water and offshore water (The North Sea, the Baltic Sea)	Depends on national implementation	Target differentiation within and between nationally determined coastal waters and basins in each member state's economic zone in the Baltic Sea
Water Framework Directive	Coastal Water in the North Sea and the Baltic Sea	Depends on national implementation	Target differentiation between coastal waters and major catchment areas
Water Framework Directive	Inland waters	Depends on national implementation	Target differentiation between water bodies within catchment areas

It is notable that all targets except the Baltic Sea Action Plan in Table 7.1 are established by each member state based on the Water Framework Directive and Marine Strategy Framework Directive. There are differences in how individual countries have implemented the directives in their legislation. Sweden, for instance, establishes the Marine Strategy Framework Directive environmental targets as legally binding in the same way as its implementation of the Water Framework Directive. Offshore waters in the Swedish economic zone of the Baltic Sea are furthermore divided into nine national basins, each having their own local environmental objectives to be achieved. Figure 7.1 shows the six basins of offshore waters in the Southern part of Sweden. The coastal waters are shown on the map between the shoreline and the line closest to the coast. In coastal waters the Water Framework Directive and Marine Strategy Framework Directive overlap. However, the environmental objective of the Marine Strategy Framework Directive only covers those of coastal water quality that are not already covered by the Water Framework Directive.

The monitoring for the fulfilment of the standards are measured monthly by permanent measurement stations. These data would be key for establishing baselines in a nutrient trading system that ensure fulfilment of the environmental objectives.

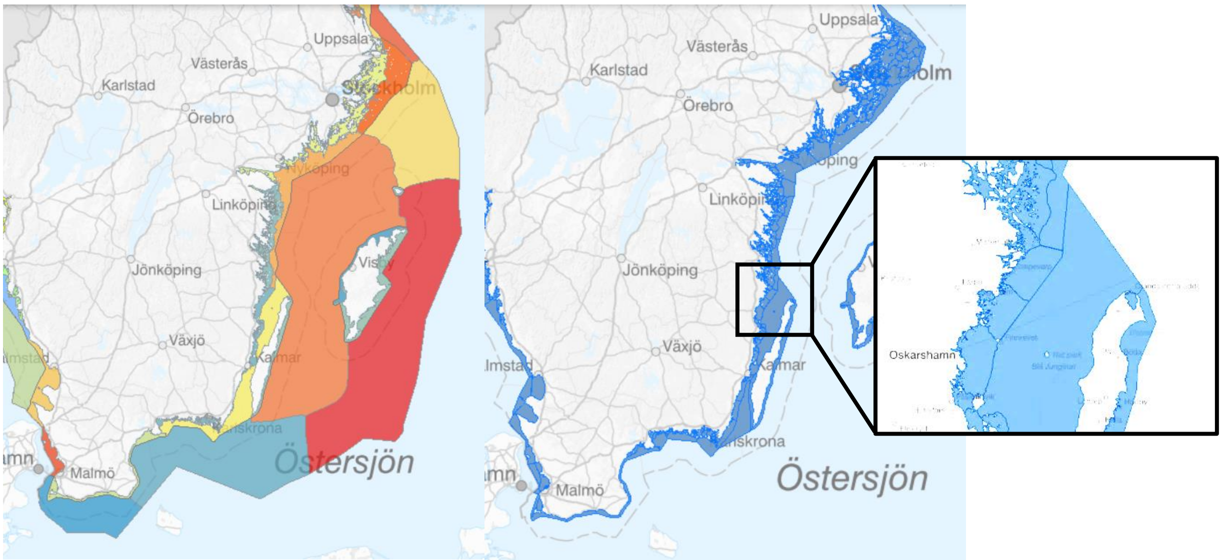


Figure 7.1. To the left: division of coastal and offshore water bodies under the Marine Strategy Framework Directive, each with its own targets for indicators. To the right: division of coastal water bodies under the Water Framework Directive, each with its own targets for indicators. (VISS, 2021b).

7.2 HOW A TRADING SYSTEM CAN REGULATE NUTRIENT LOADS TO FULFIL ENVIRONMENTAL OBJECTIVES

Environmental objectives in the Water Framework Directive and environmental targets in Marine Strategy Framework Directive are measured by several indicators, all of which must reach predetermined target levels to fulfil environmental objectives of a water body or a coastal water or environmental targets of a basin. In the Swedish implementation of both the Water Framework Directive and the Marine Strategy Framework Directive, concentration rates of nitrogen and phosphorus are indicators for the target values to be achieved in order to fulfil environmental objectives.

A nutrient trading system regulates emissions flow at the sources, and therefore indirectly regulates the inflow loads to waterbodies, coastal waters and basins. Thus, when implementing a nutrient trading system, the regulator needs to specify limits for the inflow load to each water body, coastal water and basin that are expected to achieve the target concentration rates of nitrogen and phosphorus for the indicators; this, in turn, contributes to, among other indicators, fulfilment of the environmental objective and environmental targets.

The sections below discuss how each of these geographical targets for inland waters, coastal waters and offshore waters affect the design of a nutrient trading system.

7.3 TRADING UNDER ENVIRONMENTAL OBJECTIVES IN RIVER BASINS

The Water Framework Directive requires each member state to set out environmental objectives in its inland- and coastal waters. For a trading system to achieve (and not violate) the objectives for inland waters, it needs a geographical differentiation between different environmental objectives for water bodies within each river basin. A differentiation is also needed between different river basins and coastal waters along the coast. However, as this differentiation overlaps with the Marine Strategy Framework Directive, this will be discussed in the next section. This section only focuses on environmental objectives in inland waters.

Figure 7.2 illustrates the boundary conditions of a nutrient trading system that should achieve (and not violate) the environmental objectives in two water bodies of a simple river basin with five sources. Sources 1 and 2 are located upstream and sources 3-5 are located downstream. There are no other emission sources in the area.

For simplicity, we assume there are only two water bodies (excluding the rivers): Upper Lake and Coastal Water. More water bodies between the sources complicate the picture but does not change the general principles. Each water body has environmental objectives that leads to an aggregate emissions limit for the upstream sources that affect the water body. The Upper Lake is affected by sources 1, 2 and 3. An aggregate target can be deduced from the environmental quality standard for the Upper Lake to fulfil the environmental standard that falls jointly on sources 1, 2 and 3.

The Coastal Water is affected by all five sources in the river basin and by sources polluting directly to the Coastal Water. The aggregate target for the Coastal Water assumes that the reduction to Upper Lake target is fulfilled. In other words, if the environmental quality standard for the Upper Lake is not achieved, there is a risk that the target for the Coastal Water will not be achieved either.

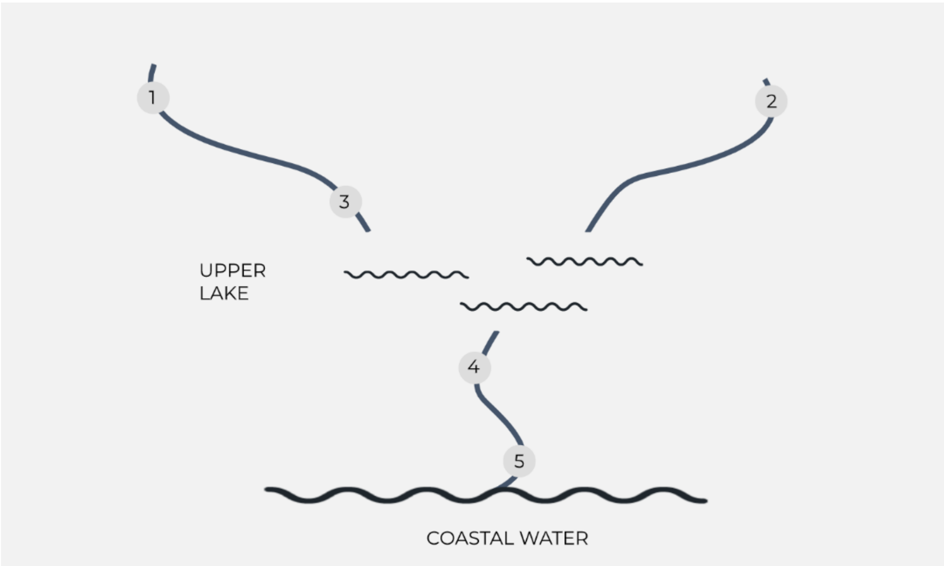


Figure 7.2. Illustrative example of a catchment area with five sources. The water flows through rivers, a lake and discharges into the coastal water.

In a river basin without branches as in Figure 7.2, retention-adjusted trade is always possible (see Section 6.6, i.e., a downstream source buys a permit (or credit) from an upstream source). When a downstream source exceeds its quota, the excess can be compensated by a retention-adjusted reduction by an upstream source. For instance, source 3 could always buy permits from 1 or 2, and source 5 could always buy permits from sources 1 through 4. However, if all sources have the same abatement costs, the lower retention between sources 4 and 5 compared to the retention between e.g., sources 5 and 1, implies that it is less costly for source 5 to buy permits from source 4, than from source 1.

Whether upstream trade is possible or not is an empirical question depending on the specific situation and the environmental quality standard at points between the two sources. Upstream trade is possible provided that the excess by the upstream source does not violate an environmental quality standard located between the two trading sources or located in another parallel water body located in a branch between the two sources. For instance, source 1 could buy permits from source 4, as long as the increase (smaller reduction) in retention-adjusted emissions by source 1 does not imply that the environmental quality standard for the Upper Lake is violated. If it is violated, then the number of traded permits would need to be partly or fully restricted to make sure that the environmental quality standard is fulfilled.

7.4 TRADING UNDER NON-DETERIORATION CONDITIONS

The environmental objectives in Article 4 of the Water Framework Directive enact obligations to prevent deterioration of the status of surface bodies and to protect, enhance and restore all water bodies to achieve good status (see also Chapter 22). The implication is "irreversibly", i.e., once high status has been achieved in a water body, a deterioration back to good status is not allowed. This would restrict trade in the same way as discussed in Section 7.3, with the only difference that the limit on trade might be more stringent than only fulfilling the environmental quality standard level.

The six trade possibilities under a non-deterioration condition are summarized in Table 7.2. A non-deterioration condition only prevents trade that increases emissions upstream. All other trade possibilities also work under a non-deterioration condition. For instance, in Figure 7.2, source 3 can increase its emissions if it engages in retention-adjusted trade with sources 1 and 2. It can also engage in retention-adjusted *trade with reductions* in trade possibilities in the cases IV – VI with any of the sources 1 through 5 in the river basin upstream or downstream. The only prevented trade is upstream trade (case III), where upstream actors buy permits from downstream actors. Hence, in our example, that means that source 3 cannot buy from sources 4 and 5.

Table 7.2. Comparison of trades without and with non-deterioration condition

Case	Trade possibilities	Trade implication	Possible without non-deterioration condition	Possible with non-deterioration condition
I	Downstream actors buy permits from upstream actors	Increasing emissions downstream compensated by decreasing emissions upstream	Yes	Yes
II	Trade in the same water body	No change in emissions in the same water body	Yes	Yes
III	Upstream actors buy permits from downstream actors	Increasing emissions upstream compensated by decreasing emissions downstream	Yes	No
IV	Downstream actors buy credits to slow down their reductions compared to baseline	Decreasing reductions downstream compensated by increasing reductions upstream	Yes	Yes
V	Trade in the same water body in reductions	No change in reductions in the same water body	Yes	Yes
VI	Upstream actors buy credits to slow down their reductions compared to baseline	Decreasing reductions upstream compensated by increasing emissions downstream	Yes	Yes

Trade in reductions (cases IV-VI) offer important opportunities for flexibility in investments under annual tightening of caps or baselines. Supply of reductions is created because some sources reach targets faster than others and because sources are often in different stages in their investment cycles. Most likely the possibility to follow the least cost investment cycles would also be the source of demand for reductions. This underlines the importance of generating a market structure that results in a thick market.

Trade in reduction works as follows in the example in Figure 7.2: Suppose that source 3 must reduce emissions by another 2 tons until next year in order to stay on its baseline. Source 3 can then buy credits from source 4 to fulfil its reduction target for next year while source 3 stays at the current emissions level for another year. Thus, non-deterioration condition is fulfilled. Trade in reductions is a way for a source to "buy time" while developing a plan for implementing measures or timing measures with other investment activities. The mandatory annual purchase of credits creates an incentive for the source to speed up this process compared to a scenario with no trading system. In summary, under a non-deterioration condition, all six trade possibilities in Table 7.2 are possible, except case III (upstream actors buying permits).

7.5 DESIGN FEATURES FOR TRADING SYSTEMS IN INLAND WATER

There are two major design strategies for trading systems to make sure that targets such as environmental objectives and non-deterioration are achieved with the trading system. The first strategy is to introduce ambient permit systems with a local cap specific to each water body, or group of water bodies (Montgomery, 1972). The second strategy is to use emissions permits with trade-ratios (Krupnick, et al., 1983) (Hung & Shaw, 2005). A hybrid version of these two strategies (trading-ratio system) is also discussed below.

7.5.1 Ambient Trading Systems

With an ambient permit system, a cap for the inflow of load of a nutrient to each water body is set in order to achieve the target of the indicators needed for fulfilling the environmental objective for that particular water body – rather than a cap for all emissions. The regulator establishes the number of "load permits" to be issued for each water body. A water quality model estimates transfer coefficients that indicate how a unit of emissions at the source (kg/year) is transmitted to inflow loads (kg/year) to each water body. The transfer coefficients are determined by the retention and the transport taking place between the emissions source and the water body.

The number of load permits issued for a water body is set to fulfil the target nutrient indicators of the environmental objective in the water body or environmental target levels in the basins. Since each source affects several water bodies, coastal water and basins, the regulator requires each source to hold a portfolio of load permits from all the water bodies, coastal water and basins that are affected by its emissions.

An ambient trading system deals with all trade regardless of the shape of the river basin, while also fulfilling the non-deterioration condition (see Chapter 22). In the example in Figure 7.2, all potential trade between sources 1 through 5 is allowed as long as no environmental quality standard, or the non-deterioration condition, is violated. The ambient trading system manages this by letting each source acquire a "portfolio" of permits (or credits) depending on how the effects of the discharge spread between water bodies of a river basin. The non-deterioration condition is explicitly handled by the cap on the inflow of load to each water body.

With an ambient trading system in the example in Figure 7.2, the Upper Lake and the Coastal Water would have its own caps and the corresponding number of permits, respectively. Sources 1, 2 and 3 would need to buy a portfolio of permits in both the Upper Lake and the Coastal Water (based on transfer coefficients for each source', determined by how its emissions affect the inflow load to the Upper Lake and the Coastal Water, respectively). Sources 4 and 5 would need to buy ambient permits in the Coastal Water. Since there is a cap in each water body, the environmental quality standard as well as the non-deterioration condition can be fulfilled.

7.5.2 Emission Permit Systems with trade-ratios

The second strategy is to use emissions permits (or credits) at the sources with trade-ratios that work in a similar way as retention-adjusted trade with restrictions (described at the end of Section 7.3). Trade-ratios are "exchange ratios" that specify the units of emission permits that a buyer must acquire to increase emissions by one unit. Krupnick et al. (1983) designed a system for compensatory measures (pollution offsets) which, in a simpler form, has been applied in several areas in the USA. In the pollution offset system, an activity must acquire compensation permits from other activities if the emissions would have led to an environmental quality standard being exceeded at any water body downstream.

The compensation permits have a trade-ratio that is similar to the "exchange rate" between the emissions units of two sources that want to trade. The trade-ratio affects the price that the buyer will pay and is calculated before each trade, such as to prevent any amount of trade that would result in the inflow of load to water body to exceed a prescribed level of inflow load. Referring to Figure 7.2, this system will, in principle, allow for any transaction between the sources 1 through 5 without causing an environmental quality standard to be violated. In practice the calculation of trade-ratios before each trade requires a computer simulation by the authority that assesses which trade-ratio must hold (see also (Atkinson & Tietenberg, 1982).

A modified and simplified version of a pollution offset system has been tested on several bilateral trade systems in areas of water quality trade in the United States over the past 20 years (Letson, 1992; Shortle & Horan, 2008). The results have shown significant transaction costs as each transaction must be preceded by negotiations between sources. Further, there is often too few transactions to allow for a market price and a computer simulation (needed to calculate the trade ratio, based on the desired number of permits to trade and the maximum allowed inflow of loads to all affected water bodies (Willamette Partnership, 2018).

Thus, emissions with varying trade-ratios is more complex than an ambient trading system. Suppose source 3 buys one emission permit from source 4 in Figure 7.2. For simplicity, assume that retention is 0. Source 4 would have to reduce its emissions by one unit, thus decreasing the emissions at the Coastal Waters affected by the emissions of source 4. Source 3 increases its emissions, thus increasing the emissions at the Upper Lake. In general, the set of water bodies affected by the emissions of a source does not equal the set of water bodies affected by the emissions of the other source (e.g., in Figure 7.2, the Upper Lake is affected by Source 3 but not by Source 4). Source 3 may emit an additional unit of emissions if this does not violate the environmental objective of the Upper Lake; in this case, the emission permit could be traded on a one-for-one basis (again, assuming the retention is zero). However, if the environmental quality standard in the Upper Lake is violated, then the emission permit must give source 3 the right to emit less than one unit of emissions. In other words, the nature of the emission permit (and the trade-ratio) will change from transaction to transaction, depending on the specific condition between the demands and maximum allowed inflow to each water body.

In practice this means that two specific sources that are interested in trade must first run a computer simulation following algorithms approved by the regulator. The simulation relies on the desired number of permits to trade, the location of the sources, and parameters from the water quality model to calculate the specific trade-ratio. Although emission permits with trade-ratios keep the number of water bodies of concern to a minimum (only binding water bodies), the sources will not know the trade-ratio until their trade has been simulated. While the two sources are considering whether they want to proceed with trade at the prescribed trade-ratio, it might happen that another trade took place by two other sources elsewhere in the river basin. The two sources that were considering a trade must then run a new simulation to get their new trade-ratio.

Running a computer simulation before each trade to calculate trade-ratios generates higher transaction costs compared to an ambient trading system, which does not require computer simulation. Uncertainties relating to the trade-ratios to be simulated and doubts over whether a trade faced by sources will be approved, will cause transaction costs to rise considerably. This is particularly difficult for large point sources because their investment decisions are long processes and they might need to buy permits from several sources, each with a unique trade ratio, to satisfy their demand. The transaction costs and the uncertainty regarding trade ratios may discourage firms from relying on permit markets in the first place.

McGartland and Oates (1985) proved formally that a competitive equilibrium for emission trading systems with trade-ratios exists and that it satisfies the first order conditions for the least-cost solution for achieving local environmental targets. However, their proof is based on the "breaking up" of emission permits to emit at a certain location. The permit to emit at a certain location, which is really a permit to pollute at a certain number of receiving waters equal to retention-adjusted emissions, is broken up into N different (ambient) permits, where each individual permit gives the owner the right to pollute receiving water with retention-adjusted units. But this results in $M \times N$ different (ambient) permit markets, which is even more cumbersome than the ambient trading system. The major drawback of emission trading systems with trade-ratios is the lack of precise definition of the permits to be traded. An individual permit, from trade to trade, may change from an emission permit into an ambient permit, and then back again to an emission permit. Transactions costs rise as a result of this ambiguity.

7.5.3 Trading-ratio system

Hung and Shaw (2005) illustrate a simplified system for upstream compensatory measures called *trading-ratio system*, which is designed for conditions that follow local water quality standards. In principle, the system can be seen as a simplified emission permit system. It has features making it a hybrid between an emissions trading system and an ambient trading system. Referring to the Figure 7.2, this system relies on the fact that retention-adjusted transactions are always possible (downstream actors buy permits from upstream actors without violating environmental objective). A downstream source can then always buy permits (credits) from an upstream source without complicated calculations (other than the retention-adjustment).

Hence, the trading-ratio system only allows downstream actors to buy permits upstream. This simplification brings forward the convenient property that the trading unit can be emissions at the sources, as in a simple cap-and-trade system. The authority assigns each source a target for the environmental quality standard that each source must meet (based on a calculation in a water quality model calculating from upstream to downstream).

The regulator does not need to consider the costs of measures, and allocation takes place only according to the conditions that good water status requires in each water body. Each activity in the system acquires compensatory rights from upstream activities. This means that a source can increase its emissions (i.e. in principle contribute to noncompliance of the environmental objective) if the increase can be compensated by a corresponding reduction in emissions at one or more sources upstream.

An advantage with the trading-ratio system is its simplicity: it can rely on fixed retention-adjusted emissions as trading units rather than concentration rates at receiving water. Provided that the environmental quality standard can be translated to a maximum inflow load per water body in the river basin, there is no need for a computer simulation between each transaction.

However, this comes at the cost of some major disadvantages: a trading-ratio system cannot deal with branches in the river basin, implying that source 1 and 2 in Figure 7.2 cannot trade with each other. Nor can it exploit any potential cost-efficiency from upstream actors buying permits from downstream actors, as this is prohibited in favour of simplicity. The latter implies that upstream sources get less opportunities to buy permits even when trading is possible without violating any environmental quality standard. The major consequence for a nutrient trading system in the Baltic Sea region is that a trading-ratio system cannot be extended between river basins. Hence, each river basin would need to operate its own isolated trading system. In summary, the trading-ratio system is a trade-off between administrative costs and the cost-efficiency potential from excluding upstream trade in the system, as well as trade between different river basins.

7.6 DESIGN FEATURES FOR TRADING SYSTEMS IN COASTAL WATERS AND OFFSHORE MARINE WATERS

The Marine Strategy Framework Directive requires member states to set out environmental targets for coastal waters and offshore waters per basin based on good environmental status. The Directive covers the sea area of the North Sea and the Baltic Sea, i.e. both coastal waters and offshore waters including each member state's economic zone.

This situation adds one further dimension, compared to trade within river basins, where water and emissions flow downstream. In coastal and offshore waters, emissions can spread in any direction between different coastal waters and different basins in offshore waters.

As long as water quality models or nutrient transport models can estimate transfer coefficients describing how nutrients, on average, are transported from river basins to coastal waters and basins, an ambient trading system or an emission permit system will do the same job as described in the previous section for inland waters. However, a trading-ratio system will not work since this system can only deal with unidirectional transports of nutrients. An emissions permit system with trade-ratios would impose considerable transaction costs for simulation trade-ratios, by adding the fact that nutrient transport can occur in any direction between coastal waters and basins.

Still, in an ambient trading system each source needs to acquire a "portfolio" of ambient permits (credits) in marine waters depending on how the effects of the discharge spreads in water bodies or between basins (Figure 7.3). Thus, the ambient trading system works according to the same principle as described for inland waters in Section 7.5.1. Specifically, each unit of emissions is compensated by a unique portfolio of ambient permits (credits).

Still, the ambient trading system is administratively more demanding than a single cap market (e.g., the EU ETS) because the regulator needs to inform the source about the portfolio of load permits that it needs to buy. A source must operate in several markets, one market for each receiving water that its emissions affect.

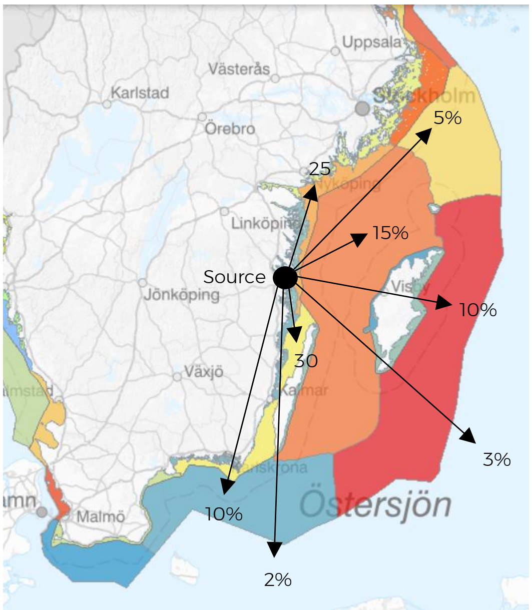


Figure 7.3. Illustrative example of a portfolio of area permits for a source at the Swedish east coast in an ambient trading system.

For each emitted ton, the source must buy a portfolio of area permits depending on how that tonne spreads and contributes to the concentration rates under the targets in each coastal water body under the Water Framework Directive and the Marine Strategy Framework Directive and seawater offshore basins under Marine Strategy Framework Directive.

However, there is no need for a computer simulation between each transaction in an ambient trading system (as is required for the emissions permit system, where trade-ratios need to be calculated before each trade takes place). This reduces this administrative burden significantly for both the regulator and the sources in an ambient trading system. Each actor only faces a single price of its emissions, which is simply the weighted average price of the specified portfolio.

Montgomery (1972) demonstrated that, under competitive conditions, the ambient trading system satisfies the condition that a market equilibrium coincides with the cost minimising allocation for attaining any predetermined targets to fulfil the environmental objective. In other words, if the regulator issues ambient permits (credits) for each of the water bodies, coastal waters and basins, competitive bidding will generate a market equilibrium that satisfies the conditions for cost minimisation. Interestingly, the equilibrium does not depend on the initial allocation of the ambient permits among the sources.

7.7 DATA AND MODELLING REQUIRED FOR A NUTRIENT TRADING SYSTEM

As with the emissions permit system with trade-ratios, the ambient trading system requires a design that accounts for averages of retention and nutrient transport between the sources and affected water bodies, coastal waters and offshore water basins. A water quality model (or hydrological model) is a simulation of a hydrological system that can predict the impacts of emissions of nutrients at different locations on the eutrophication levels in different water bodies. The Swedish Meteorological and Hydrological Institute (2010) has developed models that calculate and predict nutrient loads and concentrations in rivers and lakes and coastal waters. These models are operative and have already been used by the Swedish authorities. Today, the countries in the Baltic Sea region use different models and methods when reporting to HELCOM and EU within the Water Framework Directive (HELCOM, 2019). Under a future international nutrient trading system, countries would need to agree on a modelling approach for the Baltic Sea basins (or a coherent set of national models).

In addition to estimates of average retention and nutrient transport (between sources and receiving waters), a future nutrient trading system would require agreed-upon models and methods for connecting measures at non-point sources to nutrient load in receiving waters.

In summary, the key data needed for operating an ambient trading system are:

- Estimates of average retention and nutrient transport between each emission source and the receiving water bodies (or group of water bodies), coastal waters and offshore water basins. These estimates are the fixed transfer coefficients between each emissions source and receiving water.
- Maximum allowed nutrient loads per year for each water body (or group of water bodies), coastal waters and offshore water basins, based on the target indicators for nutrients needed to fulfil environmental objective.
- Reduction paths for the maximum allowed nutrient loads per year until the target year when the environmental objective should be fulfilled.
- Accredited flow measurements at the emissions points for point sources
- Accredited and verified measures for non-point sources with result-indicators e.g. in terms of reductions of kg of nutrients per Ha agricultural field of implemented measure.

While an emission permit system with trade-ratios requires the same information as above, it would also require computer simulations before each trade takes place to calculate the trade-ratio for the next potential transaction. The computer simulations are based on an economic model calculating the trade-ratios needed to correct for any possible excess demand that might occur between a desired transaction (input to simulation) and the maximum allowed nutrient loads to receiving water bodies.

7.8 COMPARISON OF TRADING SYSTEMS

This section compares the properties of the different types of trading systems. Table 7.3 compares design features of the two major classes of trading systems that address heterogeneous damage from emissions (i.e., cases when environmental quality is determined "locally"): ambient trading systems, emission trading systems with trade-ratios, and trading-ratio systems (a hybrid of the other two).

7.8.1 Trade Unit

All three systems take different approaches when it comes to the units of trade. In the emission permit system with trade-ratios as well as the trading-ratio system, trade units are emissions at the source, just as with a single-cap trading system (e.g., EU ETS). A trade-ratio between emissions at different locations is added to take into account the fact that emissions from different sources face different restrictions depending on locations. This trade-ratio is specific to each unique transaction and varies with the state of all trading activities in the system. For that reason, it needs to be computer-simulated before each trade can be approved.

The ambient trading system takes the opposite approach and instead creates ambient permits (credits) that are directly associated with receptor location (e.g. a water body or basin that has an environmental quality standard). Ambient permits (credits) are defined in terms of a maximum allowed contribution (or minimum allowed reduction) of the inflow load to each receptor. Since each source is affecting several receptors, each source needs to buy a portfolio of ambient permits (credits) from these receptors. Despite this, each source faces a single price for a unit of its own emissions, which is the weighted average of the prices of the permits (credits) in the portfolio.

7.8.2 Where can it be used?

Both the ambient trading system and emission trading system can be used in river basins, coastal waters and offshore waters, assuming there are estimated parameters for the average retention and nutrient transport between source and affected waters (which exist and are in use today by Swedish authorities).

The simplified trading-ratio system can only be used in upstream-downstream river basins as it makes use of the unidirectional flow of waters. For that reason, it cannot deal with branches in the river basin. Nor can it exploit any potential cost-efficiency from upstream actors buying permits from downstream actors. The major disadvantage is that it cannot be extended between river basins; thus each river basin would need to its own isolated trading system.

7.8.3 How does trade work?

In an ambient trading system, each source must buy and sell a portfolio of permits (or credits) in several water markets, one market for each receiving water that its emissions affect, where each market has its own price determined by demand and supply. The source might even have to buy in some markets while selling in other markets. This implies that two sources will not trade directly with each other. Instead, brokers provide the specified portfolios from which a source would buy and sell. Nonetheless, each source faces a single price, which is the weighted average of the permits (credits) of the receptors in its specified portfolio.

Emission permit systems use trade-ratios based on source-to-source relationships that will vary depending on the trades that other sources may engage in. The sources do not know the trading ratios until their trades are simulated. Every two sources willing to trade must first run a computer simulation based on output from a water quality model and demand to obtain their specific trade-ratio in a specific situation. If another pair of sources happen to get approved and finish a trade before them, the trade-ratio of the first two sources needs to be re-simulated before it can be approved again. Uncertainties relating to the trade-ratios and doubts over whether a trade faced by sources will be approved will result in considerable transaction costs compared to the ambient trading system.

Overall, an ambient trading system will therefore be simpler to operate and use than an emission permit system with trade-ratios. This is because the fixed transfer coefficients between source and receiving waters implies that no computer simulations are needed between transactions. Transactions can take place instantly, as in a single-cap trading system like the EU ETS, whereas an emission permit system with trade-ratios requires computer simulations before every transaction.

The trading-ratio system is a special case of an emission permit system. However, since it makes uses of the unidirectional flow of water in upstream-downstream trade in river basins, the trade-ratios between sources become fixed and independent of trade, just as the transfer coefficients is within the ambient trading system. Thus, no computer simulations are needed before each transaction.

7.8.4 How does it account for retention and diffusion between source and receiving waters?

All three systems use the same way of accounting for retention in river basins. In an ambient trading system, retention-adjustment between a source and its receiving waters is included as a component in the transfer coefficient for each receiving water. In the emission permit system, the retention value between sources is included as a component in the trading-ratios. In the trading-ratio system, the trade-ratios between sources are identical to the retention values since the trading sources are only located in upstream-downstream relationships.

7.8.5 How does it fulfil environmental objective and the non-deterioration condition?

The ambient trading system takes the simplest regulatory approach by letting the environmental authorities specify a cap (or baseline) for the inflow of nutrient loads to each receiving water that has an environmental quality standard (e.g., water body or a basin in offshore waters) and creates ambient permits (credits). In each trading period there is a physical limit to the maximum load allowed to each receiving water. The stringency of the caps (baselines) are increased every year until the final year when the targets are to be reached for each receiving water. The ambient trading system automatically fulfils the non-deterioration condition.

The emission permit system fulfils environmental quality standards and the non-deterioration condition in a more indirect way by using varying source-to-source trade-ratios in order to condition which sources can trade, when it is allowed, and under what trade-ratios they can trade. Simplified versions of emission permit systems with trade-ratios have been tested on several bilateral trade systems in areas of water quality trade in the United States over the past 20 years (Shortle & Horan, 2008). The results have shown significant transaction costs as each transaction must be preceded by simulation modelling before the regulator can approve the transaction (Willamette Partnership, 2018).

Environmental authorities might then be tempted to simplify trade in an emission permit system by using predetermined fixed trade-ratios. The risk in doing so, however, is that the inflow of loads to receiving waters – and therefore the fulfilment of environmental quality standards or the non-deterioration condition – can no longer be guaranteed. Therefore, the ambient trading system and the trading-ratio system take the simplest approach for fulfilling the environmental objective and the non-deterioration condition.

Table 7.3. Summary of properties of the major two classes of trading systems with heterogeneous damage from emissions.

	Emission permit system (or pollution offset systems)	Trading-ratio system	Ambient trading system
Trade unit	Emissions permits associated with source location		Ambient permits associated with receiving water location
Where can it be used?	River basins, coastal waters and the sea	Only upstream-downstream trade in river basins	River basins, coastal waters and the sea
How does trade work?	Buy or sell emissions permits using trade-ratios determined in simulations before each trade	Only buy emissions permits upstream using trade ratios that are fixed over time	Buy or sell a portfolio of ambient permits for each unit of emissions
How does it account for retention and diffusion between source and receiving waters?	Fixed trade ratios between sources		Fixed transfer coefficients between each source and receiving waters
How does it fulfil the environmental objective?	Variable trade-ratios depending on the relationship between load and environmental objective	Fixed trade ratios between sources	Caps per water body or basin for ambient permits
What initial allocation of permits are required for cost efficiency?	Proportional allocation to maximum load levels associated with the environmental objective		No specific requirement
Existence proved by	Krupnick at al. (1983)*, McGartland & Oates (1985), Atkinson & Tietenberg (1982)	Hung and Shaw (2005)	Montgomery (1972)

*Krupnick et al. (1983) do not provide a formal existence proof.

7.8.6 What initial allocation of permits are required for cost efficiency?

Montgomery (1972) has demonstrated that the ambient trading system satisfies the condition that a market equilibrium coincides with the cost-minimising solution for attaining any predetermined level of loads to receiving waters and does so for *any* initial allocation of permits (credits) among polluters. This requires however that the initial allocation of permits (credits) is binding in every area: i.e., there must be scarcity in the total amount of permits (credits) in all receiving waters when trade starts.

McGartland and Oates (1985) showed that an emission permit system with trade-ratios also can coincide with the cost-minimising solution while also achieving any predetermined level of environmental quality elements determined by the environmental objective. However, the initial distribution of permits must satisfy a proportional allocation to the maximum allowable load levels associated with the environmental objective. For any other initial allocation of permits, trade will not generate the cost-efficient solution. Thus, the ambient trading system has the advantage that the regulator can choose the initial allocation of permits (credits) without affecting cost-efficiency, just as in a single-cap trading system.

A caveat is that "extreme" initial allocations can result in monopoly and monopsony power in a water market in an ambient trading system (just as it can in a simple trading system such as the EU ETS if all permits (credits) in a country are allocated to a single actor/sector in a country). However, there is a stronger tendency for this to happen with an ambient permit due to the many geographically located ambient markets in the system. For instance, if a few actors are allocated large amounts of permits in one area, they may gain monopolistic power as sellers in this area (pushing up the price). Similarly, an initial allocation could result in monopsony power with only one buyer, or a few buyers, in one area (pushing down the market price). A solution is to ensure an even allocation of ambient permits (credits) across actors in a geographic area.

7.8.7 Transaction costs with heterogeneous damage

The magnitude of transaction costs is an important design consideration for trading systems addressing heterogenous damage. Several authors have anticipated high transaction costs with trading systems, especially those with many receiving waters.

With the emission trading system, computer simulated transaction-specific trade-ratios cause uncertainties and increase transaction costs. This is slightly less of a problem with ambient trading system trading because the relationships – and hence the trade-ratios – are independent of trades between other sources, and no computer simulations are needed. On the other hand, the number of receiving waters may be smaller in the emission permit system (only binding receiving waters included). The trading-ratio system reduces the administrative costs and trading uncertainty substantially, making it the system with the lowest transaction costs.

7.8.8 Thin markets

Trading systems that address heterogenous damage must ensure that targets are fulfilled and cost efficiency is achieved; this, in turn, requires that not all sources can be allowed to trade with each other. When individual regions have few sources and are distant from each other, it will naturally result in fewer trade opportunities. These regions tend to occur in the most upstream areas of river basins, specifically small river basins, and may result in markets with few participants and infrequent transactions. The consequence is that trades in so-called thin markets have high transaction costs because trades may be too infrequent to establish one market clearing price (emission permit system) or a number of market-clearing prices (ambient trading system). A thin market is less likely to produce the most cost-effective solution, although any trade will produce a more cost-effective allocation than no trade at all. In this case, authorities can introduce either guidance levels for permit prices or price floors.

The opposite (i.e., thick markets) tends to hold for receiving waters that are located downstream in river basins, in coastal waters and basins in offshore waters. Since these receiving waters tend to have a large number of sources, the traded volumes will be larger which will facilitate establishment of market prices (especially with ambient trading systems in which trade occurs in portfolios). However, even when there are many potential buyers and sellers, there may simply be too little change over time to free up permits or to increase demand for them. Thus, to create demand, it is essential that the caps are set sufficiently tight to ensure they bind from the beginning, while also increasing annually in stringency.

Whether the market turns out to be thick or thin is also a result of individual sources' perceptions of the future market. Sources tend to invest infrequently in abatement technology, which usually requires long planning and decision-making periods. This means that if sources do not expect to have potential buyers in the permit market, they are unwilling to overinvest to generate permits; alternatively, they may underinvest and rely on finding permit sellers. That is, designing a functioning market structure should consider the strategic considerations of the regulated firms.

Transaction costs and the thickness of the market can also be influenced by choosing the number of receiving waters. Transaction costs would be minimized by defining just a single receiving water, but of course this would weaken the environmental efficiency of the trading system and most likely violate the local environmental quality standard.

7.8.9 Saving permits for later use

In some cap-and-trade systems, permits can be saved from one period to another (banking), which can limit volatility in prices. If an unexpected shortage in permits causes prices to spike, parties that previously banked permits would have a strong incentive to sell, which would put downward pressure on prices.

Banking also potentially provides an incentive for covered entities to make early reductions in their emissions. Firms that believe that compliance instruments (permits) will become more valuable in the future will be more likely to invest in making nutrition reductions today, thereby freeing up compliance instruments to sell to others down the line. Banking and the use of banked permits provides important flexibility for actors, as they can adjust the speed with which they reduce their emissions. Banking can be regulated by limiting the number of permits that an entity can hold.

However, in nutrient trading systems bound by local targets, the possibilities to bank permits/credits are naturally limited. The permits banked in a previous period would eventually be utilized in a later period, potentially increasing the probability of breaching some regional environmental objective. On the other hand, with thin markets and lumpy investments, the possibility of banking could increase the level of trust (and reduce uncertainty) from regulated firms regarding the availability of permits on the market. However, borrowing would be out of the question, not only because of the environmental objective but also because of nonlinearities in the water ecosystem. An increase in nutrient loading today is not necessarily offset by a similar reduction tomorrow.

7.9 AT WHAT LEVEL SHOULD TRADE TAKE PLACE?

A major difference between a nutrient trading system and a trading system with a single cap, such as the EU ETS, is the consideration of local targets that adds to the administrative costs of the system. Even though transaction costs for individual traders can be reduced by electronic trading systems (by providing them with trade opportunities in their own price and units of emissions) the administrative costs grow as the number of local targets increases.

A way to reduce the administrative costs is to let regions, or countries, trade with each other instead of individual sources. A trading system for the Baltic Sea can be designed to include trading actors at different governance levels such as:

1. Countries using bilateral agreements
2. Regions such as the water districts maintained by local water authorities
3. River basins maintained by local authorities and/or local groups of discharge sources within the river basin
4. Individual discharge sources within or between sectors

In cases 1 through 3, trade takes place between countries or regions, which then represent the trading actors in the system (e.g., country, regional county, water district, local management of a river basin, etc). Each trading actor regulates emissions from its geographical area (e.g., through existing national and regional policy instruments), while it is obligated to buy a permit for each ton of emissions from its geographical area that reaches the Baltic Sea. In these cases, trade does not necessarily need to take place within river basins; instead it would only occur for emissions reaching coastal waters and offshore waters. Thus, in cases 1 through 3, the regulation of individual sources (e.g., individual plants or farms) is maintained outside the trading system by other (possibly already existing) national or regional policy instruments or local agreements. Any (positive or negative) effects trading would have on, say, marginal abatement costs and/or abatement targets in the Baltic Sea area, would thus be transmitted to pollution abatement via alternative instruments and agreements, rather than via a trading system.

A disadvantage of having countries and regions as traders is the potential loss in cost efficiency provided by trade among individual sources, as in case 4 above. Thus, this loss in cost efficiency needs to be balanced with the gain in administrative costs.

8 INTERNATIONAL OVERVIEW

This chapter details the insights generated from an international review of nutrient trading systems.[4] These systems have been experimented with for over forty years, becoming more prevalent during and since the 1980's. While few systems have been established since 1980, the last four decades nonetheless provide insights and lessons for the Baltic Sea, as it allows for consideration of a system's lifecycle, policy and mechanism design, establishment, operation and impact, and evaluation of current status.

We begin by providing a detailed review and synthesis of five trading programs and then provide a more general review of 25 additional programs. The focus is on evaluating the most important features of the programs and drawing conclusions about success factors.

8.1 EXAMPLES OF TRADING PROGRAMS

We select five programs based on the fact that they exemplify relevant features for a future nutrient trading program in the Baltic Sea: (1) the nitrogen trading system in Lake Taupo, New Zealand, is the world's only non-voluntary cap-and-trade program for diffuse sources; (2) the United States' Sulphur Dioxide System is the best example of a program that has completed the life cycle from an effective regulatory tool into a redundant system; (3) the Lake Dillon Phosphorus Trading Program in Colorado is an example of the most typical nutrient trading programs, but has seen very few trades; (4) the Long Island Sound Nitrogen Trading Program in Connecticut focuses on point sources and has been very effective and efficient thanks to careful economic considerations and innovative design of trading rules; and (5) the collection of trading programs in the Chesapeake Bay states is important because of its similarities with the Baltic Sea.

[4] The following systems have been reviewed: 1. Passaic Valley Sewerage Commissioners Pre-treatment Trading Project (PVSC), New Jersey, 2. Australian Water Market, Murray Darling Basin, 3. Bear River, Idaho/Utah/Wyoming, 4. no Creek Basin Phosphorus Trading, 5. Chesapeake Bay (Pennsylvania, Maryland, Virginia, and the District of Columbia)", 6. Clean Water Services Trading – Oregon, 7. Clear Creek (Colorado), 8. EU Emissions Trading System, 9. Fox River program (Wisconsin), 10. Great Miami River Trading Program (Ohio), 11. Kalamazoo program (Michigan), 12. Kenya - Naivasha-Malewa Project, 13. Lake Dillon (Colorado), 14. Lake Fuxian, China, 15. Long Island Sound Connecticut, New York, 16. Neuse River (North Carolina), 17. Ohio River Basin Trading, 18. Piasa Creek Watershed Project (Illinois) (Sediment Trading), 19. Pinot Carlota Copper Trading programme, 20. Rahr Malting Company (Minnesota), 21. Rotorua Policy Prototype (NZ), 22. San Francisco Bay Mercury Offset Program (California), 23. Snake River and lower Boise River (Idaho), 24. Tampa Bay National Estuary Program (TBNEP), Florida, 25. Tar-Pamlico program (North Carolina), 26. Taupo (NZ), 27. The Grassland Area Farmers Trading Program (CA), 28. The Regional Greenhouse Gas Initiative (RGGI) (US), 29. US Sulphur Dioxide Cap and Trade Programme, 30. Water Quality Trading in the South Nation River Watershed, Ontario, Canada. South nation conservation SNC.

8.1.1 Taupo, New Zealand

Lake Taupo, New Zealand's largest lake, is located in the centre of the North Island and attracts international and domestic tourism. A significant decline in water quality was identified in the late 1990s and was in focus in 2001 when the lake had its first ever recorded algae bloom. Following extensive health warnings and concern over water quality decline, a research effort concluded that it was caused largely by nitrogen releases from the surrounding area, where the majority were manageable nitrogen emissions from pastural land (Table 8.1).

Table 8.1 Sources of Nitrogen Losses in The Lake Taupo Surface Water Catchment (Lake Taupo Protection Trust, 2019)

Source			Load of N (tonnes/year)	Effective Yield (kg N/ha/year)	% Total	% of sources category
Unmanageable load (natural)	Atmospheric deposition		272	4.4	20%	34%
	Undeveloped land		311	2	23%	39%
	Pine on unimproved land		122	2	9%	15%
	Tongariro Power Development		87		6%	11%
	Pine on unimproved pasture		12	2.7	1%	1%
	Subtotal		804		59%	100%
Manageable load (human-induced)	Pastural	Non-dairy pasture	442	8.6	33%	79%
		Dairy pasture	68	29	5%	12%
	Urban runoff		16	8	1%	3%
	Wastewater		17		1%	3%
	Pine on improved pasture[6]		6	4.2 - 6.0 [1]	0.40%	1%
	Nitrogen-fixing scrub		7	12	0.50%	1%
	Subtotal		556		41%	100%
Total			1360		100%	

After extensive discussions with the community, consultation with landowners and Environment Court hearings, a target was set to reduce the nitrogen emissions by 20 percent from current levels. This reduction was to be achieved primarily through a 2012 capping of the nitrogen level, assigning nitrogen discharge permits and creating a nitrogen trading market managed by The Lake Taupo Protection Trust. Each farm was allocated nitrogen discharge permits to be used under a nitrogen cap for the region surrounding the lake.

All farming activities had to comply with the new regulations. Since participants and regulators could not directly measure or monitor the nitrogen discharges, a cap on the nitrogen inputs was assigned to each agricultural entity. Grandfathering of rights was used to individually calculate the cap for each entity. The cost for monitoring is part of the entities' resource consent. Before the regulations were put in place each farm was offered a buyout by the Lake Taupo Protection Trust at market value, which allowed business that were not going to be profitably under the new system to opt out. Some of these farms were converted into forest lands to help reduce nitrogen emissions.

The nutrient inputs and potential leaching were tracked through the use of the OVERSEER® model, a software that was essential for tracking each farm and ensuing they were complying with the new regulations.

The nitrogen permit trading is allowed around the Taupō catchment region. Landowners were able to buy, sell and lease nitrogen discharge permits. The majority of trades have been through the Lake Taupo Protection Trust. A trading price of NZD 300/kg for nitrogen was set in 2012 by the Trust when the system was established. Due to the high cost with recording data management, testing and transaction costs, only large farmer to farmer trades were viable. Certain farms saw the new regulations as an opportunity to promote themselves as a greener alterative and test whether consumers would be willing to pay a premium price. This led to the development of a new Taupo beef brand.

In terms of nitrogen load reductions, the trading system achieved its targets (see Figure 8.1. below) without any recorded non-compliance from dischargers. The trading market outside the Protection Funds is also working as shown by trades between farms. Trading has also promoted less nitrogen-intensive farming activities such as olives orchards and sheep dairy farms.

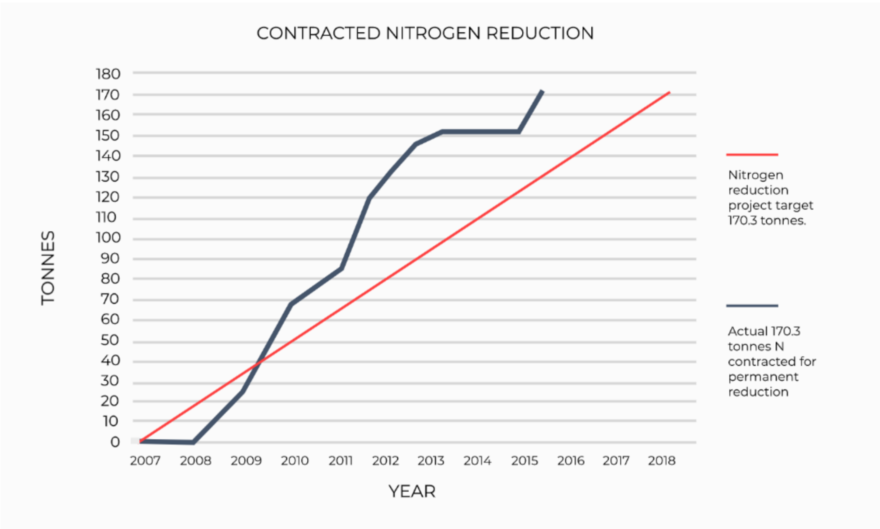


Figure 8.1. Contracted Nitrogen Reduction (Lake Taupo Protection Trust, 2019)

However, improvements in lake water quality have not been reached, perhaps because the nitrogen reductions goals were too low or, in terms of the vocabulary of the trading system, the nitrogen cap was too high. As a regulatory tool, nutrient trading is able to respond to these types of challenges by simply adjusting/tightening the existing program structure through e.g., buying permits from the market. This would increase the permit price and incentivize further abatement within the existing farming systems, or it would incentivize further land use changes into less nitrogen-intensive farming systems.

8.1.2 US Sulphur Trading Program

The US sulphur dioxide (SO_2) system has evolved over time which means some aspects are different from how a future Baltic Sea system might look. However, the lessons of how to allow markets to change over time is particularly relevant.

In response to SO_2 emissions from power plants causing acid rain in the early 1990's, the US established an emission trading system called the Acid Rain Programme, which was set out over two phases. Phase 1 (1995-1999) covered the 263 electricity-generating sources responsible for the largest volume of SO_2, subjecting them to an interim emissions cap. Phase

2 from 2000 onwards expanded coverage to all fossil fuel-generating units of more than 25 MW, with a cap of nine million tonnes (Chan, et al., 2012).

Each source was required to implement an Environmental Protection Agency (EPA) certified monitoring system to continuously measure the SO_2. The monitoring system reports hourly emissions, with monitoring and verification of the data by the agency. These transparent data systems alongside clear penalties for non-compliance have contributed to an excellent compliance record (Ellerman, 2004).

The trading system allowed for banking, with no quantity restrictions. Banking was seen as a successful indicator as participants had a vested interest in maintaining the value of banked permits and allowed participants a smooth transition into Phase II's lower cap (Chan, et al., 2012). Participation in the market is open and not restrictive, allowing non-polluters to join the market under a "general account".

Free allocation of permits generated buy-in from the industry. This was considered a critical pathway for gaining support from actors that were expected to "lose" from the policy. Permits were based on the average annual heat input during the reference period (1985-1987) multiplied by the relevant emission rate. 2.7 percent of the permits were distributed through an auction to encourage trading and allow for new market entrants. Bonus permits were further awarded for innovations promoting lower emission alternatives from both the supply and demand side (Chan, et al., 2012).

Industry buy-in was facilitated through establishment of the the cap and allocation of permits via legislation. However, it restricted EPA's ability to adjust the cap, which was initially created at an acceptable political level rather than at a scientific evidence-based level. Attempts to alter the programme and deliver greater emission reductions failed due to legislative blocks and the permit market.

The Clean Air Interstate Rule (CAIR) was introduced with the intention of reducing the cap, after a previous failure to reduce the cap through the Clear Skies Act. The CAIR required upwind states to surrender two additional permits for every tonne of SO_2, in protection of downwind states, effectively reducing the cap by two thirds (Chan, et al., 2012). This was later ruled against in the District Court of Appeals. Finally, the Cross-State Air Pollution RULE (CSAPR) was passed which only allowed trades within states and prevented the use of previously banked permits, which suddenly nullified a significant number of saved permits (Schmalensee & Stavins, 2015). This inevitably caused the permit price to collapse and fall near zero.

8.1.3 Lake Dillon, Colorado

Lake Dillon, located in the Rocky Mountains, is popular for tourists due to its pristine nature and surrounding recreational activities, while also supplying more than half of Denver's water. In the early 1980's after concerns of degrading water quality were raised and expected acceleration in local development, a phosphorus cap was established for the four (point) sources in the area, namely the region's four municipal wastewater treatment plants (Breetz, et al., 2004). The trading system changed two years later when it allowed trading with non-point sources, which was done in order to allow the original point source polluters to exceed their annual cap. The goal was to allow for development without risking water quality, while also initiating better control over non-point source pollution.

The Dillon Reservoir program sets a 2:1 trading ratio between point and non-point sources and a 1:1 trading ratio between non-point sources. The 2:1 ratio requires a 2 kg reduction of phosphorus discharge from non-point permitted sources for a 1 kg emission from a point source (Woodward, 2003).

While the system was adapted to allow these trading ratios, the system itself prohibited some key trading features. First, point sources were prohibited from trading future surplus emissions. Second, no provisions were made for non-point source permit banking. This discouraged point sources from decreasing their phosphorus output and discouraged them from participating in trading. Indeed, only one trade ever occurred within the system.

The market had no interested actors, in part because the point source polluters completed upgrades to their wastewater facilities in the early 1980's, reducing their loads well below the cap, eliminating any demand within the market (Woodward, 2003). In short, polluters chose to complete upgrades and opt into the innovation route, rather than trading with non-point source polluters. Interestingly, some estimated that the treatment plants could have cut their annual cost of reducing phosphorus in half if they had chosen to fund non-point source reductions to offset their waste load increases (via the market), instead of investing in the facility upgrades.

The proposed opportunities for point-non-point trade did not materialize in this case and, as a result, treatment plants found other ways to reduce phosphorus discharges without trading.

8.1.4 Long Island Sound, Connecticut

The Long Island Sound is a tidal estuary in one of America's most densely populated areas, located between the states of New York to the east and Connecticut to the northwest. To tackle the hypoxia of the Sound, and particularly to reach the TMDL for nitrogen and dissolved oxygen, Connecticut established a nitrogen trading market in 2002. The trading takes place between point sources.

An interesting feature of the program is that it uses trade ratios based on the location of the pollution source: the further away the source from the coastline, the higher the ratio.

By 2010, 79 municipal wastewater treatment plants participated in the trading system. In the same year, the Connecticut Department of Energy and Environmental Protection estimated that the program saved 300-400 million dollars, mostly due to economies of scale in investments.

A key feature contributing to the program's efficiency is the role of the regulator as a clearinghouse. It sets a price that will be paid for the extra abatement and the charge for emissions that exceed the limit, i.e. the permits. This addresses the thin markets problem (see Section 7.8.8) by guaranteeing that there will be a buyer for the additional abatement achieved by the point sources. This facilitates long-term investment plans by providing certainty on allowance prices and contributes to economies of scale. Furthermore, point sources are able to optimize the timing of investments. Figure 8.2 presents the nitrogen discharges and the prices set by the regulator each year (note the declining quota, which is designed to meet the TMDL requirements by 2013).

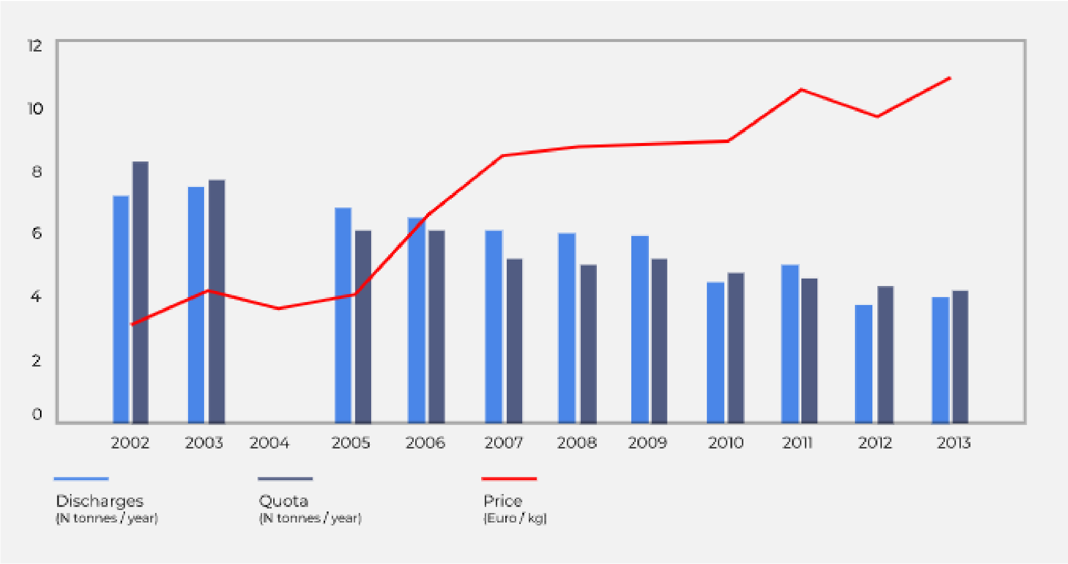


Figure 8.2. Nitrogen discharges, nitrogen quotas and prices set by the regulator (2002-2013) in the Long Island Sound trading system in the US. The price varies and is based on regulator's expectations on the marginal costs. Essentially, the program is a hybrid form of a pure trading and a traditional price instrument (a tax and subsidy scheme).

Figure 8.2 shows the efficiency of the Long Island Sound trading program, but also hints at a possible challenge: the program is not budget balanced from the perspective of the regulated entities, i.e., actors must be able to withstand temporary budget deficits and surpluses.

8.1.5 Chesapeake Bay: Maryland, Pennsylvania, Virginia, West Virginia

The Chesapeake Bay is the largest estuary in the United States, a 64,000 square mile watershed that encompasses parts of six different states: Delaware, Maryland, New York, Pennsylvania, Virginia and West Virginia and the District of Columbia. There 180,000 miles of streams, creeks, rivers and the watershed area is home to around 18 million people (Chesapeake Bay Program, 2021). The watershed has been identified on the EPA's list of impaired waters due in part to eutrophication. In 1983 the Chesapeake Bay Program was established, but despite considerable efforts, Chesapeake Bay remained on the list of impaired waters. In 2010 the EPA established a Total Maximum Daily Load for the entire watershed (Calabrese, 2012).

Chesapeake Clean Water and Ecosystem Restoration Act of 2009 proposed to amend and strengthen the Federal water Pollution Control Act (commonly known as the Clean Water Act) in order to achieve the reduction targets for phosphorus, nitrogen and sediments by 2025 (and to achieve 60 percent of that goal no later than 2017). Water quality trading has been seen as a potential tool to achieve these goals efficiently.

With its multiple jurisdictions, a trading system covering the entire Chesapeake Bay poses scientific and regulatory challenges, as the system must be sophisticated enough to achieve several different environmental and economic goals. Nonetheless, the States of Pennsylvania, Maryland, Virginia and West Virginia have adopted market-based approaches within their jurisdictions.

The World Resource Institute estimated the benefits of a "bay-wide" nutrient trading system that allows trades between basins and states. The nitrogen credit trading could generate $45-$300 million per year in revenue for the agriculture sector. The inter-state trading could also generate cost savings for wastewater treatment plants as well as optimize output and pollution through credit trading. Local stormwater programs might better succeed in achieving their goals with the help of trading, generating additional cost savings (Jones, et al., 2010). Table 8.2 below summarizes the key features of the trading programs currently operational in the four states: i.e., pollutants addressed, eligibility to participate, etc.

The Chesapeake Bay program represents the most interesting case study for the Baltic Sea, not least because it has started as a collection of trading systems across independent jurisdictions but recognized, from the outset, the potential efficiency gains of a "bay-wide" trading program. Further it relies on types of models that would be relevant in the Baltic: The Pennsylvania Program, for instance, divides river basins into zones called land-river segments (which follow the Chesapeake Bay Watershed Model), which are analogous to the zones in a zonal ambient trading system. The credit calculations are based on the model and farm management data. Further, a clearinghouse of information is provided by the governing authorities (The Pennsylvania Infrastructure Investment Authority), which was also a success factor for markets as noted in the Long Island Sound and Lake Taupo examples above.

Table 8.2 Differences in requirements for market participants in each of four states operating in the Chesapeake bay watershed (Branosky, et al., 2011).

Feature	Maryland	Pennsylvania	Virginia	West Virginia
Pollutants that can be traded [1]	• Nitrogen • Phosphorous • Sediment	• Nitrogen • Phosphorous • Sediment	• Nitrogen • Phosphorous	• Nitrogen • Phosphorous • Sediment
Eligible market participants	• Agricultural operations • Nonsignificant point sources • Other landowners • Significant point sources • Third parties	• Non-point sources (e.g. agricultural operations, other landowners) • Nonsignificant point sources • Significant point sources • Third parties	• Agricultural operations • Construction stormwater projects • Nonsignificant point sources • Other landowners • Significant point sources • Third parties	• Agricultural operations • Nonsignificant point sources [2] • Other landowners • Significant point sources • Third parties
General eligibility requirements for credit purchases	• Existing significant point sources must have an ENR in operation before purchasing credits or offsets. • Point sources accommodate growth by purchasing offsets generated by point or non-point sources	• Existing point sources may purchase credits generated by point or non-point sources to meet annual load limits subject to additional conditions of NPDES permits.	• Existing point sources may purchase credits generated by other point sources to meet annual load limits subject to additional conditions of NPDES permits. • Point sources accommodate growth by purchasing offsets in the form of WLAs from other point sources or offsets from non-point sources.	• Existing point sources must have NPDES permits and may purchase credits generated by point or non-point sources to meet annual load limits subject to conditions of the permits.
General eligibility requirements for credit and/or offset sales	• Significant point sources must have an ENR in operation before selling credits • WLA cannot be sold until it has been adopted in a NPDES permit through the public review process	• Sellers must meet baseline and applicable threshold requirements before selling credits.	• WLAs or compliance credits and offsets cannot be sold unless the facility for which the WLA was granted has been constructed and	• Point sources must have NPDES permits that contain annual load limits for nutrients and/or sediment.

	• Nonsignificant point sources must have annual load limits for nutrients [3] • Sellers must meet baseline requirements. • Facilities trading excess credits based on excess capacity must demonstrate consistency with water and sewage plans.		is operating • Sellers must meet baseline requirements before selling offsets.	• Sellers must meet baseline requirements before selling credits.

Notes

1. Pollutants must be traded individually
2. The West Virginia guidance document does not use the terms nonsignificant and significant point sources. Rather, it allows "point sources facing nutrient or sediment allocations" (i.e. both significant and nonsignificant point sources with NPDES permits that contain numeric nutrient and/or sediment load limits) and "point sources not facing nutrient or sediment allocations" (i.e. entities such as municipal stormwater programs that operate under a general MS4 permit that contains monitoring, reporting, and/or management requirements and not numeric nutrient and/or sediment load limits) to participate.
3. The cut-off discharge for nonsignificant discharges to participate in the Maryland trading program is 6,100 lbs TN and 457 lbs TP or more per year.

8.2 KEY ASPECTS FROM INTERNATIONAL SYSTEMS

In reviewing and summarizing trading systems we have considered different aspects, depending on the political and social environment. However, a system's success can often be inferred from the following:

- Achievement of the regulatory objective – has the environmental objective been achieved?
- Economic efficiency – generally a low level of distortion to markets beyond the pricing of the environmental externality
- Financial impact on participants
- Trading system cost

From a holistic perspective our analysis suggests that the most important requirement for the success of a market system is the robustness and health of the relationship between the biophysical model, the policy and the regulation it informs, and the market's ability to deliver the policies intent.

The scientific understanding and knowledge of the biophysical systems that the system serves evolves over time, which underscores the importance of adaptive management. The evolving scientific understanding can be a significant challenge to the success of a trading system if the actors fail to agree on how to address the system accordingly. This can prevent necessary system improvements over time and risk rendering it ineffective – despite the fact that it may appear 'effective' from the outside based on a high number of trades.

Our analysis suggests that the following items are success factors for implementing a trading system:

8.2.1 Biophysical Model

Many systems include a biophysical model that reflects aspects of the scientific and physical reality that the market system seeks to address. These models have two fundamental purposes in market systems:

1. **Translating regulated activity levels into units that reflect the outcome**. For example, market participants use the model to calculate the required units (permits, credits, entitlements) that they need to purchase in the market. The advantages of using models in this way is that the market is output focused; and
2. **Calculating market prices**. For example, in an interconnected system with constraints, the model can calculate the price at nodes and at different times to meet constraints. The advantage of using the model in this way is that the model calculates, potentially in real time, how location may affect the price to be paid.

Not all systems use biophysical models for both purposes, as the decision depends on the complexity of the environmental problem. The design of the model to suit the problem and market involves decisions related to the following:

- **Resolution of the model.** The level of detail should match and serve the scientific basis of the problem and the desired outcome for the market system.

- **Range of input activities**. The model must represent the activities of each polluter type and calculate the output effect from each. Models can be implemented that cover point, non-point and air pollutants. The models convert all these diverse activities to a common credit that can be traded between diverse activities/actors.

- **Location and geography**. Emissions at different locations will have different impacts on eutrophication. These differences can be built into the models so that the translation of activities into credits take location and geography into account. Although other solutions include the use of independently developed ratios, best practice suggests building these additional considerations directly into the model.

- **Centralised and decentralised balance**. The model can be completely centralised (all inputs are provided to a single centralised model) or completely decentralised (each market participant uses their copy of the model to convert their activities into market units).

- **Timing and lags**. Both short and long-term timing impacts can be built into the models. For example, the season in which fertiliser is applied to farms may have different impacts on eutrophication (e.g. spring rains that carry relatively more nitrogen to the sea). Many activities, especially from non-point sources, can have long term-effects on ecological quality, but only limited short-term impacts. Finally, models can address the banking, depreciating and expiring of credits. Best practice is to allow trading over time, but this requires that the model incorporate the difference in timing of various impacts and activities within the market.

While it is important to note that many existing models in market systems have known flaws in accuracy; but in practice they only need to be "sufficiently" accurate to support a market system. While inaccuracies in the models will create some distortion in the management of outcomes, these are generally considered to be minor compared to the overall positive effect.

Best practice allows models to be improved over time. For example, technological advancements in point source pollutant abatement and mitigation may out-pace those in non-point source pollutants. This may skew the system's design as time progresses, and non-point source polluters may become unfairly disadvantaged if the biophysical model and policy settings are not regularly updated for point source participants.

The value of increasing the accuracy of a model can be calculated from its impact on the creation of units. If the value of increasing the accuracy is greater than the cost of doing so, then the business case is clear. This suggests that relatively simple models can be implemented at the beginning in order to support market establishment, and then improved over time based on the value that these improvements generate. Model improvement over time should, however, account for the fact that too much change can cause uncertainty for market participants.

8.2.2 Building a market community

Market players can sometimes be reluctant to join an "experimental new program" as it requires departure from the traditional regulation that they already understand. The uncertainties associated with measuring the effectiveness of non-point source controls is usually what causes this reluctance. Therefore, active engagement with the market community is a critical success factor, in particular ensuring a feeling of inclusion among all prospective participants.

The type of participant ranges from voluntary (self-regulation) to required (enforced by legislation). Many systems are voluntary for both point and non-point source polluters. However, in practice polluters are often required to participate if they wish to increase their emissions over time (due to e.g., growth). Other systems are mandatory, but actors are provided with "grandfathered" rights and phased into the system. Importantly, mandatory systems need to consider the timing and phasing of future changes (e.g., including new pollutant types or new actors).

Most successful systems are voluntary but with clear incentives for participation. Voluntary systems can have a variety of incentives to join. The most obvious incentive is the ability to trade – either to be rewarded for unneeded units or to gain additional units to increase activity. At the extreme, a system can be developed such that an actor cannot perform a polluting activity without first buying the necessary permits.

In some cases, the "threat of regulation" can better encourage a well-behaved market than actual regulation. Under self-regulation, market participants refrain from actions that could be perceived as negative, in order to retain the advantages of self-regulation. When regulated, there is no downside to gaming the system even if actions can be perceived as negative.

All parties should feel that they are represented in discussions about market structure, which requires effective streams of communication. Further, parties proposing the market must be able to educate and inform other players effectively.

The consensus process is important for maintaining cohesion between stakeholder groups and keeping them committed to the project's goals—and not only in the case of voluntary systems. In fact, resistance in compulsory systems may be more passive but can still stall or undermine the system. Much like the biophysical model, ensuring the system responds to local socio-cultural and economic realities is essential for the market's success. When effectively and collaboratively designed, a trading system's governance and institutions are generally more resilient and trusted by participants.

8.2.3 Best Management Practices

Many systems encourage the use of agricultural Best Management Practices (BMP), which are important given that non-point pollution cannot be routinely metered. Credits must be generated based on observable Best Management Practices, whose effects are quantified using the models. Best Management Practices thus align the processes of earning credits/units/permits with the verification of authenticity – i.e., confirming that certain activities were in fact implemented. Further, Best Management Practiced should optimize economic and environmental land use in the catchment area. As such, it is often combined with a decentralised biophysical modelling.

8.2.4 Appropriate market size and scale

In general, it is important to have sufficient liquidity in the market (i.e., sufficient number of buyers and sellers to generate trade). However, there is some evidence that the opportunity to trade can provide sufficient impetus for the introduction of Best Management Practices and voluntary compliance: i.e., the market sends appropriate signals without the need for much trading.

Two levers for market designers are (1) the scope of the biophysical model, which allows trading between diverse market participants and (2) the potential for a public broker to act as the buyer and seller of last resort.

8.2.5 Definition of permit creation and property right

The creation of the property right and the regulations that define it, is a question for all trading systems. Some common questions include:

- What types of activities qualify? How can they be defined to reflect local reality?
- Are pollutant removals permanent? How is permanent defined? How does this influence the lifespan of the credit and the property right?
- What is the appropriate business-as-usual assumptions for establishing the baseline from which an activity may improve performance (remove pollutants)? Under what conditions is a baseline required?

We found in our analysis of existing trading systems that these aspects varied markedly and were often tied to the circumstances of the market system.

8.2.6 Governance, Compliance and Enforcement

Whether governance of a trading system is empowered by legislation or is a self-governing structure, several aspects are important:

- Guiding principles – clearly defined principles for use in future decisions.
- Market rules – clearly defined rules and processes to be followed by actors.
- Rule change process – clearly defined procedures for how the market will develop, how to correct errors, how to react to new situations, how to improve biophysical models, how to change the cap, etc.

Governance based on open-ness and transparency lowers the perceived risk of participation and is crucial for the longevity of the market.

Compliance and enforcement are critical to any governance system and is often the remit of the central government stakeholder in the system, whereas local authorities are often responsible for regular monitoring. Market participants must be able to rely on the validity of any units that they purchase or sell. Therefore, it is critical to define how rules will be enforced and how rule breaches will be identified. By ensuring such processes are clear and non-negotiable the perceived risk for market participants stays low.

8.2.7 Integration with other regulatory mechanisms

When other regulatory mechanisms were in place, such as government funding to support riparian management or improved work practices, there was less incentive for voluntary credit holders to participate. This suggests that it is important to ensure other regulatory mechanisms are well integrated, and do not conflict, with the market system.

8.2.8 Permit banking and Price Management

Permit banking is a system for banking (or storing) verified credits in a closed system to enable credit holders to sell when required, to provide for short term environmental protection or to limit new buyers from entering the market.

Many of the systems we reviewed determined that a permit banking was not desirable as they feared that a mechanism for "banking" permits might encourage participants to take advantage of the system to sell past mitigation credits at higher prices, creating economic inefficiencies. This often happened in cases where the market had no set price, or price ceiling, or when factors like inflation were not fully understood. This raises interesting and relevant questions: Should a permit generated 30 years ago have the same value as one today? What is the life span of permits? In practice, permits should depreciate in line with the duration of the modelled impact and improvement in how each unit is defined. In other words, at some point in the future the changed behaviour and performance of the distant past is no longer relevant to the present day's challenges. In these cases, a permit has lost its *real* value.

Similarly, it is common for systems to include price management mechanisms. Common mechanisms include price floors and ceilings that shift over predictable time frames and/or under certain and pre-defined market conditions (such as extreme demand/supply). Another approach for managing price fluctuations and market disruptions is for the market authority to maintain a (banking) reserve of credits that are released to the market when prices rise. Importantly, credits should be released at a pre-defined rate and only when well-defined conditions arise that warrant such a release. The goal should be to soften the extremes and flaws of market dynamics and ensure the market achieves the policy intent. This approach makes it possible to remove the potentially negative effects of setting a maximum price ceiling, thus allowing prices to rise and the market to work while nonetheless keeping participants safe from extreme prices. Furthermore, this approach is consistent with the fact that a permit bank run by the market authority is also an effective way of retiring permits to ensure the cap shrinks and the performance in the catchment continually improves.

In short, best practices suggest that biophysical models should be enhanced over time, even though it introduces an unavoidable risk to participants: having purchased a credit there is no guarantee that the unit value will not change based on an enhanced future model. This risk will inevitably affect market participants, who will either adjust their behaviour or adjust the price they are willing to pay for credits.

9 BUYERS AND SELLERS WITHIN THE NUTRIENT TRADING SYSTEM

This chapter aims to provide an overview of the possible actors in the nutrient trading system, i.e., buyers who will be demanding permits and sellers who will be supplying them. First and foremost, this would include the actors that contribute to the eutrophication of the Baltic Sea. However, even external actors that do not contribute emissions may still be interested in reducing eutrophication levels in the Baltic Sea and, as such, are potential participants.

We begin by providing an overview of the current sources of pollution in the Baltic proper. Then we consider the types of actors participating in other nutrient trading systems based on the International review (Chapter 8.1), Third, we consider several possible actors in a trading system for the Baltic sea based on their contribution to eutrophication, including both point and non-point sources. Finally, we consider external actors that do not currently contribute to eutrophication but may nonetheless be included in a future system.

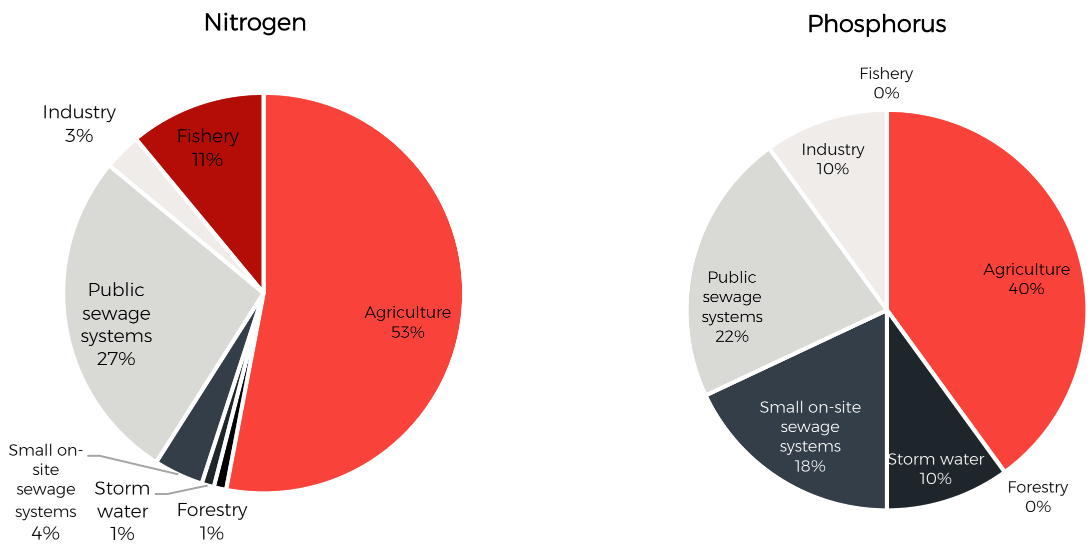


Figure 9.1. Source distribution of anthropogenic net load of nitrogen and phosphorus from Sweden in the Baltic Proper, 2017. (Swedish Agency for Marine and Water Management, 2019a)

The source distributions of the nutrient net load of phosphorus and nitrogen for the Baltic Proper from sources in Sweden are shown in Figure 9.1. The figure illustrates the case for Sweden, which may differ depending on which parts of the Baltic Sea are considered. These sources are to a large extent similar to other countries around the Baltic sea. Agriculture is the main source of anthropogenic outflows of nitrogen and phosphorus. However, the Baltic Sea is also suffering from past outflows of nutrients from poor sewage systems before the 1970s, as well as older agricultural and industrial activities. These “excess internal pools” of phosphorus are stored in the seabed of the Baltic Sea and often leaks from these anoxic areas into the water column. At times, the internal supply of phosphorus exceeds the land-based emissions of phosphorus. This internal supply cannot be controlled by a trading system unless uptake from the sea is included in the model. There is also an internal load of nitrogen in the Baltic Sea causing uncontrolled release into water bodies (from cyanobacteria that fixate nitrogen during mass algae blooms in the summer). Again, these internal loads cannot be controlled by a trading system, although they could potentially be compensated for through activities by external actors (chapter 9.4). It could be interesting to find ways to include uptake of nutrients from the sea i.e. circulated sea-based nutrients, in the system.

9.1 INPUT FROM THE INTERNATIONAL OVERVIEW

The international review of other trading systems (Chapter 8.1), described five cases in detail. Four of those are characterized as nutrient trading systems and are described in Table 9.1 (the US Sulphur Trading Program is excluded since it focuses mostly on air emissions).

Table 9.1 Summary of participants in other trading systems based on Chapter 8.1.

Trading system	Point sources		Non-point sources		External actors
	Included?	Comment	Included?	Comment	Included?
Lake Dillon	Yes	Primarily wastewater treatment plants	Yes	Included after two years	No
Long Island Sound	Yes	Primarily wastewater treatment plants	Yes		No
Lake Taupo	No		Yes		Yes
Chesapeake Bay	Yes	Both significant and non-significant, stormwater	Yes	Agricultural operations, other landowners	Yes

In the Lake Dillon trading system, both point and non-point sources are included. Initially, only four wastewater treatment plants were included. However, trade was later extended to include non-point sources which enabled the wastewater treatment plants to emit higher levels than their annual cap. The system did not, however, allow for point sources to trade future surpluses. As a result, incentives to participate were low, with only one trade occurring. In the trading system of the Long Island Sound, both point and non-point sources were included, point sources being primarily wastewater treatment plants.

Most trading systems we reviewed included point sources (mainly wastewater treatment plants). Other systems around the globe include non-point sources, however. Only one of example in our review included only the agricultural sector – the Lake Taupo trading scheme in New Zealand.

There are also examples of trading systems with external actors, i.e., actors that do not currently emit pollution. For example, the Chesapeake Bay Trading system included entities that were not considered sources of pollution, but could nonetheless purchase credits, usually with the aim of retiring them. In the Lake Taupo system in New Zealand, the Lake Taupo Trust handled the participation of external actors.

9.2 NON-POINT SOURCES

We discuss the primary non-point sources below (agriculture and forestry) and discuss incentives for these actors to participate in a trading system. We do not include air emissions.

9.2.1 Agriculture

The agricultural sector is one of the main sources for nutrient pollution in the Baltic Sea. Food production has influenced water systems by changing the outline of the landscape. Water travels faster through the landscape today due to draining of wetlands and straightening of waterways. This change of structure has diminished the natural retention of nutrients before it reaches the sea.

The countries around the Baltic Sea would seem to have ideal conditions for cultivation since most areas are old seabeds with fertile soils and high levels of precipitation. However, the cooler climate and precipitation patterns in northern Europe result in costly drainage systems.

Further, limited daylight during parts of the year shortens growing seasons. This results in difficult growing conditions compared to other areas closer to the equator, which means the agricultural sector in the Nordic countries faces stiff competition from countries to the south.

Regulatory requirements in the Nordic countries regarding climate, environment and animal ethics are among the most stringent in the world, which means that victuals produced from these areas provide higher environmental performance (IVA, 2019) than competing areas. But it also means that food is often more expensive, which means production is constantly at risk of competition from imports of food that are cheaper and have a lower environmental standard. In Sweden, 50 percent of households' food consumption is imported, and the country is struggling to gain higher self-sufficiency. In the national food strategy, there is a goal to increase food production without increasing eutrophication (Ministry of Enterprise and Innovation, 2017).

Over the past 50 years, the agricultural sector has undergone structural transformation, with small farms being merged into larger farms for improved cost effectiveness. For example, Sweden has fewer farms that employ fewer people, but produce food more efficiently (Manevska-Tasevska & Rabinowicz, 2015). Historically, regulations aimed at this sector have had a large impact on farmers (Lans Strömblad, 2019), which means that a new system to reduce nutrients might be received with suspicion. A lesson from the Lake Taupo system in New Zealand was that the trading system required that "environmental" concern become more centralized in farmers' businesses and that, over time, the attitude among farmers became more positive. The key will be to introduce a system from a grassroots perspective, allowing stakeholders to present their view and to have a voice. This may suggest starting with a pilot project that carefully considers stakeholders' perspectives (Hall, 2016).

The European agricultural sector is not only affected by consumers' purchasing power through a market. In fact, a large part of European farmers' income is governed and regulated by the EU and Common Agricultural Program (CAP) as well as national agriculture programs through subsidies. Actions that are environmentally beneficial are promoted with economic support. Different grant systems promote desired activities such as different environmental measures.

9.2.2 Agricultural sector participating in trade in other countries

The proposed nutrient trading system would be based on a biophysical model where maximum outflow of nutrients are set based on goals, creating a cap (maximum outflow in a specific area). Farmers would be assigned a certain number of permits and if they want to increase production, they would need to purchase more permits or undertake measures to reduce nutrient emissions through e.g., constructing wetlands. The cap and the scarcity of the permits creates this incentive for buying permits or constructing nutrients sinks – both of which need to be built into a farmer's management and investment decisions when expanding production.

In the Netherlands a dairy manure phosphorus regulation, outlined as a trading system, has been in place since 2018. The aim was not to reduce nutrient emissions per se, but rather to hold the total national phosphorus generation of the dairy sector under 84.9 million kg. This type of trading system has a significantly different structure than the one proposed for the Baltic Sea region, where the purpose is to *reduce* outflows of nutrients to the sea in the most cost-efficient manner (where the regional environmental objectives also play an important role). In the Netherlands, farmers work intensively with innovative and effective measures to reduce nutrient leakage by, e.g., refining manure in order to facilitate transport of nutrients to less animal-dense areas (Nilsson, 2018). The intention was that that this kind of innovation in the agriculture sector would increase due to the trading system. However, there are no international studies that show that these efforts are increasing due to the trading. Swedish agriculture has also shown interest in this kind of innovation, where development in the example above is driven mainly in the biogas sector. Hence more innovative measures to control nutrients are being developed in several countries and the increased innovation could be obtained in existing system and be intensified by subsidies such as grants for biogas.

The Lake Taupo example is different from the Baltic Sea context since New Zealand is less sensitive to food imports. New Zealand has a dominant global role in food production and has one of the highest levels of self-sufficiency in the world (Stats NZ, 2011). In the Lake Taupo trading scheme, food production was in some markets given a higher status due to the higher level of environmental consideration in the production process – i.e., goods from the Lake Taupo area are labelled "Taupo beef" and marketed with a price premium (Braathen, 2015). Further, some farms reduced pollution and reduced their compliance costs (the cost of buying credits), i.e., produced less pollution per product (beef). In some cases, this led to increased production (more beef per unit of pollution). In short, some farmers improved their capacity and, in some markets, consumers paid the bill for this higher environmental performance.

This is unlikely in the Baltic Sea countries, where agricultural goods are already more expensive than imports. This is, among other reasons, due to higher environmental requirements. In the Baltic Sea region as well as globally, many farms are already closing or being merged with other, larger and more competitive ones. Larger farms tend to increase the concentration of nutrients from manure in one place, which in turn increases the risk of leakage. The objective of a trading system is use economic incentives (higher cost for farmers) to drive more innovative and more effective solutions for handling nutrients. However, there is a risk that economic pressure instead increases the structural change or further increases cost per product. Thus, if a trading system leads to more expensive food products, it may be worth examining possibilities for communicating this information to consumers to promote the added environmental value of these products, as was done in New Zealand.

Farmers in New Zealand are now considering the costs of actions to generate permits and to trade with them in their business plans. Farm investments, for instance, are influenced by the perception of future permit prices. This is a sign of a successful trading system. Further, it rewards farmers who accumulate this new type of knowledge associated with building a business perspective that accounts for the purchase and sale of permits.

A successful trading system from a farmer's perspective is one that ensures a transparent and stable price. Figure 9.2 shows how the price of one kg phosphorus in the Dutch system fluctuated from 120 to 280 euros between 2017 and 2020, which makes things challenging for farmers.

Figure 9.2. Price variation of permits for one kg phosphorus in Holland (Fosfaatrecht, 2021).

Another design feature involves which actors within the agricultural sector can take part in a trading system. In the Netherlands only livestock producers were invited to participate as they have a high density of phosphorus discharges. In the US and Sweden, large farms tends to split their business into two parts – one for the livestock production and one for cultivating crops (LRF Kalmar, 2020). This is due to the strict regulations for spreading manure on farms that have their own livestock production; in contrast, farms that receive manure from other sources are not as tightly regulated. This suggests that farmers may exploit a loophole if crop producers are not included in a trading system (i.e., farmers will simply split their business in two and avoid regulation through the trading scheme). In Lake Taupo, crops farms participate in the trading system but are assigned lower grades of nutrient permits than the livestock producers.

Another consideration involves "multipurpose" environmental measures that are currently undertaken on farmlands, e.g., construction of wetlands that may be driven by economic, personal or environmental motivations (or all three). If a trading system only focuses on reducing nutrients, it may preclude attainment of other beneficial outputs such as biological diversity and climate mitigation. In the Lake Taupo system actors were also incentivized to reduce carbon dioxide in order to avoid possible conflicts with nutrient reduction.

There are of course other instruments used in agriculture to reach environmental goals but relying exclusively on a trading system's incentives to achieve these may be asking too much. For example, a circular economy approach in agricultural suggests that resources like nutrients be circulated and reused. Organic farming methods do not allow chemical fertilizers and instead promote the use of organic fertilizers. However, a trading system that accounts for all such aspects demands a complex model, which in turn makes implementation more complicated.

In short, there are several benefits of including agriculture in a future trading system: it triggers innovation for optimal treatment of nutrients in agriculture; farms are incentivized to produce food as well as ecosystem services like nutrient sinks; and, if the system is designed consistently across all Baltic Sea countries, it may lead to more balanced and fair environmental regulations for all farmers. There are also risks and challenges associated with including agriculture: food may become more expensive; the increased costs to farmers may further accelerate the structural transformation in agriculture towards larger units (leading to more concentrated management of nutrients and thus higher risk of leakage); and finally, introducing a new policy instrument may insert too much uncertainty, especially if many of the positive effects can be obtained and accelerated with today's existing policy instruments, including regulation and grants.

9.2.3 Forestry

The forest industry in Sweden is not considered a heavy contributor to nutrient pollution, even though it has had a similar but smaller impact on the landscape and waterways as agriculture. Deforestation is known to contribute to a few percent of the phosphorus emissions mainly due to changed soil structure that encourages leakage of metals and nutrients from acidic soil. Draining forest soils to promote growth and the use of forest fertilization has increased nutrient loading. Forestry close to waterbodies may also increase the rising problems with brownification, where higher concentrations of dissolved organic carbon and iron interfere with aquatic ecosystems that require oxygen for decomposing (Kritzberg, et al., 2020). Measures aimed at preventing these impacts could be included in a trading system, such as protection zones and experiments with continuity. In the Lake Taupo trading system for example, forest planting is calculated as a legal permit to decrease nutrients.

The benefits of including forestry in a trading system are that it drives innovative measures for reducing eutrophication and drives more action in a sector were measures to reduce eutrophication are rare. However, it remains a relatively small contributor to nutrient leakage. Further, it may be difficult to include these other factors that cause eutrophication like brownification in a biophysical model.

9.3 POINT SOURCES

We discuss the primary point sources below – public sewage systems, on-site sewage systems, stormwater, and certain industries – including possibilities and incentives for their participation in a nutrient trading system (stormwater could be considered a non-point source but since it is often channelled through a sewage system we consider it a point source).

9.3.1 Public sewage systems

Public sewage systems (wastewater treatment plants) are the second largest source of phosphorus and the third largest source of nitrogen into the Baltic Sea. In Sweden, as well as in the majority of the Baltic Sea countries, public sewage systems that treat wastewater are obliged to have a permit (according to the Urban Waste Water Treatment Directive it is required when plants handle waste for a certain number of population equivalents). The permit allows for a specified amount of emissions for a specific facility and if that limit is exceeded, fines are issued.

Many public sewage systems in Sweden need investment. During the 1970s investments measures were identified, but many of these remain unimplemented; further, treatment technology has evolved since then. Therefore, a new round of investment is required, including new pipes, adjustment to stricter standards, redistribution of small systems to a larger connected network with larger treatment facilities (Swedish Environmental Protection Agency, 2016; Swedish Water, 2017).

Today, investments are driven primarily through the environmental permit process, which stipulates legal requirements for what each treatment plant must do in order to operate. Whether there will be potential traders among existing treatment plants depends on the possibilities for them to invest in equipment that provides abatement exceeding that required by existing legal permits. A tightening cap within a trading system could bring more potential buyers to the market, but whether this demand is realized in terms of permit trading depends on the market price and the cost of investment. A treatment plant's first investment goal will be to meet the requirements in the existing permit. But after this goal is met, a future trading system will offer the possibility for a second investment decision: i.e., to consider reducing emissions further if the costs of doing so are lower than the cost of the existing permit (and then sell these credits to other sources).

Treatment levels in Sweden are driven by both the need to modernize existing plants and the existing permit process. Today most permits allow concentration levels around 15 mg Nitrogen/litre [5] while the average content of outgoing nitrogen from Sweden is approximately 14 mg Nitrogen/litre (Statistics Sweden, 2020). The most modern and effective plants today obtain treatment levels around 6 mg Nitrogen/litre, which means that one of the potential benefits of a future trading system would be to encourage a faster transition for these older plants to achieve the most effective levels of treatment, i.e. reduce by more than half the current emissions of nitrogen.

The benefits of including public sewage systems within a future trading system would be (1) to create strong incentives to *exceed* the reduction goals found in existing environmental permits and (2) to offer more cost effective ways for plants to invest in new technology (i.e., either exceed current requirements and sell these credits to offset investment costs or purchase permits from others if that is a cheaper option). The challenge of including public sewage systems is that it may be costly for some treatment plants that already reach high levels of treatment (but this depends on the price of permits in a future trading system).

9.3.2 On-site sewage systems

There are various treatment options available for houses that are not connected to a large public sewage system, but the most common is that households (or multiple households) have their own small on-site sewage system. Municipalities are responsible for these systems Sweden and so is the case for many of the other Baltic sea countries (see Part B for regulations in other Baltic Sea countries.).

There are approximately one million households with small on-site sewage systems in Sweden (SOU, 2020:10; Olshammar, M., 2018), which comprises around 18 percent of phosphorus emissions and four percent of nitrogen emissions into the Baltic Proper 2014 (see Figure 9.1) (these numbers were 13 percent for phosphorus and five percent for nitrogen in 2017) (Swedish Agency for Marine and Water Management, 2019a). When new facilities are constructed treatment requirements are fairly strict according to the legal permits, but older systems lack these high environmental standards (either insufficient treatment or no

[5] The Swedish environmental protection agency's regulation NFS 2016:6 on wastewater treatment from urban areas

treatment at all). Although small on-site sewage systems lack clear definitions in Europe, general guidelines in Sweden state that those treating household wastewater for up to 25 person equivalents are considered small on-site sewage systems (Swedish Agency for Marine and Water Management, 2016). The same environmental standards also apply to systems that treat sewage water for 1 to 200 person equivalents.

If these small on-site sewage systems are to participate in a future trading system, they must first meet the required standards and, second, be clearly identified. In Sweden and Finland, municipalities are responsible but struggle to supervise all systems. Different methods are used to meet the required standards, which results in varying levels of treatment. In general, the investments are costly, with higher levels of treatment leading to increased cost.

If stricter regulations are placed on all entities by including small on-site sewage systems in a future trading system, two levels of required treatment would apply. First, the household would have to meet required standards (e.g., baseline level of treatment). Second, it may be possible to reach a "higher than required" level of treatment, either by investing in more efficient measures, or by introducing permits into the system (i.e., undertaking certified measures elsewhere that may be more cost efficient). If the household only treats the sewage water to the required standard (the baseline), a larger share of permits will need to be purchased in order to reach the higher level of treatment. If the entity instead invests in a treatment system that obtains a higher level of treatment, less permits will be needed. As the price of the permits increase, the relative cost of investing in a treatment system that achieves "higher than required" level of treatment decreases. Thus, participation of small on-site sewage systems in a trading system offers the opportunity of reaching "higher than required" treatment levels at an overall reduced cost to society. The main challenge, however, is the administrative costs of identifying entities and enforcing baseline requirements.

An alternative is to include on-site sewage systems in the trading system indirectly, e.g., as external (nonregulated) actors that voluntarily participate in the system. An external actor could invest in certified measures that secure "higher than required" treatment levels for an on-site sewage system and then become a seller. However, this type of administration requires further investigation.

The benefits of including on-site sewage systems in a future trading system include an incentive to invest and reach a higher than required level of treatment if the investment leads to a lower share of required permits. However, the challenge is the high administrative costs to authorities for identifying all relevant households and making sure all entities reach the required standards and the high transactions cost for the households.

9.3.3 Stormwater

The stormwater accounts for ten percent of the phosphorus and around one percent of nitrogen emissions from Sweden into the Baltic Proper. As such, it is a smaller source than public sewage systems.

The regulations for treatment of stormwater are not as specific and targeted as those for sewage. However, it is increasingly important as cities continue to expand and cover natural sinks for stormwater with asphalt and buildings. Climate change will further increase the need for a well-functioning stormwater system due to extreme weather events.

In Sweden responsibility for stormwater treatment is unclear and there is a lack of regulations for e.g., maximum releases of phosphorus. In some cases, stormwater is treated as sewage water through a wastewater plant, which means requirements for sewage water applies. In other cases, stormwater is handled separately and the level of treatment varies. As a consequence of the *Weser Case* judgement in 2018 related to the Water Framework Directive, no project or exploitation can degrade the environmental objective of a water body. In practice, this means that municipalities and developers must undertake measures when cities expand (Swedish EPA, 2019).

Including stormwater in a future trading system would be challenging due to the difficulty of identifying who is responsible for treatment. One possibility would be to include it through larger sewage systems, which means the cap on the facility would apply to the stormwater it treats. The facility could be a buyer or a seller of permits, depending on the incentives and price levels. Alternatively, if stormwater was as an independent actor, then it would most likely fall on e.g., a developer of new area (or manager of an existing on) to take measures to reduce nutrient emissions caused by stormwater. That actor could then sell permits not used to other actors within the trading system.

The benefit of including stormwater in a future trading system is that, if included, incentives for proper treatment may increase since there are additional reasons and larger effects from treating it properly. The challenge, however, is the difficulty of defining responsible actors.

9.3.4 Industry

Today, the Swedish industry contributes relatively little to nutrient loading in the Baltic Sea. quarrying and mining have a small outflow of nitrogen, which could be included in a trading system. The pulp and paper industry contribute to discharge of nitrogen and phosphorus but mostly with oxygen-demanding compounds (COD and BOD) and some heavy metals (Statistics Sweden, 2020). The reduction of these substances could be driven by existing law and more precis measures than a trading system. However, industry could voluntarily contribute to reductions in nutrient emissions that exceed their requirements and, in that case, could act as buyers of permits in a future trading system.

The benefit of including some industries would be to create an incentive for further reduction in nutrients pollutants than is required in existing permits. The challenges is that it is difficult to account for other factors that cause eutrophication like oxygen demanding compounds.

9.4 EXTERNAL ACTORS

There are two ways that external actors can be involved. First, pro-environmental actors may want to voluntary buy credits, which helps to generate external capital inflows. In this case, the sources that have fulfilled common obligations through their own measures will then receive external financing for these. Second, and perhaps more importantly in an ambient credit system, external actors can voluntarily implement verified measures to reduce the nutrient emissions and get paid for this by selling their generated credits on the market. This will be a new way of attracting external actors who voluntarily implement measures for reductions in e.g. the agricultural and forestry sectors.

Potential external actors exist in the Baltic Sea region today. There are philanthropic individuals who choose to spend their money on environmental protection such as participants in the Baltic 2020, a foundation with the aim to finance measures and research contributing to a healthier Baltic Sea. The foundation, which is financed through donations, also works with information-based campaigns that target politicians, authorities and schools (BalticSea2020, 2020). Race for the Baltic is a similar non-profit organization financed by a small group of philanthropists (Race For The Baltic, 2020), whose mission is to improve the health of the Baltic Sea in part by engaging municipalities to work together to combat eutrophication.

In Finland, the aim of the John Nurmisen Foundation is to save the Baltic Sea and its heritage for the generations to come (John Nurmisen Foundation, 2021). The foundation has initiated around 40 projects, including the NutriTrade project, a platform established to collect and redistribute funds for nutrient abatement actions. The platform has facilitated, for example, neutralizing the remaining phosphorus load of the city by undertaking abatement measures in point-sources in Belarus (Univeristy of Helsinki, 2019). Turku and Porvoo, two other cities in Finland, have implemented similar compensation activities. Thus, external actors might be incentivized to participate in a future Baltic trading system to promote corporate social responsibility (CSR). Such work is gaining an increasing amount of attention as consumers demand more engagement by business in social and environmental challenges. As shown by the examples from Finland, this is also of interest for public entities.

Local water authorities and the sportfishing community are also active in implementing measures. Together with the actors noted above, municipalities, country administrative boards and authorities, the Swedish Anglers Association is participating in wetland construction projects (Swedish Anglers Association, 2020). They are also working on projects to build a richer fish fauna in the Baltic Sea. These types of environmental non-governmental organizations could participate in a trading system.

Further, although some municipalities would already be involved in a trading system since they own public sewage systems, they could also be involved by taking measures and supplying permits outside of that sector. The Municipalities' International Environmental Organization (KIMO) is an international local government network with representatives from eight countries in the Baltic Sea and North Sea regions and over 80 local government (KIMO, 2020). The group is participating in several projects working for a healthier sea and could be a potential external participant of the trading system.

Another example is the Swedish program for Local Water Treatment Projects (Lokala vattenvårdsprojekt, LOVA), a program financing measures to improve the environmental status of water bodies in Sweden (Swedish Agency for Marine and Water Management, 2020b). Other countries have similar programs. Finland has the Program to enhance the effectiveness of the water protection 2019-2023 (see Part B). The Swedish program creates opportunities for increased local engagement, which could be valuable local knowledge for a future trading system based on specific catchment areas. In Sweden funding can be approved by public authorities and non-profit organizations but it is common that the projects are carried out in collaboration with farmers. Funding to agriculture include structural liming, phosphorus retention ponds, two-stage ditches and restoration of wetlands. Also, the Finnish program includes collaboration with farmers.

If the trading system allows for external actors to buy and sell permits, the money earmarked for mitigating eutrophication could be channelled through the trading system, rather than through their own programs. But it is worth noting that current target goals that are hoped to be obtained with the trading system – e.g., more effective and innovative methods for reduction from the agriculture sector – could be achieved with existing policy instruments. For example, LOVA can be intensified and finance methods to reduce nutrients in farmland.

A key consideration related to including external actors is the share of permits that are allowed to enter and exit the trading system. In the example from Lake Taupo, a trust that reported to the Ministry of Environment was an active part of the trading system because it identified external actors that wished to participate. (Protecting Lake Taupo, 2021). The challenges is to balance the number of total permits in the system so that it does not result in negative impacts on nutrient load. This becomes even more relevant for the proposed trading system in the Baltic Sea where geographic location of each permit plays a key role.

10 CONCLUSIONS ON PRECONDITIONS FOR A NUTRIENT TRADING SYSTEM IN THE BALTIC SEA REGION

Implementing a nutrient trading system in the Baltic Sea – with its myriad river basins and countries –would be the largest nutrient trading system in the world. For such a system to gain acceptance, it must achieve its intended targets with a cost-efficient allocation of resources and with the lowest possible transactions costs for sources and regulatory authorities.

Based on the comparison of trading systems in Section 7.8, and the experiences from the international overview, we conclude that an ambient trading system is most likely. In this system sources buy and sell portfolios of permits (credits) in several markets (one market for each receiving water that its emissions affect); each market has its own price determined by demand and supply. The ambient trading system makes this easier because transfer coefficients are fixed numbers rather than computer-simulated trade-ratios that change between each transaction (as in an emission permit system). Therefore, no computer simulations are needed before a transaction takes place. Moreover, sources face single prices, which are simply the weighted averages of the permits (credits) in their specified portfolios.

To our knowledge no full-scale ambient trading system for nutrients has been implemented in practice, despite being proposed by Montgomery (1972). This is primarily because the idea has been discussed among researchers and not widely known to practitioners and policymakers. A second reason is that current nutrient trading systems have not dealt with the fine mesh of environmental objectives – in particular for water bodies and basins under the Water Framework Directive and the Marine Strategy Framework Directive.

10.1 HOW DOES TRADE WORK IN AN AMBIENT TRADING SYSTEM?

Each source buys and sells a portfolio of permits (credits) in several markets, one market for each receiving water that its emissions affect. Each market has its own price determined by demand and supply. Although the source might buy in some markets and sell in others, it faces a single price of its emissions units, which is the weighted average of the prices of the permits (credits) in its specified portfolio.

The ambient trading system can be used in river basins, coastal waters and offshore waters assuming a water quality model exists that can deliver the underlying parameters of retention and nutrient transport that are needed for the transfer coefficients between source and affected waters. Provided that river basins, coastal waters and offshore waters can be measured in a coherent modelling effort for the entire Baltic Sea area, a single ambient trading system can be designed for the entire Baltic Sea region with its river basins.

Figure 10.1 illustrates how an ambient trading system works with respect to trade in portfolios. Each water body, coastal water and offshore water basin has a market with permits (or credits) connected to the inflow of pollutants. The specified portfolio of each source contains permits (or credits) in all the receiving waters of the source. For example, source S1 (found adjacent to an inland water in Sweden) needs to buy a specified portfolio containing permits (or credits) from the Swedish rivers R1 and R2, Swedish coastal waters C1 and C2, offshore water basins B1 and B2 and perhaps also Polish coastal water C3. The sizes of shares in the portfolio are determined by the retention and nutrient transport between the source S1 and the receiving waters in the portfolio. Accordingly, the portfolio for source S1 will contain high shares of Swedish rivers R1 and R2 and likely low shares of Polish coastal water C3.

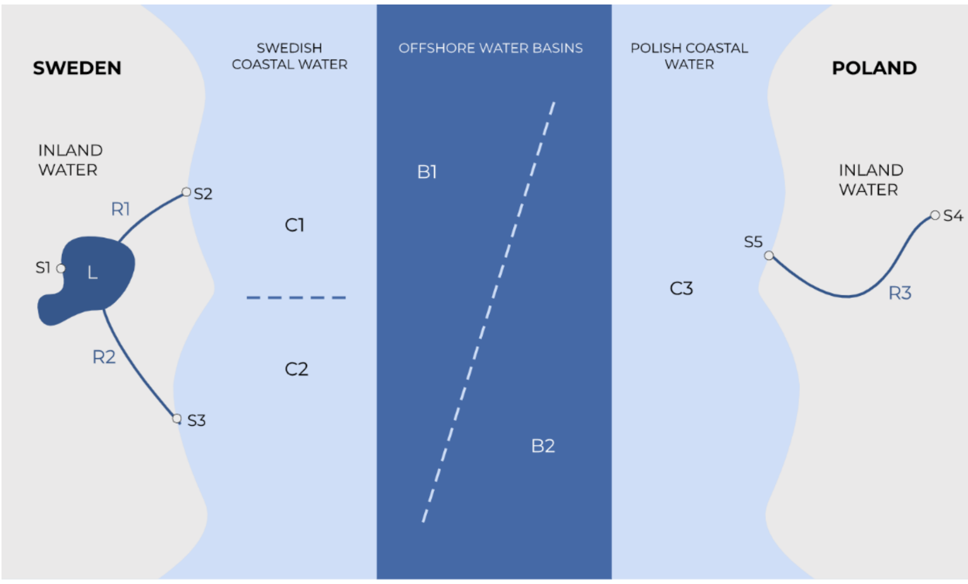


Figure 10.1 Illustration of trade in an ambient trading system.

An ambient trading system can be designed either as an ambient permit system for trading inflow loads to water bodies, coastal waters or offshore water basins or as an ambient credit system for trading reductions in inflow loads in these waters. An ambient trading system that trades with load permits works by the same principles as the EU ETS, but with two exceptions. First, traded units are inflow of loads (kg/year) to each water body, coastal water or offshore water basin rather than pollution load to the atmosphere. Second, each actor trades a specified portfolio of load permits based on the water areas it affects, rather than a common trading area.

The key steps for implementing an ambient permit system are:

1. The regulator decides the maximum annual nutrient inflow load (kg/year) for each water body or trading area. These loads set the cap, i.e. maximum number of load permits for each inland water body, coastal water body or off shore basin.
2. The regulator allocates the load permits to operators either by auctions or following an allocation rule (e.g. in proportion to last year's inflow of loads).
3. Each source must submit a portfolio of load permits corresponding to its verified inflow of loads (kg/year) to water bodies, coastal waters or basins.
4. Failure to submit load permits that correspond to verified loads may result in penalty fees and/or prosecution.

5. The regulated number of permits to be submitted for each water body or trading area is decreased annually according to an announced plan towards a target year, when the environmental quality standard is to be fulfilled.

An ambient credit system conducts trade in credits and functions according to the same basic principles as the Swedish electricity certificates. A difference is that traded units and quotas are reductions (kg/year) in the inflow loads to each water bodies, coastal waters or offshore water basins. Each actor trades a specified portfolio of reductions in the waters it affects. The key steps for implementing an ambient credit system are:

1. of inflow of load (kg/year) to each water body or trading area during the year. These reductions set the floors, i.e. the minimum number of credits for each inland water body, coastal water body or off shore basin that should be submitted by sources each year.
2. The regulator allocates duties to submit credits among sources in terms of individual quotas. The sum of Individual quotas in each water body, coastal water or basin equals the floor in each of these waters.
3. Each source must submit its individual quotas for each water area, by the end of each year. Each source may submit its quotas as credits either generated by own verified reductions, bought from other actors with verified reductions during the same trading period or bought at an auction held by the regulator.
4. Failure to submit the individual quotas may be followed by penalty fees and/or prosecution.
5. The floors, that is the regulated number of credits to be submitted for each water body or trading area is increased annually according to an announced plan towards the target year when the environmental quality standard is to be fulfilled.

Since ambient credit trade takes place in reductions of loads, non-point sources can be involved in trade, as long as they can implement verified measures that reduce emissions. A second feature is that it has distributional effects that mimic freely allocated permits, which most likely increases acceptance among potential participants. External actors generating credits by voluntarily making verified measures to reduce the nutrient emissions (and getting paid for it), can help attract external capital financing measures, primarily reductions at non-point sources. To be able to report such ambient offset measures, these need to be accounted for in the same way as load reduction credits.

10.2 TRADE UNIT IN AN AMBIENT TRADING SYSTEM

The tradable unit should be based on a physical quantity that is close to the expected environmental impacts from the emissions of nutrients. Since the geographical location is so important for the environmental impacts, simply using nitrogen or phosphorus emissions as a basis for tradable units would not be appropriate.

The ambient trading system defines ambient permits (credits) that are directly associated with a water body and its environmental quality standard. Ambient permits are defined in terms of an allowed inflow of load to each receiving water. This means that trade takes place directly in the inflow of loads that contribute to the environmental status of each receiving water. Even though ambient permits (credits) regulate the total inflow load to each receiving water, each source faces a single price of their own emissions unit (e.g. kg Total Nitrogen and kg Total Phosphorus), which is the weighted average of the prices of the permits (credits) in their portfolio.

Even though the ambient trading system can be designed as ambient cap-and-trade system or an ambient baseline-and-credit system, a certain version of a baseline-and-credit with implicit caps may be more intuitive for this purpose. Since an ambient cap-and-trade system technically relies on "credits" as opposed to permits, they have the appealing feature of being seen as "a requirement to reduce" rather than "a right to emit" (as with the ambient baseline-and-credit system). Each actor must hand in a certain number of credits every year corresponding to a certain annual reduction. These credits can be generated either by undertaking verified measures to reduce nutrient or by buying credits from other actors that have undertaken verified measures. Sources that wish to promote themselves as pro-environmental (e.g., sewage treatment plants and farmers) may prefer to trade in credits, given its focus on "reducing nutrients" rather than trading permits that grant a "right to pollute". Technically, trade is the same with permits or credits, but the semantic difference may be a way to build acceptance among pro-environmental sectors. An example of a baseline-and-credit system with a fixed implicit cap was used in the proposed CEASAR trading system for nitrogen emissions from Swedish wastewater treatment plants, which aimed to achieve a reduction target of 3,000 tonne nitrogen (Swedish EPA, 2012).

10.3 WHAT DATA ARE NEEDED TO OPERATE AN AMBIENT PERMIT SYSTEM?

An ambient permit system needs input data in terms of the average retention and nutrient transport between sources and affected water bodies, coastal waters and offshore water basins. A water quality model (or hydrological model) is a simulation of a hydrological system that can predict the impacts of nutrient emissions at different locations on the eutrophication status in water bodies. The Swedish Meteorological and Hydrological Institute (2010) has already created models that calculate and predict nutrient loads in rivers and lakes and coastal waters. These models are operative and currently in use by authorities in Sweden. In addition to estimates of average retention and nutrient transport, a future nutrient trading system would also need models and methods for connecting the impact of measures undertaken at non-point sources to the resulting nutrient load in receiving waters.

In summary, the key data needed for operating an ambient trading system are:

- Estimates of average retention and nutrient transport between each emission source and the receiving water bodies (or group of water bodies), coastal waters and offshore water basins. These estimates are the fixed transfer coefficients between each emissions source and receiving water.
- Maximum allowed nutrient loads per year for each water body (or group of water bodies), coastal waters and offshore water basins, based on the target indicators for nutrients needed to fulfil the relevant environmental objective.
- Reduction paths for the maximum allowed nutrient loads per year until the target year when the environmental objective should be fulfilled.
- Accredited flow measurements at the emissions points for point sources.
- For non-point sources, verified measures with result-indicators that describe "reductions per unit of measure undertaken" for an agricultural field (e.g., kg nutrients per Ha).

10.4 HOW TO FULFILL ENVIRONMENTAL OBJECTIVES AND THE NON-DETERIORATION CONDITION?

Designing a nutrient trading system in the Baltic Sea for achieving broad Baltic Sea Action Plan targets that will not violate or contradict the fulfilment of environmental objectives of the Water Framework Directive and the Marine Strategy Framework Directive, will automatically contribute to a cost-efficient fulfilment of local targets, even if this is not the intention (See Chapter 20.3 for a clarification of the confusing terminology used under each of these Directives). For that reason, a trading system represents a natural policy instrument for achieving the targets of Water Framework Directive and Marine Strategy Framework Directive (for EU member countries).

Among the available trading systems, the ambient trading system takes the simplest regulatory approach by letting the environmental authorities specify a cap (or baseline) for each receiving water with an environmental quality standard, and then creates water-specific ambient permits (credits) for the maximum load and concentration rates in each water body. The caps (baselines) increase in stringency every year until the final year, when the intended targets are to be reached for each water body. The same principle works for ensuring non-deterioration conditions.

10.5 INITIAL ALLOCATIONS OF PERMITS (CREDITS) IN AN AMBIENT TRADING SYSTEM

In simple trading systems with a single cap, such as the EU ETS, trade will in theory lead to a cost-efficient allocation. This property makes it possible to use the initial allocation of permits (credits) for distributional purposes, which in turn may provide help increase acceptance for a trading system.

The property of initial allocation is not true *generally* for trading systems designed for heterogeneous damage and/or multiple caps, but the ambient trading system is unique in being able to achieve this. Montgomery (1972) demonstrated that the ambient trading system can generate a cost-efficient allocation for attaining any predetermined level of environmental objective and for any initial allocation of permits (credits) among sources.

In order to achieve this property, the caps must be set to ensure scarcity in the total amount of permits (credits) in all water bodies at the beginning of each trading period. Hence, the initial cap in every receiving water must be set either at the starting level of the planned path towards targets fulfilment, or at a level that results in a positive market price, whichever is more stringent. A way to achieve this in practice is to use local auctions to allocate ambient permits and set the cap levels sufficiently stringent to generate positive bids.

Under this circumstance, the ambient trading system has the advantage that the authority can choose initial allocations of permits (within each receiving water, in the case of ambient permits) to achieve distributional targets without affecting cost-efficiency. But this implies constraints in the allocation: While any initial allocation of ambient permits can be chosen by the regulator, it does not necessarily mean that an actor can report all of these ambient permits to compensate his own emissions. He can only use ambient permits from water bodies, coastal waters and basins that are affected by his own emissions. He cannot sell ambient permits from other water bodies, coastal waters or basins on the market.

In other words, the initial portfolios for distributional purposes do not necessarily need to be bound by the local caps affecting the actor. It is only the use of permits for compensating one's own emissions that are bound by caps. For instance, the system could initially allocate "surplus" ambient permits to actors in a given country (i.e., more permits than there are actors in the country with respect to compensating the actors' own emissions under the local caps). The local surplus could be sold to actors that could use them in a neighbouring country and its revenue finance other activities in the first country. Thus, actors within the system can be "external actors" to receptor markets that their own emissions are not affecting.

Finally, "extreme" initial allocations can result in monopoly and monopsony power in a market. If a few actors are allocated large amounts of permits in a market, they may obtain monopolistic power as sellers in these markets. Similarly, an initial allocation could result in monopsony power with only one buyer on the market being able to push down the market price for many sellers. This could also happen for very extreme initial allocations in a simple trading system, such as the EU ETS, if all permits in a country were allocated to a single actor, or a single sector, in the country.

10.6 AMBIENT LOAD OFFSETS IN AN ABMITENT TRADING SYSTEM

To be able to report compensatory offset measures these offsets must be accounted for in the same way as load permits and credits, i.e., as shares in the portfolios determined by the location of the compensatory measures. This makes ambient load offsets possible in any location of the system. Trade takes place with ambient credits (reducing loads) meaning that a source buys a portfolio of credits from a group of other sources who may have generated those credits through a verified compensatory measure.

10.7 THIN MARKETS

An essential feature of all trading systems that address heterogenous damage is that target fulfilments and cost efficiency require that not all sources be allowed to trade with each other. Regions with few sources that are distant from other regions will have fewer trade opportunities, which in the ambient trading system are regulated by fixed transfer coefficients. These regions tend to occur in upstream areas of river basins, in particular upstream in small river basins. These regions pose a risk of "thin" markets, i.e., few participants and infrequent transactions. Trades in thin markets usually have high transaction costs since trades may be too infrequent to establish a market clearing price. A thin market is therefore not likely to produce the most cost-effective solution, although any trade will produce a more cost-effective allocation compared to the case of no trade. In this case, the authorities can introduce either guidance levels for permit prices or price floors that represent fixed minimum price levels.

The opposite holds for receiving waters that are located downstream in river basins, in coastal waters and basins in offshore waters. Since these waters are receiving waters for many sources, the traded volumes may be very large, especially with an ambient trading system. Market prices will most likely establish. However, even when there are many potential buyers and sellers, there may simply be too little change in the market structure to free up permits or to increase demand for them. Thus, to create demand, it is essential that the caps are set sufficiently tight to bind from the beginning and include an annual increase in stringency over time. Consequently, a prerequisite for a successful and efficient trading system is a strong political willingness among member countries to increase the momentum for achieving good environmental status.

10.8 TRANSACTION COSTS IN TRADING SYSTEMS FOR HETEROGENEOUS DAMAGE

In practice, the magnitude of transaction costs is an important consideration for trading systems designed for heterogenous damage (i.e., time spent on registering and reporting). Several authors have previously suggested that transaction costs will be high for trading systems that have many receiving waters.

The ambient trading system uses fixed average relationships between each source and receiving waters. The fixed transfer coefficients provide certainty and preclude the need or computer simulations before each transaction. It means each source faces a single price, which is based on the weighted average of the prices in the specified portfolio. With brokers providing the specified portfolios, the transaction costs or sources should not be much different from a single-cap and single price system such as EU ETS.

By avoiding computer simulations before each trade, the ambient trading system reduces substantially the trading uncertainty and the transaction costs faced by both sources and authorities.

10.9 WHO CAN TRADE?

There are essentially three types of potential actors in an ambient trading system – point sources, non-point sources and external actors.

The largest sources of nutrient emissions to water in the Baltic Sea are agriculture, sewage treatment plants, forestry, fishery and certain industries, which also represent some of the potential actors to include in a nutrient trading system (note that these are all point sources except for agriculture and forestry). In addition, a large share of the nutrient load, especially nitrogen load, stems from deposition of air emissions where the main sources are nitrogen oxide emissions from combustion sources specifically transports, power plants, industry and agriculture. Including deposition of air emissions in the nutrient trading system requires a modelling approach that identifies the air borne relationship between these sources of air emissions and their impact on the sea or a water body.

Non-point sources such as agriculture, can be included as mandatory participants in an ambient credit system provided there are verified methods for connecting measures and reductions per year and agriculture field area (kg per year and Ha). Since total emissions from agriculture activities cannot be monitored, agriculture activities cannot be included in an ambient permit system as this corresponds to total emissions. Thus, including agriculture in an ambient trading system would likely require an ambient credit system.

Finally, external actors are not emitting nutrients themselves anywhere in the system and are thus not mandatory to own permits (credits) for emissions (generating reductions). These actors may be buyers with the aim increase scarcity by buying and retiring permits. The external actors can also gain permits by taking measures to reduce the nutrient emissions and making the gained permits (or credits) available on the market. For the Baltic Sea region, there are already actors with these types of incentives active in combating the eutrophication. One group of such actors are philanthropic individuals who choose to spend their money on environmental protection.

A major difference between a nutrient trading system and a simple trading system with only one cap, such as the EU ETS, is the consideration of local targets that adds to the administrative costs of the system. Even though transaction costs for individual traders can be reduced using electronic trading systems (which provides each trader with trade opportunities in his own prices and units of emissions), the administrative costs of the system grow as the number of local targets increase.

10.10 BENEFITS AND CHALLENGES FOR BUYERS AND SELLERS IN A TRADING SYSTEM

A trading system could lead to more innovative methods of reducing nutrients in the agricultural sector, since it offers farmers the possibility of getting compensated for developing ecosystem services like nutrient sinks, which could be cheaper than buying the necessary permits. There is, however, a risk that permits will increase the cost for farms. Ideally, this would be passed on to the food consumer, which would provide more financial resources in the system for developing more effective methods.

However, if costs are not accepted by food consumers, international competition may squeeze farmers that are already at a disadvantage given growing conditions in Nordic countries. This trend was not seen in the Lake Taupo trading system in New Zealand, but that country is competitive on the international food market, which is not the case for Nordic countries. In this case, existing trends toward structural change may accelerate within the agricultural sector: i.e., larger farms with more animals per area, as well as more manure and nutrients per square meter, and thus increased nutrient leakage and biodiversity decline. On the other hand, more manure gathered in one area opens up the possibility for more cost-efficient refining of manure.

In summary, although a trading system offers the possibility of more innovative methods and more financial resources in the agriculture sector it may lead to increased nutrient leakage. To avoid this outcome, a trading system could be used as infrastructure for the continued use of existing subsidies, but in this case earmarked for purchasing permits or credits that are tied to a verified set of measures that reduce emissions from non-point sources.

Many of the benefits expected of a trading system could also be achieved through existing policy instruments. For instance, subsidies and grants for environmental investments, biogas, wetland development, and programs like LOVA that target eutrophication could be further developed to stimulate the same benefits that a trading system may achieve, namely more effective measures and methods. However, since these re-designs are not likely to achieve cost efficient allocations, a larger reduction could be achieved at the same cost.

10.11 WHAT HAPPENS WHEN ALL TARGETS HAVE BEEN ACHIEVED?

When all targets have been achieved, the system may either be terminated or re designed to maintain loads that preserve good environmental status. Determining which alternative is most efficient depends on the frequency with which actors enter and exit the markets for nutrient permits. A high frequency of entry and exit would mean a constant flow of new actors entering the market that need to buy permits from the actors that are leaving the market or from actors that are willing to reduce their emissions even further. In this case the system could continue, and the trading system could help to maintain environmental objectives in a cost-efficient manner. On the other hand, if entry and exit are less common, it might be more efficient to terminate the trading system and instead manage environmental objectives with today's current policy instruments.

PART B: CURRENT INSTRUMENTS AND POSSIBLE ROLE FOR A NUTRIENT TRADING SYSTEM

The Baltic Sea countries vary in terms of culture, income levels, and environmental policy commitment which, in turn, can influence possibilities for an international nutrient trading system. Part B assesses the current instruments and possible role for a nutrient trading system in the Baltic Sea region.

- Chapter 11 reviews current nutrient pollution levels, including sources and pathways through which nutrient pollutants travel to the Baltic Sea.
- Chapter 12 maps current policy instruments designed to address nutrient pollution through desktop studies and interviews across the nine countries.
- Chapter 13 provides a qualitative assessment of the effectiveness of existing policy instruments and whether they are likely to help achieve water quality goals.
- Chapter 14 analyses possibilities for collaboration among the nine countries and considers the countries' incentives to participate in a future trading system.
- Chapter 15 concludes Part B by assessing the possibilities for a trading system, given the challenges associated with existing instruments and the incentives faced by each of the countries in terms of future collaboration on nutrient pollution.

11 ENVIRONMENTAL CONDITIONS IN THE BALTIC SEA

The environmental conditions of the Baltic Sea are largely a function of human activities that give rise to nutrient pollution. While there is some uncertainty in estimating exact contributions from individual sources (especially non-point sources from agriculture, which can vary from year to year based on weather and agricultural practices), the aggregate numbers presented in this chapter represent a consensus in how the major sources contribute to the overall pollution loads and water quality in the Baltic Sea. There are several relevant questions in this context:

- Loads. How much nutrient pollution ends up in the Baltic Sea?
- Pathways. How does nutrient pollution get to the Baltic Sea?
- Sources. Where does nutrient pollution come from?
- Status. What is the outcome of nutrient pollution in terms of current water quality status?

11.1 LOADS

The first question is: *how much nutrient pollution ends up in the Baltic Sea*? In 2014, the total water- and airborne inputs of nitrogen and phosphorus to the Baltic Sea were 825,825 tonnes of nitrogen and 30,949 tonnes of phosphorus (HELCOM, 2018a). Figure 11.1. shows an overview of nutrient pollution loads in the Baltic Sea, by country. Poland is the largest contributor of nutrients to the Baltic Sea, followed by Sweden and Russia. See Appendix 1 for quantities per country.

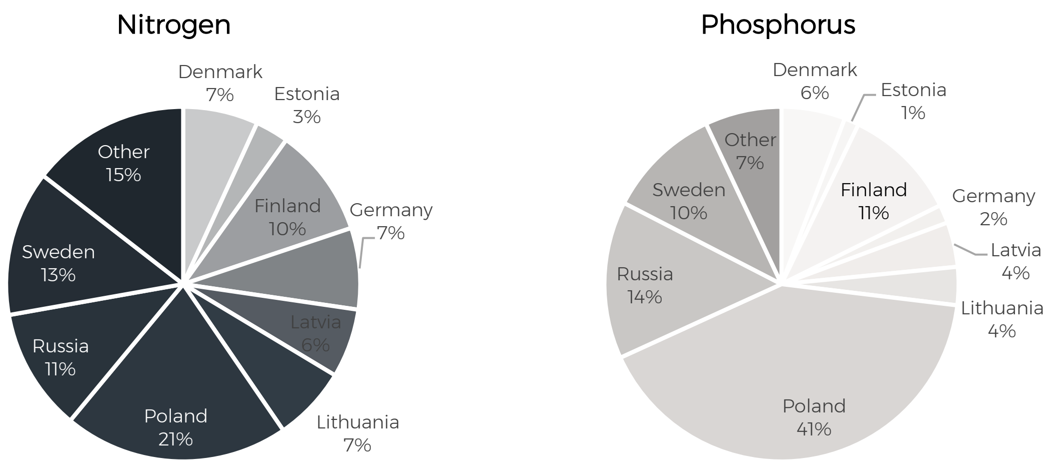


Figure 11.1. Share of total inputs of nutrients to the Baltic Sea in 2014 (HELCOM, 2018a).

11.2 PATHWAYS

The second question is: *how does it get there*? Figure 11.2 shows the pathways through which nitrogen (N) and phosphorus (P) find their way into the Baltic Sea, including percent contribution to the total loads. Land-based nutrient inputs enter the Baltic Sea either air- or waterborne. The main pathway is *riverine* (emissions enter inland surface waters within the Baltic Sea catchment area and are then transported by rivers to the sea) while the second largest pathway for nitrogen is *air* (atmospheric deposition directly into the Baltic Sea). Direct discharge into the sea (e.g., point-source or end-of-pipe emissions) represents only a small share of the total.

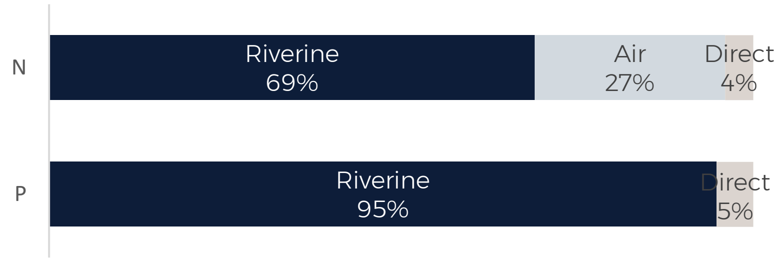


Figure 11.2 Pathways of total nitrogen (N) and phosphorus (P) input to the Baltic Sea (HELCOM, 2018a).

Table 11.1 shows how nutrients are transported to the Baltic Sea, per country. As shown, most countries contribute to both nitrogen and phosphorus via rivers (Germany is an outlier for nitrogen, as its relatively short border with the Baltic Sea means that most of its contribution comes via air).

Table 11.1. Pathways of nitrogen (N) and phosphorus (P) input per country (HELCOM, 2018a). Data from 2014.

Country	Nutrient	Riverine	Air	Direct	Total
Denmark	N	69.7%	26.3%	3.9%	100%
	P	83.4%	-	16.6%	100%
Estonia	N	87.5%	10.4%	2.2%	100%
	P	92.6%	-	7.5%	100%
Finland	N	85.5%	8.3%	6.2%	100%
	P	93.8%	-	6.2%	100%
Germany	N	23%	75.9%	1.1%	100%
	P	96.7%	-	3.3%	100%
Latvia	N	94.1%	4.9%	1%	100%
	P	95.2%	-	4.8%	100%
Lithuania	N	92.7%	7%	0.3%	100%
	P	99%	-	1%	100%
Poland	N	82.6%	16.9%	0.5%	100%
	P	99.4%	-	0.6%	100%
Russia	N	78.4%	11.9%	9.7%	100%
	P	88.1%	-	11.9%	100%
Germany	N	23%	75.9%	1.1%	100%
	P	88%	-	12%	100%

11.3 SOURCES

The third question is: *where does it come from*? The primary sources for the inputs of nitrogen and phosphorus to the Baltic Sea include:

- Atmospheric emissions of airborne nitrogen compounds emitted mainly from land and water-based traffic or combustion for heat and power generation, industrial processes, and from fertilizer applications, animal manure and husbandry.
- Point sources, including inputs from municipalities, industries and fish farms both discharging into inland surface waters and directly into the Baltic Sea.
- Anthropogenic diffuse sources, mainly from agriculture, but also nutrient losses from e.g. managed forestry and rural areas. Losses from scattered dwellings and storm water overflows are also included under diffuse sources.
- Natural background sources, mainly natural erosion and leakage from unmanaged areas as well as the corresponding nutrient losses from e.g. agricultural and managed forested land that would occur irrespective of human activities.

11.3.1 Sources of riverine emissions

Natural background loads of nitrogen and phosphorus make up around one third of the total load of nutrients to the Baltic Sea (Figure 11.3). Among the anthropogenic sources, the diffuse sources (mainly from agricultural activities) constitute the major part. Point-sources constitute 12 percent of the total nitrogen load and 24 percent of the total phosphorus load. Transboundary sources originate in upstream countries.

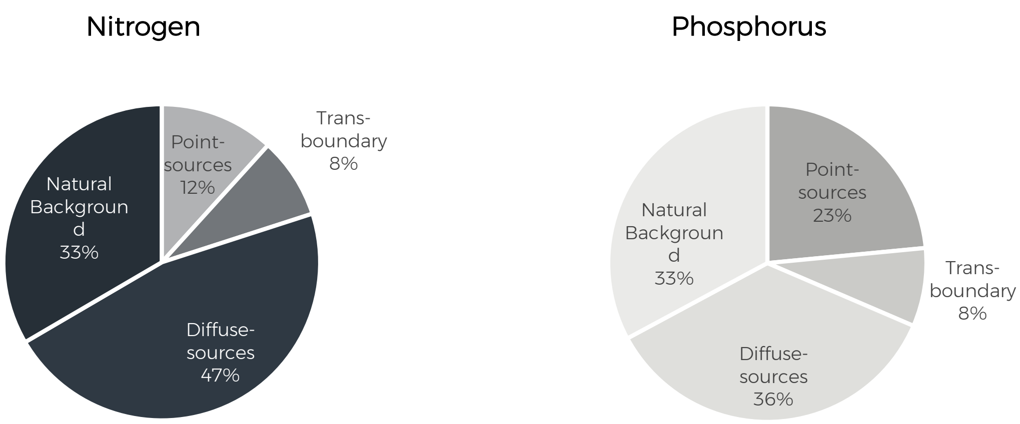


Figure 11.3 Sources of riverine nutrients in 2014 to Baltic Sea (HELCOM, 2018a). Data from 2014.

Figure 11.4 and Figure 11.5 show the sources of riverine nutrient loads from different countries. Agriculture is the main source for most of the countries; natural background levels are relatively high for Russia and Sweden. The information should be interpreted with caution as the nutrient allocation modelling may vary from country to country. Detailed information on the nutrient sources is only available for Germany, Denmark, Finland, Lithuania, Poland, and Sweden, whereas the other HELCOM countries have reported a more generalised source apportionment (HELCOM, 2018a).

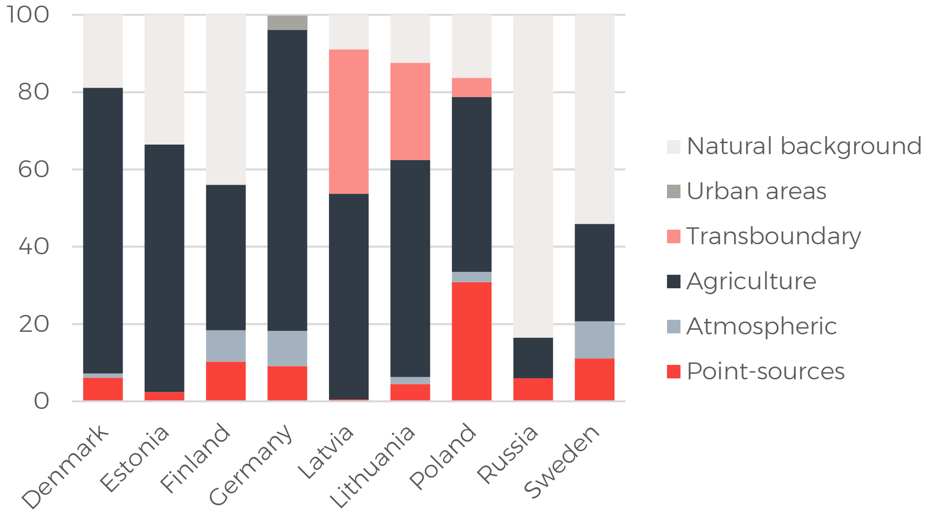


Figure 11.4 Riverine load of <u>nitrogen</u> from different sources (%) (HELCOM, 2018a). Data from 2014. Note: Estonia, Latvia and Russia reported diffuse sources instead of agriculture, but the main part of it consists of emissions from agriculture.

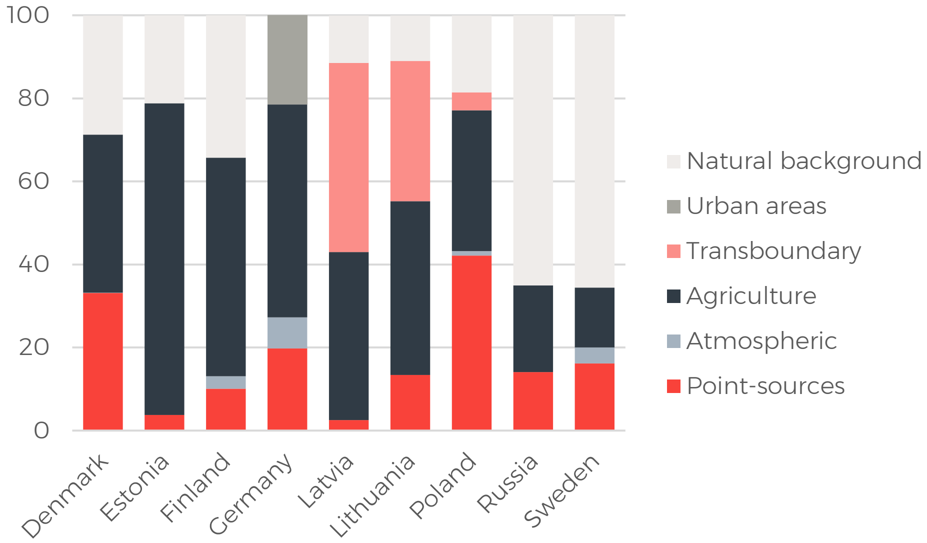


Figure 11.5 Riverine load of <u>phosphorus</u> from different sources (%) (HELCOM, 2018a). Data from 2014. Note: Estonia, Latvia and Russia reported diffuse sources instead of agriculture, but the main part of it consists of emissions from agriculture.

11.3.2 Sources of airborne emissions

Table 11.2 shows the sources of airborne emissions. Only nitrogen emissions are included since phosphorus is mainly waterborne. Transport and combustion are the main sources for all countries: Denmark, Lithuania and Sweden contribute mostly from transport, while Estonia, Finland and Poland contribute largely from combustion.

Table 11.2 Proportion of airborne emissions of nitrogen from the main sectors from HELCOM countries (HELCOM, 2015).

Country	Transport	Combustion	Agriculture	Other	Total
Denmark	68%	32%	<1%	<1%	100%
Estonia	52%	48%	<1%	<1%	100%
Finland	50%	46%	1%	4%	100%
Germany	48%	34%	11%	7%	100%
Latvia	51%	37%	<1%	12%	100%
Lithuania	74%	22%	0%	4%	100%
Poland	43%	56%	0%	1%	100%
Russia	52%	26%	2%	9%	100%
Sweden	67%	23%	0%	10%	100%

11.3.3 Sources for direct discharge to the sea

The nutrient loads from direct point-sources are dominated by municipal wastewater treatment plants (See

Figure 11.6, which refers only to nitrogen direct discharge). The Finnish, Swedish and Danish coastlines generally have many smaller municipal wastewater treatment plants, while other countries tend to have fewer larger plants near the coastal cities. Large industrial point-sources also exist, especially along the Swedish coast and to some degree along the Finnish coast. Nutrient loads from sea-based aquaculture activities mainly come from Finland, Denmark, and to some extent from Sweden (HELCOM, 2018a).

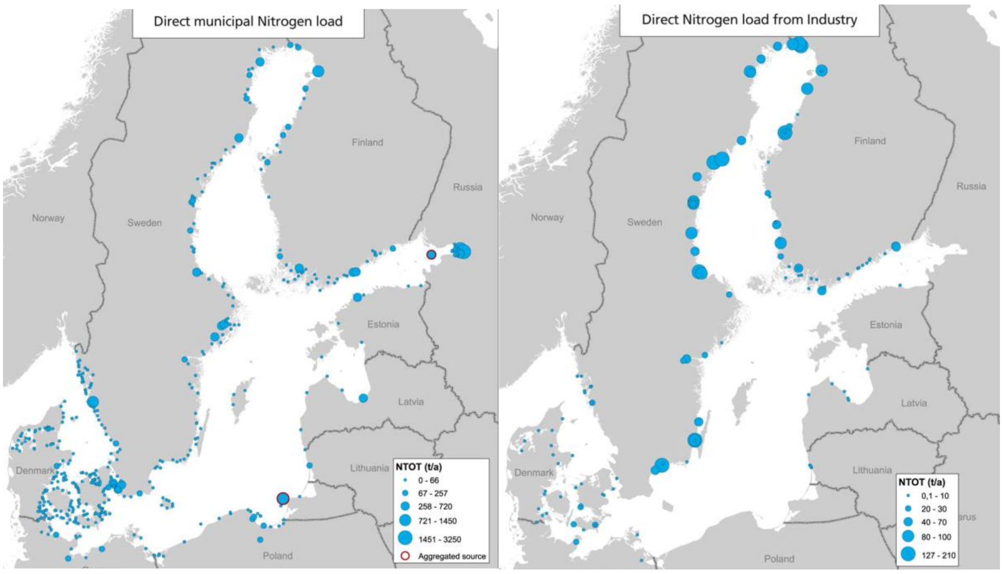


Figure 11.6 Direct nitrogen loads from municipal wastewater treatment plants and industry. NTOT = Total Nitrogen (the sum of different forms of nitrogen) (HELCOM, 2018a).

11.4 WATER QUALITY IN THE BALTIC SEA TODAY

The combined sources and loads described above have resulted in poor water quality in the Baltic Sea, based on several water quality indicators that fail to meet basic standards. We summarize four of these below (eutrophication, phosphorus, nitrogen, ecological status).

11.4.1 Eutrophication levels

The Baltic Sea is one of the largest brackish waters in the world and, due to its climatological and oceanographic characteristics, highly susceptible to nutrient input and eutrophication (European Environment Agency, 2019). Because of human activities, the Baltic Sea is experiencing large-scale problems of eutrophication, the first signs of which emerged in the beginning of the last century and peaked near the end of it. Documented improvements have been identified over the past 15-20 years due to reductions in nutrient inputs, but eutrophication remains a large-scale problem. Only 2 percent of the Baltic Sea has been classified as non-problem areas, while 98 percent have been identified as problem areas by the European Environment Agency (2019). The most affected areas are the Bothnian Bay, the Gulf of Finland, the Baltic Proper and the Bornholm Basin, many of which are located downstream to catchments with high population densities and agricultural activities. The European Environment Agency (2019) argues that additional reductions of nutrient inputs are required to meet the objectives of the Baltic Sea Action Plan, WFD and the MSFD.

11.4.2 Concentration of nitrogen

For total nitrogen, 13 open-sea assessment units were studied in the same period as for phosphorus (2011–2016) by HELCOM (2018c). Good status was achieved in two assessment units (Kattegat and the Great Belt). In coastal water assessment units, most threshold values for good status were not reached, although there were some exceptions for parts of Estonia, Finland, Poland and Sweden. In total, there were 17 open-sea assessment units studied and out of these, four units were not assessed (Kiel Bay, the Bay of Mecklenburg, the Arkona Sea, and the Bornholm Sea).

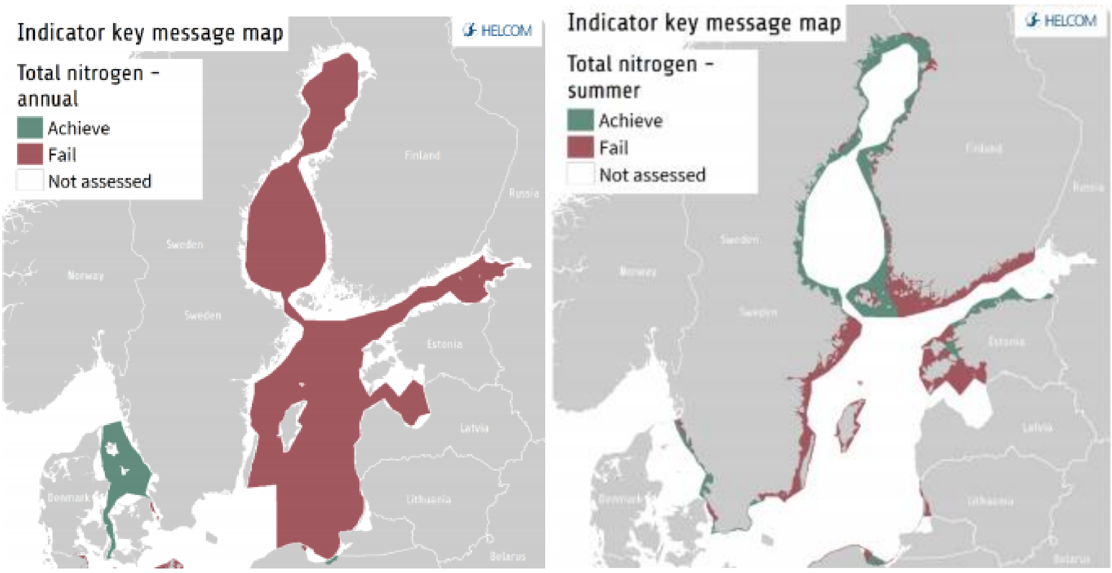


Figure 11.7 Status assessment evaluation of the indicator Total Nitrogen – annual and summer values (HELCOM, 2018c)

11.4.3 Concentration of phosphorus

Total phosphorus levels were measured in the Baltic Sea using averages for the period 2011–2016 (HELCOM, 2018d) and only one (Great Belt) of the 12 open-sea areas showed achievement of good status (See annual and summer values in Figure 11.8). Concentration levels in Kattegat, Gdansk Bay, and the Bothnian Bay were only slightly above the threshold value. In most coastal water areas, phosphorus levels failed to reach good status. In total, there were 17 assessment units (five were not measured in the report: Kiel Bay, the Bay of Mecklenburg, the Arkona Basin, the Bornholm Basin and the Eastern Gotland Basin). Out of the remaining 12, only the Great Belt had an average concentration of phosphorus below that of the threshold value (0.76 < 0.95). Only about 8 percent of the assessment units measured achieved the targeted threshold value.

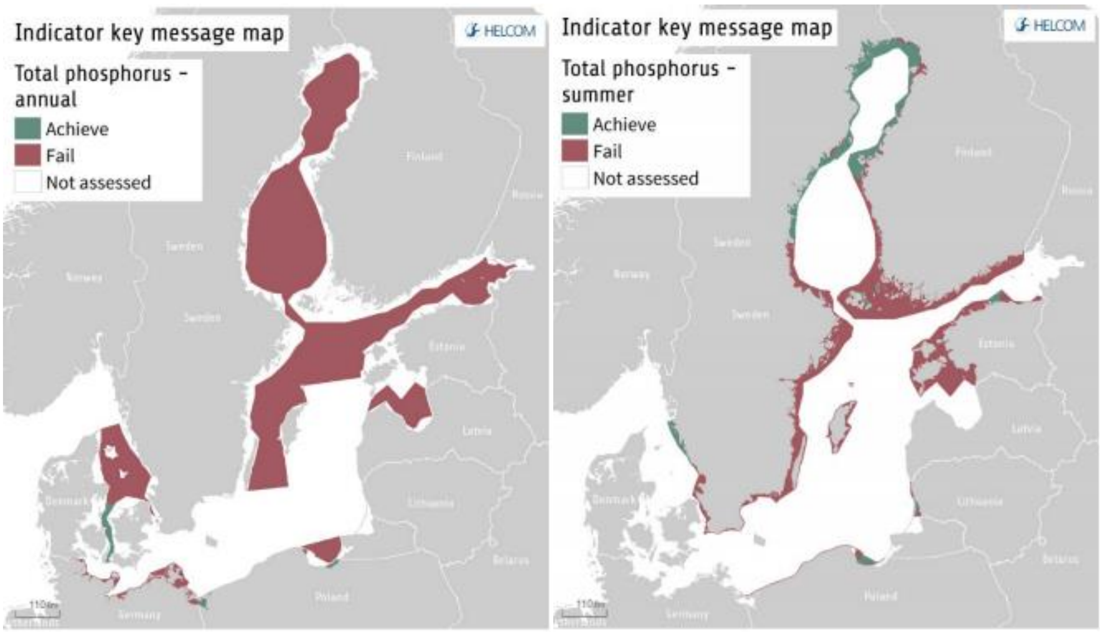


Figure 11.8 Status assessment evaluation of the indicator Total Phosphorus – annual and summer values (HELCOM, 2018d)

11.4.4 Ecological status

Ecological status under the Water Framework Directive is used as an assessment of the quality of surface water ecosystems and illustrates the influence of pressures such as pollution and habitat degradation on identified quality elements. Based on biological quality elements and supported by physico-chemical and hydro-morphological quality elements, the ecological status is determined for all types of surface water bodies, e.g. rivers, lakes, transitional waters, and coastal waters.

In many of the countries surrounding the Baltic Sea, most of the rivers have less than good ecological status except for Finland and Estonia (WISE WFD Database, 2018). This is illustrated in Figure 11.1 where the ecological status has been divided into six categories with “High” representing the best category and “Bad” representing the worst. The country with the highest percentage of rivers in less than good condition is Germany (DE).

The European Commission (2019) reports that Germany and Latvia are far from reaching good ecological status, and other objectives in the Water Framework Directive, despite efforts to increase surveillance monitoring in relation to surface waterbodies. The reported ecological status has deteriorated in Denmark, Latvia and Sweden since reporting started with the first river management basin plans (however, in Sweden, this is mainly due to changes in the classification methods).

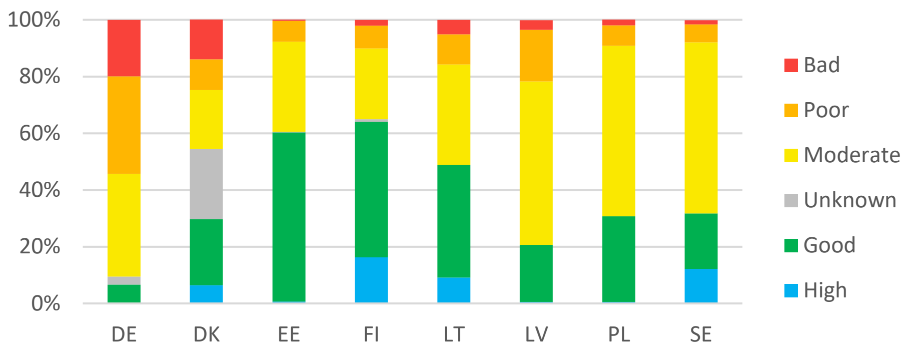


Figure 11.1 Ecological status of rivers in the Baltic Sea region (WISE WFD Database, 2018).

12 CURRENT POLICY INSTRUMENTS

This chapter provides an overview of the coastal countries' strategies and policy instruments to combat eutrophication. We categorize the range of policy instruments used to address nitrogen and phosphorus pollution based on documented studies and interviews with authorities. Focus is on sources that may be included in a future nutrient trading system (waterborne loads from rivers and direct discharge, which captures 73 percent of nitrogen and 100 percent of phosphorus loads that enter the Baltic Sea (HELCOM, 2018a). Policy instruments aimed at air emissions are excluded in this chapter in part because they are challenging to include in a nutrient trading system (see difficulties of measuring the destination of airborne pollutants in Section 6.5).

12.1 COMMON GOALS

International work on protecting the Baltic Sea started 50 years ago. In 1974, the coastal countries of the Baltic Sea signed the Convention on the Protection of the Marine Environment of the Baltic Sea. In 2007, the Baltic Sea Action Plan (BSAP) was adopted by the nine coastal countries (i.e. the HELCOM countries), which was revised in the 2013 HELCOM Ministerial Declaration (HELCOM, 2013). According to the Baltic Sea Action Plan, the goal is to restore the Baltic Sea to a good environmental status by 2021. In 2009, the European Council adopted the European Union strategy for the Baltic Sea region to advance environmental protection, including the reduction of nutrient loads, by promoting increased cooperation between neighbouring countries.

Implementation of the HELCOM targets are based on mandatory reporting of mitigation strategies (Hassler, 2016). Therefore, it is reasonable to expect that the contracting countries will choose different approaches and policy instruments for reaching their targets. Eight of the nine HELCOM-countries are also EU member states (meaning that they must transpose EU Directives to national legislation), which suggests these countries are likely to have similar policy instruments.

12.2 NATIONAL ENVIRONMENTAL STRATEGIES

All countries bordering the Baltic Sea have environmental strategies that address nutrient pollution to varying degrees. We review these strategies below to determine whether eutrophication receives specific attention. We also consider possible goal conflicts between a country's agricultural strategy and nutrient pollution.

As
Table 12.1 suggests, only Finland, Sweden, Estonia and Lithuania specifically refer to the Baltic Sea as a priority in their environmental strategies. Further, only Denmark and Latvia refer directly to EU Directives (WFD and MSFD). The other relevant EU member states have formulated national targets in their environmental strategies but, interestingly, rarely mention the Baltic Sea Action Plan (For Estonia, the Baltic Sea Action Plan was agreed upon after the national environmental strategy was adopted). Russia, the only non-EU member state, does not address the Baltic Sea in its federal target program "Water of Russia" (although it does identify eutrophication problems in other parts of the country) but it does discuss target programs for Lake Ladoga and Lake Onega, which are upstream to the Neva river and thus within the Baltic Sea watershed. Strategies from some of the individual Russian regions refer to the need to reduce nutrients to the Baltic Sea, with a focus on urban wastewater.

Table 12.1 Country strategies related to nutrient pollution and eutrophication

Country	Overview of Environmental Strategy	Comment
Denmark	Target 23 of the Danish National Strategy for Sustainable Development from 2014 states that water and marine environments should fulfil good quality according to the WFD and MSFD (Danish Government, 2014)	Refers to EU directives
Estonia	The Plan on Environmental Use and Protection implements the National Environmental Strategy to 2030 (Ministry of the Environment, 2007). The plan outlines four targets for the environment. The water target aims at achieving and maintaining good status of marine, surface and groundwater.	Refers to national env. programme
Finland	The Government Programme of Sanna Marin (Government Programme, 2019) includes a strategic focus on Baltic Sea protection, including very specific measures to combat eutrophication.	National priority of the Government
Germany	Eutrophication is mentioned in environmental and agricultural strategy documents. In 2017, the Ministry for Environment published the first comprehensive nitrogen-report of the federal government (BMU, 2017), which stresses the need for a nitrogen action program.	Main focus on nitrates
Latvia	The Sustainable Development Strategy is general and does not mention eutrophication. Water quality improvements largely rely on River Basin Management Plans	Water policy relies on EU directives
Lithuania	Water Resources Development Programme for 2017-2023 specifically mentions eutrophication and defines related and specific objectives in the National Environmental Protection Strategy (Ministry of Environment, 2016), see e.g. policy implementation direction "41. Reduction of pollution in the Baltic Sea".	Part of national environmental protection strategy
Poland	State Ecological Policy 2030 includes a development strategy in the field of environment and water management. Emphasis is on improving water quality (Ministry of Climate, 2019).	Part of national environmental protection strategy
Russia	The Federal Target Program "Water of Russia" focuses on the goals of the Federal Water Strategy. Decree on the national development goals of Russia through 2030 (Government of Russian Federation, 2020). One target is "improvement of ecological status of water bodies" but the Baltic Sea is not listed among prioritized waters (other lakes in the	Russian Baltic Regions address eutrophication of the Baltic

	Baltic Sea watershed are however, including Lakes Ladoga and Onega. Russian Baltic regions address eutrophication and call for improvement of wastewater treatment.	Sea, rather than the federal level
Sweden	"Zero Eutrophication* is one of the 16 Swedish Environmental Objectives. Other relevant objective are "A Balanced Marine Environment" and "Flourishing Coastal Areas and Archipelagos" (Swedish EPA, n.d.)	Included in national objectives

Table 12.2 suggests that all countries have a goal of increasing competitiveness of agricultural production. Further, eight of the nine explicitly acknowledge the possibility of a conflict, i.e., mention the need to moderate agricultural goals with respect to nutrient pollution or other environmental goals. The only exception is Russia, where the Leningrad region focuses exclusively on increasing agricultural production (Note, however, that the Kaliningrad region prioritizes "eco-agriculture" without explicitly mentioning nutrient pollution).

Table 12.2 Agricultural strategies and how they potentially conflict with nutrient reduction (or other environmental) goals.

Country	Description of possible goal conflict
Denmark	The Food and Agricultural Package intends to increase primary production while simultaneously protecting the environment. (Ministry of Environment and Food of Denmark, 2017)
Estonia	The Agriculture and Fisheries Development Plan until 2030 establishes a goal of having competitive agriculture that is consistent with environmental protection. The development plan states that nutrient pollution is a problem to be addressed. (Ministry of Rural Development, 2020).
Finland	Bio and circular economy are emphasized as goals for a competitive agricultural sector in the Forest and Agriculture Strategy for 2030 (Ministry of Agriculture and Forestry, 2019).
Germany	The Agriculture Commission at the Federal Environment Agency (KLU) and the BMU stress the need for a more far-reaching greening of the CAP with respect to, among other, nitrogen.
Latvia	Establishes a goal of increased agricultural productivity, while also mentioning the need to consider the Nitrate Directive with respect to milk production.
Lithuania	Established goal of effective and competitive agriculture with reduced environmental impact. However, water is not specifically mentioned regarding agriculture.
Poland	The main goals for agriculture are to increase competitiveness and innovation as a part of the Strategy for Sustainable Rural Development, Agriculture and Fishery 2030. The strategy highlights e.g. rational management of fertilizers
Russia	Leningrad Region aims to double agricultural production by 2024 and Kaliningrad Region is expected to increase the agricultural area by recapturing former agricultural land. The Kaliningrad region prioritizes sustainable eco-agriculture but does not directly address question of pollution.
Sweden	The Food Strategy aims specifically to increase production of food while simultaneously reaching environmental goals.

12.3 MAPPING OF EXISTING POLICY INSTRUMENTS

Policy instruments are mapped by country, considering both the target sectors (wastewater and agriculture) and the general category of policy instrument.

12.3.1 Categories of policy instruments

Environmental policy instruments are categorized in the literature for the purpose of comparison and assessment. Although categorizations vary somewhat, they generally fall into three main categories (see e.g. Sterner & Coria (2011)).

- Information (public engagement). This relies on the provision of information to actors to influence or steer them toward a desirable environmental outcome. Usually the aim is to improve understanding of cause-and-effect or simply to share knowledge about poorly understood mechanisms for environmental impacts (e.g., information to farmers about how certain practices can influence their total discharge of pollutants). Examples include information disclosure (to consumer or producers), labelling, environmental certification of actors, and/or community participation. Use of information instruments can sometimes lead to cooperative agreements between authorities and regulated community. For example, the provision of information, technical guidance, and advice/support by authorities can stimulate voluntary measures to reduce nutrient pollution, rather than relying on mandatory requirements.

- Regulation (command-and-control). This imposes an explicit restriction on an activity (across time and space) or an explicit standard that must be upheld, sometimes referred to as "command-and-control" regulation. Examples include e.g., zoning restrictions, regulation of fishing, harvesting and re-planting rules in forestry, pollution levels, etc. It may focus on *process* (e.g., requiring a specific technology for abatement regardless of environmental impact) or on *outcome* (e.g. requiring that a water quality standard or goal is met, without specifying how).

- Economic policy instruments. This relies on economic incentives to steer actors toward a desirable environmental outcome, rather than requiring it or simply providing information. There are many forms, including e.g., subsidies to encourage a behaviour (or removal thereof to discourage a behaviour), environmental charges/fees, carbon taxes, deposit-refund systems, or environmental markets. Economic policy instruments are versatile – sometimes they are driven by regulation (i.e., carbon emissions trading would not exist in the absence of the requirement to reduce such emissions) or may coincide with voluntary measures (e.g., subsidies that encourage, but do not require, farmers to conserve soil/protect biodiversity; opportunities for third parties to purchase emission permits to reduce overall emissions, etc.). The analysis below distinguishes between three subcategories of economic policy instruments: Taxes/fees (e.g., fees for discharging wastewater or pollution charges and sewage taxes to incentivize new technology[6]), Subsidies (e.g., payments to farmers for nutrient sequestration projects), and Markets (e.g., trading systems for nutrients).

6 Although penalties could be seen as economic policy instruments if they increase with the size of the violation (thus incentivizing reductions to some extent), we exclude them from this category since they are predominantly linked to "regulation" (command-and-control) instruments.

12.3.2 Information sources

The review of policy instruments has relied on two sources of information:

- Desktop study. The primary information source has been a review of relevant EU and national policy documents from the nine countries. Further, we have conducted searches into relevant literature related to policy instruments and collected documents from individual countries about their policies to address nutrient pollution.
- Interviews. To complement the desktop study, we conducted interviews with 29 respondents at policy making agencies responsible for water and agriculture in Estonia, Finland, Germany, Latvia, Lithuania and Poland to better understand the instruments and measures used to address nutrient pollution (See list in Appendix 2). The interviews covered, among other things, major sources of pollutants, instruments applied, experience with economic policy instruments and challenges faced in addressing nutrient emissions. Interviews lasted about 60 minutes.

12.3.3 Results per country

The result of the mapping is presented below, where each country's instruments aimed at waterborne nutrient pollution are divided into agriculture and wastewater.

Although our focus is on mapping agriculture and wastewater instruments, we acknowledge at least two other sectors that are relevant with respect to nutrient pollution: shipping and storm water. We exclude these from our analysis because they represent relatively minor contributions today, but we note the following: (1) Nutrient pollution control from Baltic Sea shipping came into force by agreements between HELCOM and the International Maritime Organization (IMO), and applies to passenger ships under Annex IV of the MARPOL Convention. Discharge from ships must be handled at port reception facilities (in effect for new ships since 2019 and all ships in 2021), and (2) Management of storm water discharge covers upgrade of infrastructure and pollution abatement and is generally shifting towards nature-based solutions such as green areas, retention ponds, rain gardens and infiltration trenches. In several countries e.g. Denmark, Sweden and Germany, policies are moving away from mixing storm water with sewage infrastructure. Implementation of storm water measures is generally the responsibility of municipalities.

DENMARK	
AGRICULTURE	
INFORMATION	In addition to free advisory services to farmers, Denmark has appointed Catchment Officers (Oplandskonsultenter) who assist farmers with wetland implementation (Water CoG, 2020).
REGULATIONS	Implementation of the Nitrates Directive restricts when, where, and how fertilizers can be spread and applied. For example, livestock manure and other organic fertilizers are limited to 170 kg worth of nitrogen per hectare (Ministry of Environment and Food of Denmark, 2017). Farmers of a certain size are required to hand in accounts of their fertilizer use each year containing information of their use of nitrogen and phosphorus. Further, in their aim to balance the uptake of nitrogen, a fertilizer quota calculated by a central agency based on optimal levels of nitrogen fertilization, soil type, available nitrogen from the previous season, crop, and the price of crops and fertilizers is applied for farmers. Moreover, farms over a certain size are required to plant a minimum area of catch crops and failure to do so results in a lowering of this fertilizer quota. The application of organic fertilizers containing less than 75 percent manure (i.e. sludge) is restricted to 30 kg of phosphorus per hectare over a three-year period. Since 2018, there are ceilings for phosphorus emissions set at farm level as a kg of phosphorus per hectare, which applies to all types of fertilizers. Stricter ceilings are applied to catchment areas with aquatic systems vulnerable to phosphorus emissions. In 2019-2020, this ceiling was set to 30-39 kg per hectare for non-sensitive zones and 30 kg per hectare in sensitive zones with the exception for derogation cattle farms where 35 kg per hectare is applied (Laakso & Loustarinen, 2019). Starting from 2007, Danish livestock farmers must apply for an environmental permit for more than 75 livestock units (Ministry of the Environment, n.d.). In order to comply with the Water Framework Directive, more geographically targeted regulation of agriculture will be implemented, i.e. individual farms can face stricter regulation (Ministry of Environment and Food of Denmark, 2017). For each farm, a leaching permit to the aquatic environment is appointed. The permit is calculated as the maximum nitrogen leaching from the root zone per hectare (kg N per hectare). Each farm within a catchment area will be appointed the same leaching permit per hectare. Farmers can themselves choose among some instruments with which to decrease leaching, e.g. catch crops, buffer strips, reduced nitrogen application etc. Farmers could also be compensated for costs to comply with the permit. Danish farmers are obliged to ensure an inspection of their slurry tanks (with a capacity above 100m3) by an authorized inspector, every 5 or 10 years depending on farm location relative to water.
ECONOMIC INSTRUMENTS	In 2004, Denmark implemented a phosphorus tax on animal feed of 0.5372 euros per kg phosphorus (OECD, 2020). To reduce the amount of artificial fertilizers by households, Denmark has a tax of 0.6715 euros per kg fertilizer (OECD, 2020). An agreement in 2015 led to government-financed subsidies for farmers when they invested in the following measures: establishing wetlands, establishing mini-wetlands, afforestation and taking low-lying agricultural lands out of production.
WASTEWATER	
REGULATIONS	Denmark has implemented four River Basin Management Plans across the country to reach targets set in the EU Water Framework Directive and the Baltic Sea Action Plan. These plans contain three measures designed to reduce organic matter emissions, which will reduce emissions of nitrogen and phosphorus. First, households in sparsely populated areas will be mandated by municipalities to install a set standard of sewage treatment equipment. Second, municipalities are to arrange wastewater discharge from storm water outlets. Third, municipalities must improve sewage treatment plants to reduce pollution levels to waterbodies not reaching environmental targets (Ministry of Environment and Food of Denmark, 2016). Further, municipalities are required to create wastewater plans that establish which properties that are to be connected to the communal wastewater system and which properties that are to have individual treatment systems with the use of permits. These permits stipulate quality of standards for discharged water considering the requirements for nitrogen and phosphorus removal as well as environmental objectives for individual waterbodies established in the River Basin Management Plan. Denmark has also chosen to implement strict requirements for nitrogen and phosphorus removal for all municipal wastewater treatment plants serving more than 10,000 person equivalents. The Best Available Technology (BAT) limit value is 8 mg/l for nitrogen and 0.4 mg/l for phosphorus (Preisner, et al., 2020). Failure to meet the environmental objectives, even with BAT, results in stricter limits on emissions (Baaner & Tegner Anker, 2013). There are separate industrial discharge permits for wastewater directly to surface waters and these permits mandate requirements for treatment and limit emission values. Sludge from wastewater treatment plants is limited to 7 tonnes of dry matter per hectare and year.

ECONOMIC INSTRUMENTS	In addition to the permits, Denmark also has a sewage tax targeting companies, wastewater treatment plants, and housing in rural areas with individual wastewater treatment systems. The purpose of this tax is to create an incentive to improve technology in reducing pollutants and the amount of water discharged. The tax is dependent on the amount of pollutants being emitted, including nitrogen, phosphorus, and organic matter. The tax rates of treated wastewater concern three pollutants: BOD5 (2.47 euros/kg), total N (4.44 euros/kg), and total P (24.46 euros/kg) (Preisner, et al., 2020). Rural houses are taxed with a fixed rate based on the treatment technology used (Baaner & Tegner Anker, 2013).

ESTONIA

AGRICULTURE

INFORMATION	Estonia provides advisory services for farmers and depending on EU rules some of them are for free. The provision of individual counselling services is supported up to 90 percent, for services within, e.g. organic farming; forestry; environmental protection and nature conservation. During interviews it has been pointed out that a shortcoming is that Estonia does not have farming advisers specialised on environmental protection, (compare to Greppa Näringen advisers in Sweden). In Estonia, advisers have basic knowledge of environmental issues but specialize in e.g. crop cultivation or animal husbandry.
REGULATIONS	Use of fertilisers and manure are regulated by a ban to spread in wintertime and when fields are flooded or saturated with water. The per hectare limit of manure is 170 kg nitrogen per year and 25 kg phosphorus as a five-year average, according to the Water Act (RT I, 22.02.2019, 1, 2019). Starting from 2021 farmers will be required to calculate nutrient balances on field level for nitrogen and phosphorus, (Riisenberg, 2019). Large farms with 400 animal units or more are required to hold an integrated environmental permit. These farms are also obliged to implement Best Available Technology (BAT). The BAT requirement has implications on animal husbandry since there are stricter requirement concerning the choice of manure storage for cattle, than for pig and poultry farming. In 2023, every livestock building with more than 5 livestock units will be required to have a manure storage capacity of 8 months. For diffuse source pollution, farmers are required by the Water Act to follow “Good Agricultural Practices” e.g. cultivation of winter crops. In the nitrate vulnerable zones, there is an obligation to plant 30 percent of arable land with winter crops. In Estonia, water protection zones (1, 10, or 20 m) have been implemented by law. The strictest zones concern the shores of the Baltic Sea and Estonia’s major lakes. According to the Water Act (§119) cultivation and use of fertilizers are forbidden in water protection zones.
ECONOMIC INSTRUMENTS	Subsidies: EU grants are used for environmental purposes. Eligible environmental protection measures include e.g. extension of the water protection zones; construction of a sedimentation pool; adjustable drainage to save local water resources; drainage water reuse pond.

WASTEWATER

REGULATIONS	Enterprises and wastewater treatment plants are obliged to hold a water permit for discharge of pollutants and treated effluent and cooling water into a recipient (Water Act § 187). Environmental permits are issued by the Environmental Board (Keskkonnaamet) and these define limit values for pollutants. In agglomerations of at least 2,000 population equivalents (p.e.), the local government is obliged to supply public sewerage services according to the Public Water Supply and Sewerage Act (RT I 1999, 25, 363, 1999). The maximum allowable limit of nutrient content is 10 mg/l for nitrogen (Ntotal) and 0.5 mg/l for phosphorus (Ptotal) according to the ordinance of the Minister of Environment (RT I 12.11, 2019). In permits for wastewater treatment plants the requirements are based on the status of the recipient and its sensitivity to nutrient pollution. If required by the Water Framework Directive, it is possible to issue stricter permits than what is defined by the ordinance.
ECONOMIC INSTRUMENTS	Estonia introduced environmental charges more than 20 years ago and charges are paid by those who are obliged to have an environmental permit. Water charges include charges for emitting nutrient pollutants. The charges cover only point-sources, since pollution from non-point sources are not required to have an environmental permit. In principle, the agricultural sector does not pay, except farmers who are obliged to have an integrated environmental permit for air emissions. They pay for air emissions, of which some end up in water, but they do not pay for their diffuse water pollution.

The wastewater charge of phosphorus is 12,014 euros per tonne and 2,826 euros per tonne of total nitrogen. Those who exceed the limit values of their environmental permit, pay 10 times the rate of the charge for the exceeding amount.

Estonia provides investment grants to wastewater infrastructure. If the owner of the infrastructure lacks funds, it is possible to apply for investment support. The main sources of investment support include EU cohesion funds and proceeds of environmental charges (through the environmental funds of KIK (KIK stands for the Environmental Investment Centre)). The grants available and their purpose have shifted somewhat over time, recently support to households has been added. The purpose is to provide funding to households to connect their house to the wastewater infrastructure.

	FINLAND
AGRICULTURE	
REGULATIONS	For mitigating nutrient loading, buffer strips (3m – 10m wide if fields are bordering surface waters) and fertilization limits (particularly for phosphorus fertilization) are two important ones. Fertilization limits are set by the voluntary agri-environmental scheme, which comprise a majority of farmers. Soils are classified into seven categories based on their soil phosphorus levels. For cereal crops it is not allowed to fertilize soils in the highest categories. For the third highest category the farmer can apply 5 kg per hectare of phosphorus, for the fourth highest 10 kg per hectare, and the remaining categories 16, 26 and 34 kg per hectare respectively. The idea of these limits is to gradually deplete the excessively high levels of phosphorus in the soil, which strongly contribute to the loading of dissolved phosphorus. The fertilization limits also apply to animal farms although with some exceptions from the strict limits. As participation rates for agri-environmental programs traditionally have been high (around 90 percent of farmland), the environmental permitting system applied for the largest animal farms implicitly assumes that farmers follow the nutrient limits set by the program. Moreover, farmers can also choose from other sets of measure including incorporation of liquid manure, nutrient circulation, and permanent crop cover to mention a few.
ECONOMIC INSTRUMENTS	In Finland, the entire farm area is entitled to the Less Favourable Area (LFA) as well as an extensive agri-environmental subsidy scheme that was established with a strong income support element. More than 90% of farmland receives agri-environmental subsidies and the annual payments for the measures amount to more than 300 million euros. Further, this agri-environmental policy consists of two interconnected entities: the agri-environmental program of the CAP and the environmental permitting system for the largest animal facilities. All farms within the EU eligible for CAP subsidies need to comply with the environmental cross-compliance conditions. Finland allocates national funds to the program “Enh ance the Effectiveness of Water Protection” with a budget of 69 million euro for the period of 2019-2023. The funds are targeted to water protection measures to mitigate nutrient loading from land to waters, to improve water management in agriculture and forestry, to restore water bodies, to improve the control of runoff from urban areas and to fund research (Ministry of the Environment, n.d.). Agriculture and forestry are allocated about 34 million euro.
WASTEWATER	
INFORMATION	Informational: In connection to the Baltic Sea Challenge, several cities have established and shared plans to improve the control of urban surface runoff to better understand the environmental impact of such waters, how to control it, and raise public awareness.
REGULATIONS	According to Finnish legislation, all wastewater treatment plants exceeding 100 person equivalents must possess an environmental permit. Further, the Environmental Protection Act (5277/2014) sets minimum requirements for phosphorus removal while the nitrogen removal requirements must be set in the environmental permit. The Environmental Protection Act sets a limit on scattered discharge. The load of domestic wastewater must be treated so that at least 80% of organic matter is abated, at least 70% for total phosphorus and at least 30% for total nitrogen. The scattered settlements follow a set of technical standards implemented by municipalities.

GERMANY

AGRICULTURE

INFORMATION	First, informational measures focus on enhancing cooperation within the agricultural sector by building up a communication structure for reducing nitrogen loads entering surface waters. This also includes counselling and voluntary certification schemes (BMUB, 2016; LAWA, 2015). Second, information is provided to incentivize research, to develop legume cultivation and to reduce the use of chemical fertilizers and to produce plant-based, protein-rich food. This has prompted the adoption of a protein-plant strategy (Bundesregierung, 2016). Third, information aims at reducing food waste and changing the public's dietary habits, where excessive consumption of meat is best avoided from a nitrogen perspective.
REGULATIONS	Fertilizers are regulated in accordance with the Nitrates and NEC Directives (DüV, 2017). The Fertilizer Ordinance (DüV) and the Ordinance on systems for handling water-polluting substances (AwSV) apply to all agricultural enterprises. The DüV stipulates that the amount of fertilizers used must be calculated based on the nutrient need of the crop and existing nutrient stocks in the ground. The maximum amount of total nitrogen to be applied on agricultural land may not exceed 170 kg per hectare and the use of nitrogen fertilizers should be adapted to the needs of the crops in question as well as local soil conditions to minimize leakage to the aquatic environment. There is no maximum level set for phosphorus although the regulation stipulates that needs should be calculated based on local conditions. In May 2020, revisions to the Fertilizers Ordinance and Water Act included mandatory measures in areas with high levels of nitrates in the groundwater or with surface waters eutrophied by phosphorus such as prolonged periods during the year when fertilization is prohibited; banning fertilizer application to frozen ground; enlarged year-round vegetated buffer zones for water bodies in areas with inclination, and mandated record-keeping.
ECONOMIC INSTRUMENTS	Public authorities pay forest owners to manage their forests in accordance to certain ecological criteria. Similarly, water utilities compensate farmers to undertake water protection measures. The aim is to secure drinking water quality and supply. The initiative relies on the federal Water Act, but payments are mostly financed by water tariffs. The main federal instrument for promoting agrarian structures is called the National Fund for Improving Agriculture and Coastal Protection of which the annual task budget amounts to roughly 1.5 billion euro. The task is regulated by law and administered at a federal level by the Ministry of Food and Agriculture and to a large extent implemented by the federated states. A financial plan with a four-year span is drawn up on a regular basis in cooperation between the federated states and the federal government. In the 2019-2022 plan, eutrophication-related measures eligible for funding included use of low-nitrogen fertilizers (30 kg/ha), diversification of crops, refraining from using fertilizers containing nitrogen in certain areas or under certain conditions, and establishing and managing natural landscape elements such as buffer strips (BMEL, 2019).

WASTEWATER

INFORMATION	Germany's efforts to reduce the amount of nitrogen found in wastewater include, among other things, influencing the public's dietary habits towards more plant-based foods by developing tools for calculating one's nitrogen-footprint as well as implementing awareness-raising measures targeting nurseries, schools, and the general public. In addition, Information aimed at recycling sewage sludge, after separating nitrogen and phosphorus, for use as a fertilizer (UBA, 2014).
REGULATIONS	Wastewater treatment is regulated by the Wastewater Ordinance, where the whole country is regarded as a sensitive area per the UWWTD meaning that stringent treatment must be applied in order to remove at least 75 percent of the total nitrogen and phosphorus. Moreover, the federal Sewage Sludge Regulation was amended in 2017 to ban the use of unregulated sewage sludge on agricultural land, requiring instead that sewage sludge producers report their planned and implemented measures to ensure phosphorus is recycled by 2023. Since 1980, Germany has regulated phosphorus content in detergents, including both textile detergents and, more recently, dishwashing machine detergents. As of 2005, national legislation in the area of detergents are backed by the EU Detergents Regulation (648/2004/EC).
ECONOMIC INSTRUMENTS	The law on wastewater fees (AbwAG) stipulates that fees should be paid for discharging wastewater, including stormwater, into water bodies. The law applies to wastewater from households, agriculture or other commercial activities, stormwater from urban areas, and leachate from waste facilities. The fee is paid for by the private actor discharging the wastewater, but the federated states can decide to transfer this liability to public corporations. The fee itself is calculated based on the amount of pollutant, where a harmful unit of total nitrogen corresponds to 25 kg and 3 kg for phosphorus. Each harmful unit equals a fee of 35,79 euros per year, which is collected by the federated states.

LATVIA	
AGRICULTURE	
REGULATIONS	In 2014, Latvia introduced a two-piece legislation to comply with the Nitrates Directive; one regulating the use of fertilizers and the other regulating the storage of manure, which are used instead of an action programme that is commonly used in other EU member states. Use of fertilizers is prohibited on frozen, water-saturated, and snow-covered soil as well as flood-lands. Mineral fertilizers cannot be applied outside the crop vegetation period and must be applied shortly before sowing or planting. Animal manure is limited to 170 kg worth of nitrogen per hectare, if livestock of a holding produce an excessive amount it must be transferred and spread to another farm. Latvia does not have requirements on maximum allowable phosphorus fertilization (Laakso & Loustarinen, 2019). Further, areas with high levels of dissolved nitrogen in ground and surface water, or that show signs of eutrophication, qualify as Nitrate Vulnerable Zones. In such zones, the spreading of livestock manure and mineral fertilizers are prohibited for five months during winter and autumn. In Nitrate Vulnerable Zones, at least 50 percent of agricultural land on a farm must be covered by a winter crop (European Commission, 2019b). On fields with a slope towards a waterway, the application of fertilizers is particularly regulated with regards to timing of spreading in relation to planting or tilling. For lands on bare fallow or on steep slopes, it is forbidden altogether. There are also regulation targeting livestock holdings of more than 10 animal units (5 animal units in Nitrogen Vulnerable Zones). Construction material for drainage and floors must be waterproof, a system for drainage and storage of liquid manure must be installed, and solid manure should be stored indoors on a liquid-proof base. For outside storage, the quantity should not exceed what is necessary for set fields, the base should be waterproof or consist of at least 30 cm of absorbing materials, not stored in proximity to waterbodies and for a maximum of five months. If storage capacity is exceeded, extra manure must be transferred to another storage facility.
WASTEWATER	
REGULATIONS	In the Regulations Regarding Discharge of Polluting Substances into Water, the emissions standards prescribed for wastewater treatment plants are described. The emission level required depends on the number of population equivalents that are connected to the wastewater treatment plant, where the requirements increase along with the population. In agglomerations with population equivalents exceeding 10,000, wastewater treatment plants are to consider the technical possibilities of introducing additional separation of the total nitrogen and phosphorus. The emission levels should be evaluated on an annual basis and the daily average may not exceed 20 mg of nitrogen per litre. Increased requirements for wastewater treatment and pollution from agricultural activities apply to highly sensitive territories.
ECONOMIC INSTRUMENTS	Since 1991, Latvia has a Natural Resource Tax, where phosphorus emissions are taxed at 270 euros per tonne (Likumi, 2020). The tax only targets point sources and is paid by class A and class B holders of integrated environmental permits required under the EU Industrial Emissions Directive. Wastewater treatment plants and emitting industries are required to pay the tax and the same tax rate applies for both class A and B operations. When the best available technology is used and emission levels are in accordance with the maximum level allowed in the permits, the standard rate is applied. In cases of non-compliance with the permit, the level is increased ten times. Although municipalities operate sewage systems, they cannot force households to connect. According to interviews, some co-finance is available to connection costs to incentivize for households to connect.

LITHUANIA

AGRICULTURE

REGULATIONS	Integrated Pollution Protection and Control (IPPC) permits are mandatory for farmers rearing a certain amount of poultry, cattle, or operating installations of certain capacity. The use of fertilizers, specifically, the spread of organic fertilizers on frozen, snow-covered, or waterlogged soil is forbidden. Application of organic fertilizers are allowed between April 1st – November 15th as well as between June 15th – Aug 1st on fallow, meadows, pastures, or areas used for winter-crop cultivation. The maximum amount of manure applied to agricultural land must not exceed 170 kg of nitrogen per hectare. Animal density on agricultural land is limited to 1,7 livestock units (one unit of livestock equates to 100 kg of total nitrogen) per hectare. Should animal density exceed this limit then the area must be increased, or manure surpluses must be transported to other farms not exceeding the limit. Further, Lithuania applies mandatory measures in accordance to the Nitrate Directive on all its territory (European Commission, 2019c). Phosphorus use is not regulated (Laakso & Loustarinen, 2019).
ECONOMIC INSTRUMENTS	Holders of the IPPC permit are also to comply with the pollution tax and farmers with a certain amount of animal units should calculate the tax for every unit of discharged pollutant to pay at the end of each calendar year. When permitted pollution limits are exceeded, non-compliance fees apply, which differs depending on the type of pollutant discharged (OECD, 2019).

WASTEWATER

REGULATIONS	In accordance with the Environmental Protection Law, local authority institutions are required to manage the environmental resources, including water. The Law on Water states that wastewater must be collected and treated using the best available technology, disposed based on the lowest environmental impact, and that it is prohibited to discharge water directly into underground waterbodies. Furthermore, Integrated Pollution Protection and Control (IPPC) permits need to be held by agents with activities hazardous for the environment, which include discharging of wastewater into waterbodies. The IPPC permit is given by the authority appointed by the Lithuanian government. Moreover, the IPPC permit includes restrictions on nitrogen levels but not for phosphorus, however, regulations for both total nitrogen and total phosphorus my apply for a specific water treatment plant.
ECONOMIC INSTRUMENTS	Holders of IPPC permits are in most cases also required to pay a pollution tax. The tax is based on the amount of pollutants discharged and is paid in euro per tonne. For example, the tax rate for total phosphorus and total nitrogen amounts to 1,007 euros per tonne and 208 euros per tonne respectively.

POLAND

AGRICULTURE

INFORMATION	Poland has implemented an informational campaign called “Rational Fertilizer Management” aiming to provide farmers, particularly in Nitrate Vulnerable Zones with information regarding the need for rational fertilizer management. Specifically, the campaign aims to provide information about conscious nutrient management within the field, farm, region, and the country to be able to obtain an optimal level of agricultural production while simultaneously maintaining nutrient levels in soil and water.
REGULATIONS	The Fertilizers and Fertilization Act regulates conditions and principles of placing fertilizers on the market, the use of fertilizers and soil conditioners, sewage sludge use as fertilizer, disposal of livestock manure, and the requirements for a fertilization plan. Furthermore, it regulates the use and storage of fertilizers. It is forbidden to store ammonium nitrate and other in-bulk fertilizers containing ammonium nitrate of above 28 percent. Slurry and liquid manure are to be stored in closed tanks and other natural fertilizers in impermeable plates, secured in such a way that spills cannot go into the ground. In accordance with the Nitrate Directive, there are restrictions to the use of fertilizers based on soil and weather conditions, distance to waterbodies, and steepness of terrain. Moreover, solid natural fertilizers can be used on arable land between March 1st – October 31st. For perennial and permanent grassland crops, this period is extended to November 30th. For liquid natural fertilizers, such as liquid manure and nitrogen-containing mineral fertilizers, the use and spread of slurry on arable land depend on the region. In most of Poland fertilizers can be used between March 1st – October 25th. In north-eastern Poland and in foothill-regions, fertilizers can be used between March 1st – October 15th, and in eastern Poland, this period is extended to October 20th. The maximum amount of manure on agricultural land may not exceed 170 kg nitrogen

	per hectare per year. Standards for the maximum amount of phosphorus doses in livestock manure are under development (Laakso & Loustarinen, 2019).
ECONOMIC INSTRUMENTS	In accordance with the Agri-Environmental and Climate Scheme, Section 4.1, farms can receive investment support and partial co-financing of construction or modernisation of storage tanks for liquid livestock manure.
WASTEWATER	
INFORMATION	An Internet campaign addressed to the operators of sewage treatment plants is carried out to raise awareness of the importance of phosphorus reduction and to promote the HELCOM recommendations. In comparison to nitrogen, additional removal of phosphorus can be achieved at relatively low cost at treatment plants already equipped with phosphorus treatment facilities.
REGULATIONS	The highest permissible values of pollutants for sewage from household water treatment plants and municipal water discharge into water or ground depends on the person equivalents of the treatment plants and ranges from 10 mg of total nitrogen to 30 mg of total nitrogen per litre. For total phosphorus, these figures are set between 1 mg to 5 mg per litre. Pollutants for water from water treatment plants in agglomeration into water or ground also depends on the person equivalents of the treatment plants. For nitrogen, limits are set between 10 mg to 15 mg of total nitrogen per litre. The equivalent for total phosphorus levels are set between 1 mg and 2 mg per litre.
ECONOMIC INSTRUMENTS	Poland has implemented water charges for uptake of ground and surface waters as well as discharge of sewage waters into the ground. The wastewater fee is paid by entities whose operations require an environmental permit, charges apply to biochemical oxygen demand (BOD) and chemical pollutants but not to discharge of nitrogen and phosphorus (Paquel, 2017).

RUSSIA

AGRICULTURE	
REGULATIONS	The Federal Waste Classification Catalogue classifies animal and poultry manure as well as other derived products into different hazardous classes ranging from moderately to not hazardous. All enterprises are obliged to have a license to generate, collect, transport, handle, dispose, neutralize, and place manure or other derived products. Further, enterprises must report the procedure to the authorities as a part of a report on environmental control. The Sanitary Rules state that manure and poultry containing nitrogen and phosphorus used to enrich the soil must undergo a preliminary neutralization and comply with the requirements of regulatory documents regarding composition and properties. In addition, manure treatment used to produce organic fertilizers must be developed and approved on an individual basis in accordance with The Technological Regulations (for environmentally safe processing of animal and poultry manure to be used as an organic fertilizer), which is considered a regulatory legal act. The Technological Regulations are developed in accordance with methodological recommendations approved by the Ministry of Agriculture of the Russian Federation. According to the HELCOM regulations, the maximum amount of manure applied in a year, including animal excrement during grazing, should not exceed 170 kg/ha for nitrogen and 25 kg/ha for phosphorus. In addition, Russian legislation regulates the annual fertilization rates for nitrogen depending on fertilized crop and include higher values compared to HELCOM. In measures to reduce nutrient runoff, the state standard document General Requirements for Surface and Underground Water Protection Against Pollution with Mineral Fertilizers prohibits the destruction and cleaning of fertilizer containers used for transportation and application in sanitary protection zones; application of fertilizers during floods, on frozen and snow-covered ground, and fertilizers with irrigation water if the discharge if this causes pollution of surface and ground waters. Further, it is prohibited to use aerial spraying of fertilizers in sanitary protection zones and when wind speeds exceed 10 m/s. It is also prohibited to wash containers, machinery, and equipment contaminated with fertilizers in water bodies. The General Technical Regulation about Sewerage also states the required levels of nitrogen and phosphorus in sewage sludge to be used as fertilizers at no less than 0.6% dry matter for nitrogen and no less than 1.5 percent dry matter for phosphorus. The Hygienic Requirements to Wastewater and Sewage Sludge Use for Land Irrigation and Fertilization sets additional regulations on the total amount of nitrogen coming into soil with wastewater used for irrigation at 300 kg/ha per year.

WASTEWATER	
REGULATIONS	Individuals and legal entities are required to have a permit to discharge wastewater into surface water in accordance with the Water Use Agreement. The agreement includes detailed information about locations, permissible volumes of discharged wastewater, and water quality requirements in water bodies at discharge points. This agreement is supervised by Russian Federal Agency for Water Resources, which also approves the standards for permissible levels of mineral and organic discharges based on environmental standards and wastewater data from the users. The Water Code of the Russian Federation prohibits the discharge of wastewater that has not been sanitized and decontaminated into waterbodies. The federal law General Technical Regulation about Sewerage sets requirements for acceptable levels of nitrogen and phosphorus in discharged wastewater into waterbodies after treatment, starting from settlements with 2,000-50,00 p.e. The strictest limits apply to settlements with 250,000 p.e or more where the limit is 1.25 mg/l of total phosphorus and 8 mg/litre for total nitrogen in non-vulnerable and 1.1 and 5 respectively in vulnerable zones. The requirements on sewerage systems entered into force in 2020. In accordance with the law, it is prohibited to discharge any type of wastewater that does not meet the required levels into waterbodies. Further, the regulation stipulates that in 2026 the wastewater quality must comply with the water quality target indicators of water bodies. The rules for cold water supply and sewerage sets maximum permissible levels of nitrogen and phosphorus in wastewater coming to sewerage system before treatment to prevent damage of the sewerage network and facilities. These levels amount to 50 mg/litre for total nitrogen and 12 mg/litre for total phosphorus. In St. Petersburg, the HELCOM regulations are applied, which are stricter than the federal regulations. Further, in 2013 a scheme for the water supply and sewerage for St. Petersburg was introduced, which provides a construction/reconstruction plan for the sewerage system in the city. The aim of this plan is to completely cease the discharge of untreated industrial and household wastewater into waterbodies by 2023. By 2030, all rural settlements with a population exceeding 1,000 people need to be provided with a centralized water supply and sewerage system, including wastewater treatment plants.
ECONOMIC INSTRUMENTS	In accordance with the Water Use Agreement, there are fees for using specific waterbodies for wastewater discharge and possible penalties in events of delayed fee payments. The Federal law N7-FZ (2002) imposes charges on the discharge of pollutants, microorganisms, and other substances into surface waterbodies, groundwater bodies, and catchment areas. This payment is set by the Water Use Agreement and it is set individually and considered a fiscal fee rather than a tax.
	SWEDEN
AGRICULTURE	
INFORMATION	Through the Swedish Board of Agriculture, local nutrient advisers in several parts of the country coordinate local advisory services for farmers. The project ‘Focus on Nutrients’ (Greppa Näringen) offers advice free of charge to motivate and inspire farmers to reduce the environmental impact of their activities. In 2018-2021 Sweden is running a pilot project with Catchment Officers appointed to 20 areas, who assist farmers with implementation of water quality projects. Moreover, the Swedish Board of Agriculture produces information and publications regarding nutrients and handling of manure, as well as a simulation program that can be used as a tool to ease the reduction of eutrophication (Swedish Institute for the Marine Environment, 2017).
REGULATIONS	The Environmental Code (SFS 1998:808) states that farmers should take environmental consideration, and this is further defined in ordinances (SFS 1998:915) and (SJVFS 1999:119), which provide details on winter and autumn crops, requirements concerning the spread of manure, as well as descriptions on best practices. Municipalities and County Administrative Boards are responsible to follow up implementation via supervision and inspections. Animal farming is classified as a hazardous activity and permits are needed. For farms holding more than 400 animal units, required permits are issued by the County Administrative Board. For farms holding between 100 – 400 animal units, reporting to the municipality is needed but not a permit. For farms with less than 100 animal units, reports and permits are not required by default. Moreover, there are no permits needed for growing crops within the agricultural sector, but regulation on best practices and on the spread of manure are applicable. Farmers can spread a maximum of 22 kg of phosphorus per hectare farmland annually, calculated as an average during a five-year period (Swedish Board of Agriculture, 2020a) (Ordinance SJVFS

	2004:62/2015:21). In order to keep track on fertilization and manure handling, farmers are expected to apply crop production planning. Regulation of emissions due to the spread of manure is dependent on location. In Nitrate Vulnerable Zones, a maximum of 170 kg of nitrogen per hectare per year is set as the limit. Further limits apply to fertilization with accessible nitrogen in the autumn: 60 kg/ha for oil seeds and 40 kg/ha for other crops. The spread of manure is also restricted across the year. In Nitrate Vulnerable Zones, it is prohibited to spread manure between November 1st – February 28th and outside Nitrate Vulnerable Zones this restriction is between December 1st – February 28th. Further, farmers must place the manure at a depth of 10 cm in the soil within 12 hours from the time of the spread (Swedish Board of Agriculture, 2020b). Regulations for storage of manure depend on the number of animals and location. Farms with more than 100 animal units are obligated to store manure equivalent to manure production for eight months (cattle, horse, sheep, or goat) or ten months for other animals. Farms with more than 10 animals in all sensitive areas, the same conditions apply as mentioned above. Farms with more than 10 animals but in a non-sensitive area, a storage of manure production for six months (cattle, horse, sheep, or goat) or ten months for other animals are obligated. Farms with less than 10 animals and in a sensitive area are obligated to store manure production of six months (Ordinance 1998:915, Section 6).
ECONOMIC INSTRUMENTS	The Swedish Board of Agriculture supply compensation for various measures farmers and landowners can engage in within the Rural Development Programme 2014-2020. Support for reduction of nutrient leakage include riparian strips with extensive ley, cultivation of catch crops, spring tillage and cultivated grasslands (Swedish Institute for the Marine Environment, 2017). Further compensation for measures within the Agri-Environmental programme consists of targeted buffer zones, controlled drainage to steer the groundwater level, structure liming, and creation and restoration of wetlands. The funding is provided by the EU and the Swedish Government (Swedish Board of Agriculture, 2020c). Additionally, the Swedish Government offers state grants for Regional Water Treatment Measures for funding of measures to improve, restore, plan and protect marine and water sources, where LOVA-funds also are included (Ordinance 2009:381 for Public Funding). Another program is called the LONA-fund and may be used for wetland projects administered by municipalities, where 90 percent of the total cost may be financed. The LOVA and LONA funds can only be allocated to public authorities and non-profit organizations, but it is also common that municipalities use the funds to finance water projects, which includes measures involving farmers. These programmes are funded through the state budget.
WASTEWATER	
REGULATIONS	Wastewater facilities that treats water of more than 2000 person equivalents are obligated to hold a permit. If it is less than 2000 but more than 200 person equivalents, the facility is required to report its activity. Permits are issued by different public instances depending on the person equivalents the facility is covering. The permits issued to the sewage facilities contains specific requirements for allowed emissions of phosphorus, which varies depending on the location and size of the facility. For wastewater treated in public sewage systems located between the Norwegian border and Norrtälje, the highest allowed volume of nitrogen emission disposed in the marine environment are regulated as follows: 15 mg N/l for areas with 10,000-100,000 person equivalents and 10mg N/l for areas with more than 100,000 person equivalents. For areas with 10,000 person equivalents, the lowest acceptable reduction rate is 70 percent or more as a yearly average.

12.3.4 Summary of the policy instrument mapping

Below we summarize results from the policy instrument mapping, including (1) an overview of our findings per sector (agriculture and wastewater) and (2) a count of the most frequently-used instrument categories per country (

Table 12.4), which helps to highlight both common and underused instrument types.

Agriculture

Manure handling in agriculture is addressed in all countries through command-and-control regulation. Large farms (75-400 animal units) are controlled by permit requirements in the EU countries, while all farm enterprises in Russia require a licence to handle manure. Based on the Nitrates Directive, EU-countries apply rules for maximum application of manure on agricultural land, generally 170 kg nitrogen per hectare and year. In some EU countries these levels are implemented only in the Nitrate Vulnerable Zones and in others they apply for the whole territory. Russia allows larger loads of nitrogen. While the Nitrate Directive does not regulate phosphorus, HELCOM has recommended a limit on allowable phosphorus from manure at 25 kg/ha, but only Estonia and Sweden regulate according to this limit. Denmark and Germany have implemented less strict limits, while there is no regulation in Finland, Latvia, Lithuania, Poland and Russia. However, Laakso & Luostarinen (2019, p. 62) report that in the Russian part of the Baltic Sea catchment area, the limit on phosphorus in manure "is mostly observed". Other regulations implemented in EU-countries include requirements of buffer zones on farmlands bordering surface waters and requirements to grow catch crops and winter crops.

Informational activities are primarily channelled through farm advisory services, which are offered in all EU countries, generally free of charge. The purpose is to help farmers better understand and meet the EU rules for environment, public and animal health, animal welfare and to reach good agricultural and environmental conditions (European Commission, u.d.). For purposes of nutrient abatement, Denmark has appointed specialised catchment officers (Oplandskonsulenter) to assist farmers implementing water protection measures and in Sweden, local nutrient advisers (Greppa Näringen) have been instructing farmers on nutrient management for more than a decade.

The use of economic instruments like taxes and fees for nutrients is not common. Denmark has a tax on phosphorus content in animal feed and in Lithuania farmers with a certain number of animal units pay a tax per unit of discharged pollutant. On the other hand, subsidies are an important policy instrument in all EU-countries. The funds from the common agricultural policy are to various degrees used for environmental purposes such as implementing water protection measures beyond legal requirements (wider than required buffer zones), cultivation of grasslands or establishment of wetlands.

Wastewater

Informational measures are rare in the wastewater sector. But Poland's programme of measures of the Marine Strategy Framework Directive includes an Internet campaign addressing the operators of sewage treatment plants to implement the phosphorus limit prescribed by HELCOM (KPOWM, 2016, p. 105). The policy assumes that the promotional campaign will encourage treatment plant operationl to voluntarily increase the degree of phosphorus reduction from 1 to 0.5 mg P/l. Germany uses information to reduce nitrogen in wastewater by promoting dietary habits towards more plant-based foods and providing tools for calculating one's nitrogen-footprint, as well as awareness-raising measures targeting nurseries, schools, and the general public. In Finland several cities conduct public campaigns to raise awareness of the environmental impact of urban surface runoff.

All countries regulate urban wastewater treatment plants with command-and-control instruments by issuing environmental permits. The permits state the requirements for nitrogen and phosphorus limits. According to the Urban Waste Water Treatment Directive the requirements can either be stated as concentrations (mg/l) or percentages in relation to the load of influent. The limit values can either be uniform across the country (varying only with respect to the number of person equivalents, or p.e.)[7] or may be set with respect to the environmental status of the water body. Table 12.3 shows limits with respect to person equivalents based on available data per country.

Table 12.3 Maximum concentration limits for total nitrogen (mg/l) and total phosphorus (mg/l) (data from reports and interviews).

Country	Total nitrogen (mg/l)	Total phosphorus (mg/l)	Applicable in settlements where loads exceed person equivalents (p.e.)
UWWTD[1]	10	1	100,000
HELCOM	10	0.5	100,000
Denmark	8	0.4	100,000
Estonia	10	0.5	100,000
Finland	*	0.3	100,000
Germany	13	1	100,000
Latvia	10	1	100,000
Lithuania	10	1	100,000
Poland	10	1	100,000
St Petersburg	10	0.5	100,000
Rest of Russia	8 [5]	1.25 [1.1]	250,000
Sweden	10	0.3**	100,000

Note: [1] Urban wastewater treatment directive, * ≥80% reduction in relation to load of influent, ** varies across water bodies, currently 0.3 mg/l at Stockholm Henriksdal wastewater plant. Brackets [ ] denote vulnerable zone in Russia.

Denmark, Finland and Sweden assign more stringent limits on phosphorus than what is prescribed by the Urban Wastewater Treatment Directive. However, considerations of the environmental status of the recipient water body may require stricter limits. In Finland, overcompliance is possible (i.e., exceeding mandatory requirements). Voluntary programmes from the cities of Porvoo, Turku and Helsinki in Finland have made it possible for the wastewater treatment plants to neutralise their phosphorus discharges by financing abatement elsewhere. There are also examples of compensating measures in agriculture and wastewater treatment investments in Belarus. There are also examples of less strict limits. In Finland, wastewater treatment plants upstream from the Bothnian Bay do not have to comply with the nitrogen limits. This approach has similarities to the Swedish requirements to nitrogen as they do not apply north of Norrtälje on the Swedish east coast.

According to legislation that became obligatory in 2020, Russia has implemented nitrogen and phosphorus limits (N 284072-4, 2011). The limits on nitrogen are more stringent than those for the EU countries (based on the Urban Wastewater Treatment Directive), but less stringent

7 One p.e. corresponds to the pollution load of sewage generated by one inhabitant.

concerning phosphorus. While the limits differ from those of the EU, the city of St. Petersburg has adopted the limits of HELCOM (Vodokanal, 2018).

In the EU countries, the Urban Wastewater Treatment Directive stipulates that all agglomerations above 2,000 personal equivalents must either have collection systems in place or another wastewater system offering the same level of environmental protection (European Court of Auditors, 2016). Russia also applies limits to wastewater treatment plants starting from the level of 2,000 personal equivalents. However, direct discharge of non-treated wastewater occurs in Russia from wastewater collection enterprises that do not have treatment facilities. If such enterprises lack treatment facilities, there is no legal obligation (Inchagov, 2020).

As shown in Figure 12.1 five countries apply taxes or charges in addition to the command-and-control measures. In practice, these include taxes/charges paid by facilities (industrial polluters and wastewater treatment plants) who are required to have an environmental permit. All five countries apply rates that are five to eight times higher for phosphorus than for nitrogen. Denmark has implemented the highest tax rates for both nutrients, followed by Estonia and Germany. The rates are relatively low in Latvia and Lithuania.

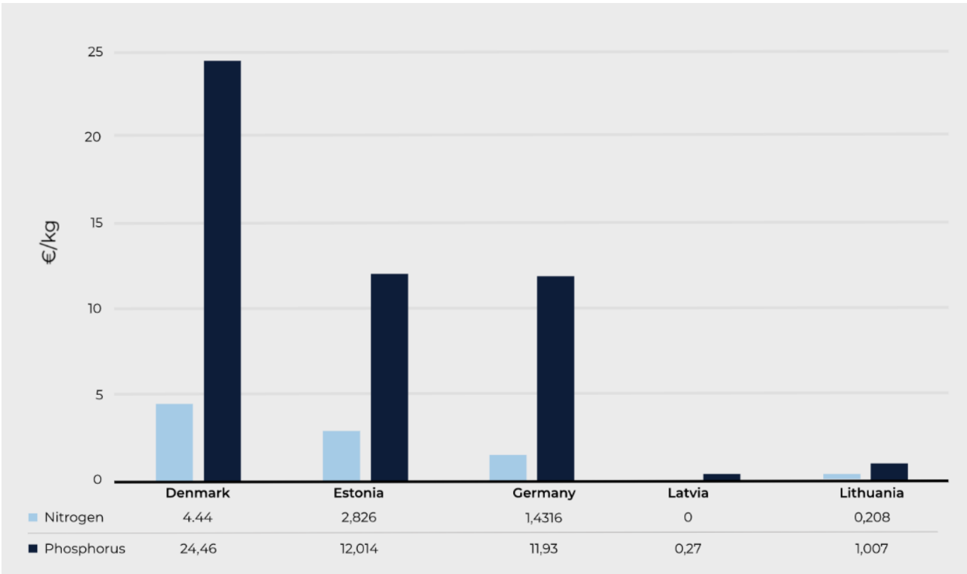


Figure 12.1 Tax rates of point sources, Euro per kg nitrogen and phosphorus, (data from reports and interviews).

In addition to the economic incentive from the tax, charges increase by 10 times in Estonia if the polluter exceeds the limit values of the environmental permit. If the limit values of the discharged wastewater are less than or equal to the limit values, then the water charge of the source is multiplied by 0.5. In practice, this means that Estonia applies lower taxes than Germany. In Lithuania, stationary sources that undertake measures that reduce pollution by at least 5 percent are exempted from paying the charge for a three-year period.

12.4 CATEGORIES OF POLICY INSTRUMENTS

To highlight both common and underused instrument types we provide a count of the most frequently used instrument categories per country in

Table 12.4. The table summarizes the categories of policy instruments per country used to address nutrient pollution in the wastewater and agricultural sectors.

Table 12.4 Summary of policy instrument categories per country aimed at nutrient pollution from the wastewater and agricultural sector. ***Information based on best available data and may miss some instrument categories.***

Country	Sector	Policy Instrument Category				
		Information	Regulation	Economic		
				Taxes/fees	Subsidies	Markets
Denmark	Agriculture	☒	☒	☒	☒	☐
	Wastewater	☐	☒	☒	☐	☐
Estonia	Agriculture	☒	☒	☐	☒	☐
	Wastewater	☐	☒	☒	☒	☐
Finland	Agriculture	☒	☒	☐	☒	☐
	Wastewater	☒	☒	☐	☐	☐
Germany	Agriculture	☒	☒	☐	☒	☐
	Wastewater	☒	☒	☒	☐	☐
Latvia	Agriculture	☒	☒	☐	☐	☐
	Wastewater	☐	☒	☒	☒	☐
Lithuania	Agriculture	☒	☒	☒	☐	☐
	Wastewater	☐	☒	☒	☐	☐
Poland	Agriculture	☒	☒	☐	☒	☐
	Wastewater	☒	☒	☐	☐	☐
Russia	Agriculture	☐	☒	☒	☐	☐
	Wastewater	☐	☒	☒	☐	☐
Sweden	Agriculture	☒	☒	☐	☒	☐
	Wastewater	☐	☒	☐	☐	☐

Some of the key conclusions, ranked in order of relative importance based on our own analysis, are:

1. **All nine countries use regulations for both agriculture and wastewater sectors, but none of the countries rely on markets in either of the sectors.** The reason could be that there is a long tradition of applying regulation for environmental purposes and thus a shortage of experience with respect to how market-based instruments can help to abate nutrients in Europe. Additionally, since both HELCOM recommendations and EU Directives provide explicit limit values, it may encourage continued use of this command-and-control instruments in national legislation.
2. **Information instruments are more common in agricultural sector, while taxes/fees are more common in wastewater.** All EU countries provide information instruments in terms of farm advisory services. The relatively more affluent countries (SE, FI, DK, DE) appear to put relatively more resources into these instruments compared to other countries, particularly in agriculture where they have dedicated nutrient farm advisory services. One reason could be that these countries have already introduced strict regulation and that the acceptance of new incremental approaches may be easier with information instruments rather than further tightening regulation. Information instruments are not as common in wastewater, where taxes/fees are more common (see point 3 below). Economic policy instruments may be more challenging for non-point sources in part because it is often difficult to connect pollution to the source (see e.g., Denmark's

phosphorus tax on animal fed which focuses on taxing the inputs rather than the output/emission).

3. **There is significant variation in the use of taxes/fees and subsidies instruments across sectors** Two countries tax nutrients originating from agricultural activity and five countries tax nutrients in wastewater pollution. Most countries apply subsidies to agriculture, while subsidies are less common in the wastewater sector.

13 ASSESSMENT OF POLICY INSTRUMENTS

This chapter assesses the effectiveness of the policy instruments mapped out in the previous chapter. The approach for the assessment, which draws on similar information sources as the previous chapter, is a qualitative assessment of whether existing policy instruments are likely to help achieve water quality goals in order to draw general conclusions about whether new instruments may be warranted. Where possible, the analysis makes use of quantitative information – e.g., some, but not all, countries have conducted their own assessment of existing instruments and even estimated costs of reaching current goals. The focus is on generating an overall picture of how countries' policy instruments compare to each other and to consider the best way to integrate existing policy instruments with a trading system.

The key questions of the assessment addressed are:

- Challenges. What are the major challenges associated with current policy instruments?
- Efficiency. Are current policy instruments efficient? What, if any, shortcomings exist?
- Needs. Is there a need for new policy instruments or is it likely that existing ones can address the current challenges?
- Integration. Is it possible to integrate a trading system with existing policy instruments?
- The analysis is theoretical and focuses predominantly on qualitative assessments of instruments with respect to certain objectives, such as likelihood of achieving water quality goals, costs, distributional effects, etc. Given the nature of the assessment, we are not able to quantitatively evaluate the trade-offs that may exist between different objectives (e.g., a country can, in theory, achieve more in terms of water quality goals by spending more money).

13.1 RESULTS

Our results suggest that current instruments are insufficient to reach water quality goals (Section 13.1.1). Further, we identify several economic and policy challenges with existing instruments, as described in Section 13.1.2 and 13.1.3. Finally, given the current challenges, we consider other ways (besides a nutrient trading system) of improving the accuracy and cost-effectiveness of instruments. The major results are ranked (numbered 1 to 7) in order of relative importance based our own analysis.

13.1.1 Current instruments are insufficient to reach goals

Although EU countries made implicit promises to achieve good status through their programme of measures, it remains to be seen how and if this will be achieved. The absence of explicit proof from each country that their programmes of measures will indeed lead to full achievement of goals, together with the data we have collected in this analysis, leads us to conclude that the current policy instruments are likely inadequate for reaching water quality goals. Thus, the overarching conclusion from our analysis is the following:

1. While it is uncertain whether existing instruments will, in fact, achieve goals, our analysis and data collection suggest it may be difficult and that "minor adjustments" to existing instruments may not be sufficient.

Results from the assessment of BSAP implementation suggest that existing instruments and collaboration have not been sufficient, as HELCOM has admitted that many of the water quality goals set for 2021 are not going to be met (HELCOM, 2018b). Admittedly, the international agreements of HELCOM with its action plan BSAP and those associated with EU's Water Framework Directive are not directly comparable – the former is merely an international convention while the latter represents a supranational body that can decide over national legislation. Nonetheless, the most recent revelation by HELCOM that recent goals have not been achieved could be interpreted as a sign of things to come with respect to Water Framework Directive compliance by 2027. Already, there are indications more time will be needed for compliance. In order to implement necessary measures in agriculture, the Swedish Water Authorities have suggested an extension until 2033 (The Water Authorities, 2020d).

13.1.2 Economic challenges with existing instruments

This section provides a synthesis of key economic challenges (See also Table 13.1 for detailed findings).

2. Today's instruments are expensive, often lack sufficient financing, and suffer from high transaction costs.

Sweden's estimated costs to achieve the goals of the Water Framework Directive are significant, representing nearly 50 percent of the country's total environmental budget for a given year (which is 9 billion). Based on data from the Water Authorities the cost for implementing the renewed Swedish river basin management plan 2021-2027 is estimated at approximately 5 billion SEK/year[8] (The Water Authorities, 2020a). Similarly, Estonia's estimated costs for their six-year plan represented nearly two full years of typical environmental expenditures by the state.

About 55 percent of Sweden's costs are funded by taxpayers via the public sector (e.g., information provision, supervision, funding of agricultural measures, renovation of road drums, municipal water management), while about 45 percent are paid for by households and the private sector (e.g., higher water tariffs, restrictions on agricultural production, investments in pollution control equipment) (The Water Authorities, 2020b). While some of these abatement costs are unavoidable (e.g. water pollution control measures), others could be reduced through more efficient instruments. For example, while command-and-control instruments are often costly because regulation may specify abatement technology, economic policy instruments such as taxes or trading systems improve cost-effectiveness by allowing flexibility,

8 Based on calculations from WSP

additionally they tend to reduce transaction costs, bring in private financing, and reduce overall costs.

Lack of financing is a challenge, also among more affluent countries in the Baltic Sea region. Several Government reports have pointed out there is lack of financing to be able to reach environmental goals related to water quality in Sweden (SOU 2019:66, p. 150). Public financing from national funds (LOVA) and investment support to water quality measures from the common agricultural policy amount to about SEK 250 million annually[9]. This is less than those 500 million, the Swedish Water Authorities have indicated necessary for agricultural measures (The Water Authorities, 2020e).

Burdensome reporting requirements and heavy bureaucracy lead to high transaction costs. Several countries report that permit applications and reporting requirements are identified as a costly administrative burden for both government and regulated communities. A specific issue is that reappraisal of environmental permits incurs high administrative costs, when authorities start the process. This is due to that authorities need to deliver evidence in order to initiate the process of introducing new stricter limits, which requires information sharing from the regulated community who, in turn, does not have incentives to share information, thereby slowing down the process (Swedish EPA, 2012, pp. 168-). In Russia, an additional burden is related to a long chain of decision-making process, which slows down progress: federal – regional – local levels. Further, as a result of high search costs for information that is needed to target measures effectively, nutrient reduction measures often lead to ad hoc solutions that result in ineffective outcomes (SOU, 2020:10) (Swedish EPA, 2012). The challenge is most significant in targeting measures to abate non-point source pollution in agriculture, since nutrient leakage from farmland depends on several factors including choice of crop, crop rotation, supply of fertilizers and manure, tilling and on natural conditions such as soil, topography, temperature, rain- and snowfall.

Table 13.1 Economic challenges with existing policy instruments aimed at nutrient pollution in 9 Baltic Sea Countries. Review includes all 9 countries and all categories of instruments used today.

Economic challenges	Description
Costly implementation	• The cost for implementing the renewed Swedish river basin management plan 2021-2027 is estimated to 48 billion SEK, or approximately 5 billion SEK/year (The Water Authorities, 2020b), which is higher than earlier estimate of 6 billion SEK. (Swedish Agency for Marine and Water Management, 2015). For comparison, annual budget for country's environmental budget is 9 billion. • Ek & Persson (2016) find that Sweden's implementation of the WFD goals are not cost-effective, since current measures leave little room for flexibility, e.g. the environmental permits are often too detailed for the producer to decide how to reduce pollution and regulation imposes a cost to the firm for abatement, while a tax imposes a cost for the amount not abated . • The cost estimate of Estonia's River Basin Management Plan was estimated to 363 million euros 2015-2021. For comparison annual environmental expenditures in state budget were 190 million euros in 2021 • The estimated cost (2014) for reconstruction of sewerage system and treatment facilities in St. Petersburg and its suburb (2015-2030) is 210, 500 bl.rub.

[9] CAP "agri-environmental water measures" are about 50 million SEK per year according to budget 2014-2020, plus 200 million SEK in LOVA grants in 2019.

	• Poland's first Program of Measures (2009 – 2015) includes a total investment of 10 780 million euros to implement community legislation for water protection and 37.39 million euros on all other measures. (PL) (SWD, 2019)
Lack of financing	• Lack of personnel for international collaboration, one person at the ministry working directly with the Baltic Sea issues, hard to cover everything (LT,PL). A recent investigation in Sweden estimated a need for an additional 80 Catchment Officers to effectively reach goals (SOU, 2020:10, p. 179) • Lack of financing to be able to reach environmental goals related to water quality in Sweden (SOU 2019:66, p. 150) • More research is needed to understand the problem, but data and resources are lacking (LT) • Finances are highly dependent on how the federal budget is distributed (RU, Leningrad and Kaliningrad)
High transaction costs	• Permit applications and reporting requirements are identified as a costly administrative burden for both government and regulated communities. (EE, SE) • Current push is to reduce bureaucracy, digitize reporting, and reduce permitting requirements (EE); • Heavy bureaucracy, a long chain of decision-making process make progress slow: federal – regional – local levels (RU) • Limited Information sharing with Russia (EE, LV), almost no transboundary cooperation • Costly to obtain information on where best to implement voluntary measures so they have the best possible environmental impact (SOU, 2020:10) (Swedish EPA, 2012, p. 46)

13.1.3 Policy challenges with existing instruments

This section provides a synthesis of key policy challenges (See also Table 13.2 for detailed findings).

3. There is ample evidence that current instruments are simply not adequate or sufficient and that either more or new instruments are needed

Both interviews and studies have suggested that existing instruments are ineffective. Moreover, the Swedish EPA (2020) identifies an "action gap", i.e., that existing action programmes do not contain enough measures to reach the environmental targets.

4. Today's instruments impose a skewed distribution of costs and benefits across individual actors and across countries.

While existing regulatory approaches impose more lopsided burdens on actors (e.g., countries, sectors, and/or facilities), a trading system can help re-distribute the costs of abatement toward actors that can more efficiently make further reductions (i.e. those with lower marginal costs) (Ek & Persson, 2016). Sharing costs more efficiently means the distributional effects of financing nutrient reductions do not fall disproportionately on certain actors. Even if re-distribution is more efficient, it may nonetheless result in both "winners and losers". As such, a potential risk with a trading system is possible "leakage" of emissions if the redistribution has a net negative effect on some actors who find it beneficial to move production outside the trading area.

5. Some suggest that existing instruments are insufficient, but many argue that existing instruments simply need to be implemented and communicated more effectively

For example, support payments to farmers for reducing nutrients fail to account for where such measures are likely to have the greatest effect in part because the information required is costly. A trading system provides this information via the price signal itself.

Even economic policy instruments appear ineffective. For example, five countries apply taxes for nutrient pollution from point sources, but their level varies significantly across countries, which raises the questions of whether they could all have a similar effect on emissions (Figure 12.1 shows the rates of taxes in euro per kg per country).

The low tax levels in Latvia and Lithuania imply incentives might not be sufficient drivers to increase abatement levels of nutrients in wastewater, which is partly confirmed by Hautakangas et al. (2014). Hautakangas and his co-authors assessed marginal abatement costs of wastewater treatment plants in the Baltic Sea region. According to their estimates, the marginal abatement cost of nitrogen is about 5.5 euros per kg at 70 percent abatement in a large wastewater plant (>500,000 p.e.) and the equivalent is 9.5 euros per kg in a small plant (10,000-80,000 p.e.), suggesting current tax levels do not incentivise further abatement of nitrogen in any of the countries. The costs of phosphorus reduction generally are lower since abatement mostly consist of costs of chemicals. Increasing the abatement level of phosphorus from 70 to 95 percent has a marginal cost of 1 euro per kg at a large wastewater plant, while the marginal abatement cost is about 1.5 euros per kg phosphorus in a small wastewater plant. These levels are higher than Latvia's, higher and equal to the level of Lithuania's phosphorus tax, while phosphorus taxes in Denmark, Estonia and Germany are high enough to incentivise further reductions. Comparing tax levels with abatement costs suggests that the low levels are not sufficient for increasing abatement in Latvia and Lithuania, while the opposite hold for phosphorus taxes in Denmark, Estonia and Germany.

However, taxes on point sources do not consider non-point source pollution, which implies that current taxes have no possibility for achieving cost-effectiveness beyond point sources. The best solution for cost-effectiveness would be to treat point- and non-point sources equally. The Danish phosphorus tax on animal feed demonstrates how taxing could be expanded, but the tax level of 0.5 euros per kg still fails to match that of the point sources of 24.5 euro per kg (see Figure 12.1).

6. Many actors do not accept that there is a problem, suggesting that information about who is causing nutrient pollution is either lacking or not credible

This would suggest a need for more information or for improving ways of disseminating it. Several interviewees suggested that existing communication strategies were insufficient and some even noted that introduction of economic policy instruments like markets will require improvement in how information is formulated and shared with the right actors. At the same time, it remains a challenge to produce evidence, since it is not possible to monitor non-point source emissions from farmland. An additional complication is that emissions vary substantially between and within arable fields.

7. Some interviewees and reports suggest that the problem lies in the organization of environmental control authorities or the political will, rather than the existing instruments (or lack thereof)

For example, investigations in Sweden have suggested re-organization of the divided responsibilities between agencies to address the problem (SOU 2019:66). In some cases, there is a lack of political support to improve water pollution control. Some of the interviewees point to the lack of studies to determine whether instruments are effective or to make changes in organisations when they found to be less effective.

Table 13.2 Policy challenges with existing policy instruments aimed at nutrient pollution in 9 Baltic Sea Countries. Review includes all 9 countries and all categories of instruments used today

Policy challenges	Description
Lack of adequate or sufficient instruments (need for more or new instruments)	• For eutrophication measures, there are existing gaps in both action and implementation. The action gap signifies that the existing action programmes do not contain enough measures to reach the environmental targets. (SE) (Swedish EPA, 2020) • Existing instruments insufficient to address nutrient pollution (EE, LT, SE) • Existing instruments are voluntary measures but could be made mandatory for better effect (DE) • The Danish Green Growth Agreement was based on ambitious mandatory measures but had to be withdrawn because of failure to address local conditions with mandatory measures (DK). (Jacobsen, et al., 2017) • Some countries have undertaken assessments of current instruments (SE) to determine possible need for new instruments. Bång and his co-authors suggest value-based payments (Bång, et al., 2018) and a study conducted by the German EPA has suggested new taxes instead of a nutrient trading system in response to the 2008-study by the Swedish EPA (Swedish EPA, 2008). A main concern of the German study is that a nutrient trading system would be incompatible with the WFD and the MFSD, (SE, DE) • Eutrophication committee in Sweden concluded that existing voluntary measures by agricultural sector financed by the state do not work sufficiently, since they fail to direct measures in locations where they have the greatest effect. (SOU, 2020:10) • In settlements with 2,000 or more inhabitants, the law requires all discharged (point source) water to be treated, but there is a loop-hole in legislation since water collection enterprises with no treatment facilities, do not have the legal obligation to treat waste water before release (RU) (Inchagov, 2020). • All current focus is on improving instruments aimed at point sources (sewerage) as this is not currently adequate; this leaves a gap in instruments aimed at agriculture which must be dealt with in the future instead (RU) • More ambitious action programmes are needed in order to reduce the supply of nutrients to lakes, watercourses, coasts, and seas to levels that can lead to an aquatic environment free from eutrophication in the long-term. Further, policy instruments that implements cost-effective measures for agricultural land are needed in order to reach the environmental goal of zero eutrophication (SE) (Swedish Agency for Marine and Water Management, 2019b).
Poor implementation of *existing* instruments	• Voluntary information/counselling measures targeting agriculture are not always utilized by the regulated community (DE, SE) or in other cases are not adequately reaching the target group (EE, FI). • Poor experience with implementation of earlier taxes (LV). Further, some suggest that existing taxes are too low to have an effect, but no follow-up studies have been conducted to asses effectiveness (LT, RU) (OECD, 2013) • Lack of information to link clearly the existence of diffuse pollution to specific sources in the agricultural sector, which makes it hard to assess compliance with rules (DE, SE): • Existing instruments lack sufficiently strict requirements to have an effect (e.g. regulation of fertilizer use) (DE)

	• Poor/insufficient implementation of EU Directives, with some countries penalized by EU (DE, PL, SE) • Lack of information to connect measures with subsequent improvements makes it hard to communicate to the public the importance and need for instruments (DE). Communication is even more difficult with respect to economic instruments (FI). • Long experience with environmental fees, but hesitant to propose fertilizer taxes (EE) • Challenge to impose one-size-fit-all solutions when nutrient pollution varies across regions and farms (DE), e.g., larger farms benefit from voluntary subsidies because they have the resources to adapt and implement them, whereas small farms find this difficult
Skewed distributional effects & "lobbying"	• Unfair distribution of pollution abatement costs – including negative effects on competition – cited for resistance and lobbying from regulated community (PL, DE, EE, LV, RU, LT) • International agreements may impose unfair reduction requirements on some countries; e.g., countries with historically large pollution loads tend to have an advantage in negotiations because otherwise their abatement burden would be larger than that of countries with currently small pollution loads (EE) • Fear that more instruments and increased fees would harm economically small farmers (EE, PL)
Acceptance of the problem	• Lack of acceptance that there is a problem to be fixed, largely from agricultural community (PL, LT, DE SE). Need for better communication and mutual understanding to avoid conflict with agriculture community (LT, FI, EE, RU) • Unaware or refuse to believe that they contribute to the problem, largely from agriculture (PL), but in some countries there is an increase in the willingness to accept that the problem is real by some lobby groups (LT, DE), although actors are heterogeneous and hard to classify.
Ineffective organization or lack of priority for addressing problem	• There is divided responsibility between agencies in water management planning in Sweden, re-organisation to match institutional structures has been suggested in order to improve effectiveness (SE) (SOU 2019:66). • The amount of individual wastewater disposal systems (IWDS) in need of restoration increases every year with the current pace of measures (ca 1-2%). With this pace, it will take about 70 years to upgrade all IWDS's. (SE) (Swedish Agency for Marine and Water Management, 2013, p. 56). The pace of upgrades has increased. The latest data suggest it will take 49 years to upgrade all IWDS (VVS-fabrikanternas råd, 2020). • Renewal of all environmental permits in Wastewater treatment plants can take from 15 to 30 years (Swedish EPA, 2012). • Lack of information or studies about the effectiveness of current instruments, or in some cases studies are conducted, but the results are not utilized (LT, FI, PL). Germany explored new economic policy instruments and recommended fees/taxes rather than a nutrient trading system, but resistance from agricultural community has prevented any new tax proposals (DE) • Eutrophication is only addressed as one of many environmental challenges, rather than receiving specific focus/attention (RU). • Agricultural impacts are not prioritized, focus is on point sources (RU). • Lack of coordination between local and regional government, where the latter is slow to take over and provide centralized management and financing. (RU)

13.2 DISCUSSION

The results suggest that current instruments are insufficient. This raises two issues: (1) what else can be done to improve current instruments besides creating a future trading system? and (2) if we rely on a future trading system, how can it be integrated with current instruments?

13.2.1 Other ways of improving current instruments

While a nutrient trading system could address many of the challenges noted above, it is not the only way of achieving better allocation of measures with respect to cost-effectiveness or improving distributional effects. For example, this could be achieved by taxation on nutrient pollution which, if designed well, could address the economic challenges discussed above (see also Chapter 4). Swedish EPA (2012) compared different economic instruments for nutrient emissions from municipal wastewater treatment plants exceeding 2,000 p.e in Sweden. The conclusion was that current regulation with environmental permits performs slower than what taxes or a nutrient trading system would do: 15-30 years in comparison to 10-20 and 10-15 years respectively. In contrast to regulation, both taxes and nutrient trading would result in cost-effective choice of measures at plant level. Since only some of the countries currently apply taxes to water pollution, there is significant potential to improve cost-effectiveness.

Further, while several countries rely on taxation of point sources, non-point sources are not addressed. Taxation of non-point source pollution is possible, but much more difficult than taxing point sources. Non-point pollution can be addressed, either via taxes on inputs or taxes based on estimation of pollution leakage from fields with help of mathematical modelling (the latter is challenging, though). Increasing the coverage of nutrient taxation to include other sectors would improve cost-effectiveness and likely improve the chances of achieving water quality goals. Finally, it is worth noting that although Germany does not currently tax nutrient pollution from agriculture, the country does rely on environmental charges for discharge of wastewater. Further, interviews conducted as part of this study suggest that Germany has considered extended use of environmental taxes to address nutrient surpluses and mineral fertilizers.

One could improve the accuracy and cost-effectiveness of measures directed towards agriculture by considering the design of policy instruments. Current subsidies compensate farmers for their costs. This results in incentives for farmers to implement measures with low costs and on land with low productivity – rather than to optimize environmental benefits (Sidemo-Holm, et al., 2018). Result-based payments would instead compensate farmers in proportion to the environmental benefits they create. But effective results-based payments require information on how the location of measures for pollution abatement actually affect nutrient emissions, but this information is often difficult to obtain (Bång, et al., 2018). For example, it is complex to measure water quality and particularly challenging to estimate how changes in water quality depend on agricultural practices since nutrient leakage from fields depend on both farmers' actions (including tilling and fertilization, which are difficult to monitor) and on natural circumstances (e.g. weather conditions). Therefore, indicators should be based on previous research on how nitrogen and phosphorous pollution is affected by abatement measures in agriculture.

Bång et al. (2018) conclude that mathematical prediction of the effects of measures on emissions at the field level could form the basis for results-based payments (see also Section 7.7 on data and modelling). Further, they find that six measures qualify for their requirements on result-indicators (catch crops, spring cultivation, buffer strips, adaptive buffer strips, structural liming and, wetlands & ponds).

All six of these measures qualify for agri-environmental payments and two of them (structural liming and wetlands/ponds) are also eligible for funding via Local Water Treatment Projects (Lokala vattenvårdsprojekt, LOVA). The authors suggest that prior to implementation, result-based payments should be tested in a pilot study. If payments can be based on value, all six measures should be included. If payments can only be based on costs, as is the case with EU-funds for the period 2014-2020, the authors find that the suggested system has limited benefits in terms of improved incentives. However, the authors do not discuss the potential to use other funds, such as LOVA-funds.

13.2.2 Integration with existing policy instruments

If one instead relies on a future trading system to address challenges with existing instruments, then a critical question is how best to integrate it with the range of existing policy instruments? While a more comprehensive analysis of how -and whether or not- to replace existing instruments will be needed before proceeding with a trading system, our brief analysis of the challenges and possibilities for integration suggests that existing instruments can sometimes be integrated relatively easily by re-defining or adjusting them, but in other cases, existing instruments may need to be removed or replaced. A few key considerations include:

- **Information about actors.** All countries require environmental permits for emission control from point sources (of a certain size). Since environmental permits are based on registration and measurement of pollution loads, they form a starting point of a future trading system. Note, however, that comprehensive data may be lacking for non-point sources, which may become a challenge depending on how big a market is needed. Even though information about farms may be available, emissions from farmland are not possible to monitor and they may vary substantially within and between fields.

- **Information instruments may be relatively easier to integrate with a trading system.** Farm advisory services and info brochures that highlight cause and effect can likely continue within a future trading system. In fact, advisors may take on a new role since they may inform about the trading system and help stimulate nutrient abatement activities.

- **Design the trading system to meet challenges of overlap with quantity regulation.** All countries apply quantity regulation on point sources. Typically, environmental permits define the maximum limit on the annual load of pollution which the source may release into a receiving water body, e.g. in kg phosphorous and kg nitrogen per year. A nutrient trading system also regulates the pollution covered by the environmental permit. Applying both types of policy instruments, creates uncertainty about which of them is valid: the volume of the environmental permit or the volume of the trading system? In case it is established that the strictest volume is binding, and assuming that the polluter has fewer load permits than the maximum volume defined by the environmental permit, would imply that the trading system applies. If a lower volume is allowed by the environmental permit, the polluter will have load permits in excess of the binding volume. In the latter case, the polluter sells load permits in the nutrient market. However, if environmental permits systematically allow lower volumes than the supply of load permits, this could undermine the trading system putting down-ward pressure on prices (Swedish EPA, 2012). Since it is not realistic to believe that EU countries would eliminate maximum limits, the design of a nutrient trading system needs to secure that the trading system is binding i.e. making sure there are continuous cuts in the volume of load permits. The challenges of technology standards such as Best Available Technology (BAT) may be another issue, since technology standards reduce flexibility and cannot, therefore, secure cost-effectiveness. On the other, hand, technology standards generally regulate several other emissions, besides phosphorus and nitrogen. Abolishing current technology standards would thus jeopardize the quality elements of other pollutants and put environmental objectives at risk.

- Risk of overlap with taxes. Countries that currently rely on taxes and charges will most likely have to replace them with a different economic policy instrument: the trading system. Otherwise, there is a risk for overlap which can lead to a variety of challenges. For example, combining current charges and taxes with a trading system may reduce the nutrient price, thereby weakening the incentives generated by the trading system. Experience from carbon trading systems suggests that combinations of price (taxes) and quantity (permit) instruments require re-orientation of the tax to address price volatility; in particular, a price ceiling or a price floor (Fankhauser, et al., 2011). A price floor implies that actors pay a charge on top of the permit price when prices fall beyond some pre-defined level while a price ceiling suggests that additional permits will be made available when prices rise too high.
- Subsidies. Subsidies that regulate the same emissions as the trading system may not be compatible with each other. In principle, subsidies can affect trading systems by either lowering the permit prices or adding rent to actors in the market (Fankhauser, et al., 2011). On the other hand, current public funding programmes and agri-environmental support have the potential to complement a nutrient trading system. To avoid “thin markets”, there might be a need to re-direct public funds toward nutrient trading, i.e., instead of funding measures via subsidies, public sector actors buy nutrient abatement permits via the trading system, thus resembling the design of results-based payments. Subsidies to farmers for “nutrient reduction” projects under the current system are ineffective, because farmers are given incentives to implement measures with low opportunity costs, but not to optimize environmental benefits (Sidemo-Holm, et al., 2018). A future trading system has potential to improve the location of nutrient reduction projects.

14 COUNTRIES’ MOTIVES TO PARTICIPATE IN A TRADING SYSTEM

A theoretical analysis has been undertaken to assess countries’ incentives to participate in a future trading system. The work involved development of a framework to better understand incentives at play and how they may affect future negotiations. The major findings and conclusions are summarized in this chapter.

The theoretical analysis addressed two key questions:

- What are the incentives for individual Baltic Sea countries to collaborate more intensively to reduce eutrophication of the Baltic Sea?
- Given these incentives, which pathways forward are likely to increase the likelihood of participation in a future nutrient trading system (with all or a subset of countries)?

Countries' incentives to collaborate on reduction of pollution generally depend on estimates of how pollution from other countries influence national interests. These estimates are uncertain, not only in biophysical terms, but also in relation to public views and concerns. The fact that HELCOM countries have shown an historical willingness to collaborate *generally* on nutrient pollution goals does not necessarily suggest that all of them will participate in a trading system *specifically*. This is especially true given that a trading system requires significant trust among participants.

While predicting the future behaviour of individual countries with any accuracy is beyond the scope of this analysis – several political, economic, and social factors are at play – it is nonetheless possible to map and assess some of factors that may influence a country's incentives which, in turn, can inform implications about the scope of overall participation in a future nutrient trading system.

14.1 FRAMEWORK FOR ANALYZING COLLABORATION

A theoretical framework has been developed to facilitate the analysis of incentives for international collaboration to address nutrient pollution. The framework's structure helps to understand (1) the varying incentives the Baltic Sea countries face in relation to Baltic Sea Action Plan targets and (2) why collaboration is required if objectives are to be reached. Ultimately, the benefit of the framework is to support future negotiations by identifying strategies that provide benefits to all countries through the concept of a "win-set." In the following sections we describe the benefits of collective action (collaboration) and how the concept of a win-set can help illustrate and enlarge the area for common ground between countries.

14.1.1 The benefits of international collaboration

Each country is assumed to balance costs and benefits from reduced nutrient pollution to the Baltic Sea, but factors that vary across countries – such as economic growth, technological development, attitudes among voters, changes in stakeholder pressures and information – may influence such balancing. The framework facilitates mapping of incentives to better understand collaboration; importantly, it does not aim to develop negotiation strategies per se, which can be affected by several contextual factors.

A so-called two-level games approach is useful as it distinguishes between domestic (first level) and international motives (second level), where the two are assumed to differ but could be reconciled to form an agreement (Putnam, 1988). The underlying assumption is that the domestic interest is the prime driver for individual countries, but since outcomes at the regional level offer the possibility for additional benefits, interactions with other countries are also relevant (international level). Cooperative solutions are sought when countries believe they can benefit from cooperation, but for voluntary cooperation to be sustained, each individual country must believe they will actually receive the benefits. Thus, net gains from reducing eutrophication at the regional level is a necessary, but not sufficient, requirement for political action. Each country must balance "domestic constraints" (what the voters will accept) with expected benefits from collective action.

A critical and complicating factor in this case is that reducing pollution results in costs and benefits that are distributed unevenly not only across sectors, but also across countries. Although the benefits of reducing nutrient pollution in a country directly benefits that country, it also leads to collective benefits as adjacent countries also receive value from the reduction.

However, the country reducing pollution does not consider the collective benefits and thus chooses to reduce pollution less than they would have, had they considered these. As a result, the full collective benefits are not realized (this is referred to as an impure public good).[10] The practical implication is that it hurts all participants if each country acts on self-interest alone, since it leads to a suboptimal level pollution reduction. Thus, collaboration is the best outcome from a regional and societal perspective. But how can collaboration be designed to maximize the benefits to all countries? How can interdependency in decision-making be harnessed by better understanding – and perhaps re-directing – positive spill-over effects from one country to another?

14.1.2 Creating and enlarging win-sets

A "domestic" win-set defines a policy proposal that is believed to be accepted on the national level, i.e., to win a majority of voters. Thus, at a general level, a win-set is a policy proposal that is relevant and credible in an international negotiation because it is likely to be accepted domestically. While win-sets cannot be fully predicted beforehand, they can be mapped and analysed in order to understand countries' likely negotiation positions. In the case of a nutrient trading system, it is worth considering positions likely to be taken by domestic sectors like agriculture (or the trade organizations that represent them), environmental organizations, NGOs, political parties, etc. This type of knowledge can help identify common ground between countries in a future negotiation.

A relevant question is how to create or enlarge win-sets, i.e., increase the common ground between countries in such a way that the benefits of collective action can be realized.

Figure 14.1 includes two figures: the one on the left depicts a situation where a shared win-set between the three countries does not exist, since there is no place in which the net benefits overlap (the Y-axis represents benefits and the X-axis represents costs – in this case associated with implementing the Baltic Sea Action Plan, BSAP). The squares represent domestic win-sets, that is, areas where agreements are believed to have support within the country. However, the figure on the right reflects the possibility that the net benefits of several countries may overlap – a shared win set[11] – which suggests the possibility that all actors may be made better off from a negotiated agreement. More specifically, the figure reflects a situation in which Country A decides to transfer resources for achieving the goals of the Baltic Sea Action Plan to County B.

10 Pure public goods benefit all actors equally, whereas, impure public goods benefit some actors more than others.

11 Many factors may affect the size and extent of a shared win-set. For example, the figure only shows outcomes that are acceptable, but says nothing about which part of the shaded area may be more or less preferred. Note further that the availability and credibility of information about the costs and benefits of a given action will also affect the shared win-set, which is best seen as a dynamic concept rather than a static one.

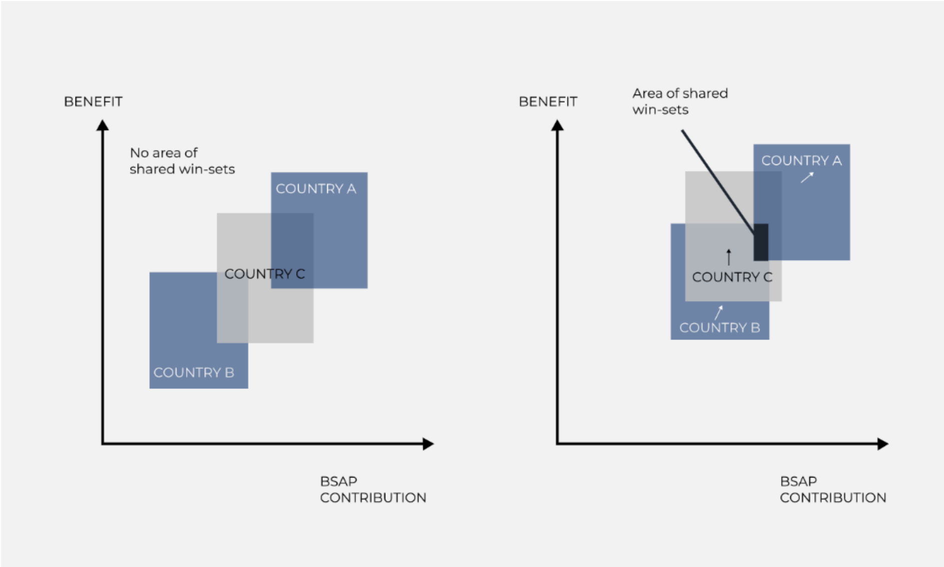


Figure 14.1 Schematic portrayal of a situation where no shared win-set exists (left) and where a shared win-set was created when Country A subsidized Country B (Country A pay subsidies but still gets net benefits, Country B pays part of the extra contribution, but not more than experienced benefits, and Country C benefits "for free" thanks to positive side-effects from the increased contributions by Countries A and B).

A shared win-set may be achieved naturally over time through, e.g., differences in economic growth between countries or shifts in public opinion, but it may also be *created* through negotiation. For example, if a government wants to promote collaboration – e.g., participation in a regional nutrient trading system — but a shared win-set is unlikely to exist (or does not cover crucial aspects), it could apply the following strategies[12] to create or enlarge win-sets:

1. Expand domestic win-sets. The country could focus inward and improve policy possibilities on the domestic level by striking a balance between conflicting interests: e.g. between parties that prefer one policy instrument over another or between sectoral interests. The latter is common i.e., governments compensate (via subsidy) the agricultural sector for potential losses associated with increased environmental protection measures, as this enlarges the domestic win-set while simultaneously reducing nutrient pollution.
2. Expand other parties' win-sets. The country could focus outward by improving possibilities for other countries, commonly through side-payments or issue-linkage. Side-payments typically involve monetary payments or partial funding for a specific purpose, in exchange for the recipient country's participation in an agreement. The outcome benefits both countries. An alternative to compensatory payments is issue-linkage, which also has the objective of increasing other countries' win-sets by linking collaboration from the recipient country to some issue that has value for that country. For example, support for terrestrial nature reserves in the recipient country can be made conditional on reduced nutrient pollution of the Baltic Sea.
3. Alter the scope of the collaborative framework. The country could focus on reducing the scope, since collective action tends to be more challenging the larger or more

12 It may involve a combination of these strategies, all of which would benefit from empirically informed estimates of other parties' win-sets. Thus, the importance of mapping incentives of all parties.

diverse the number of participants become (Hassler, et al., 2019) (Olson , 1965). In other words, transaction costs are lower when the scope is reduced. This can be done through e.g., defining a smaller geographic range, covering fewer nutrient pollutants, or including fewer participants (e.g., countries, buyers and sellers, sectors). This approach can be a useful first step in an agreement that includes additional actors over time.

As described in Section 14.2.1, strategy (2) involving compensatory payments or issue-linkage provides a particularly promising path forward for a nutrient trading system, as it is commonly relied upon to facilitate international agreements. For example, insight into the incentives of actors may lead to suggestions for redistributing costs so that participation in a trading system makes both a reluctant and enthusiastic country better off, compared to a scenario where both choose not to participate and are worse off.

14.2 ANALYSIS

The analysis finds that the nine Baltic Sea countries have diverging national interests and thus different incentives to collaborate. Based on this information and the framework's concept of a "win-set", we consider different negotiation strategies and what this may imply for the size and extent of future participation in a trading system.

Key factors affecting incentives to collaboration

Figure 14.1 identifies eight factors that can tell us something about a country's incentives to collaborate, where these factors are assessed empirically via a proxy. For example, countries like SE, DK, and FI are likely to have greater domestic public support for collaboration because of a higher willingness to pay by citizens of these countries for obtaining benefits of nutrient reduction (point 1 in Figure 14.1). In contrast, the finding of lower willingness to pay in RU and PL suggests weaker domestic support, all else equal.

The economic importance of coastal resources, such as maritime shipping, ecosystem services, etc. (point 3, Figure 14.1) can be proxied by "relative length of coastline" (length of coastline in relation to country size). Countries with longer relative coastlines are more likely to be affected by nutrient pollution and therefore more likely to collaborate on solutions – all else equal. The relative length of coastline proxy suggests that DE, LT, PL, and RU are less likely to participate.

Additional factors that are likely to influence incentives to collaborate are described in Figure 14.1. Although these factors may not be very informative individually, together they make it possible to identify possible incentive structures.

Table 14.1 Factors that may influence individual countries' incentives to collaborate on pollution reduction.

Factors influencing national incentives to collaborate	Empirical assessment	Likelihood of Collaboration[b]
1. Domestic public support	Average WTP for reduced pollution as a marker for domestic political support for collaboration (Ahtiainen, et al., 2012)	(+) SE, DK, FI (-) RU, PL (also largest contributors to pollution**)
2. Citizen prioritization of environmental protection	Level of environmental concern expressed in attitude questionnaires (Franzen & Vogl, 2013)	(+) DK, EE, FI, DE, SE (-) LV, LT, PL, RU
3. Economic importance of coastal resources	Relative length of coastline, as a marker for use and non-use values related to the Baltic Sea (Hassler, 2003)	(+) FI, SE, LV, EE, DK, (-) LT, PL, RU, DE
4. Resource mobilization potential	Gross National Income per capita [13]	(+) FI, SE, DE, DK (-) EE, LV, LT, PL, RU
5. Sectoral competition	Level of lobby activity, primarily related to agricultural vs. environmental protection interests based on interviews (see Appendix 2)	(+) FI, SE (-) DK, EE, DE, LV, LT, PL, RU
6. Policy Instrument Preference	Positive attitude towards trading system for nutrient pollution based on previous experience	(+) FI[a], SE[a] (-) DK, EE, DE, LV, LT, PL, RU
7. Historical bilateral structures	Previous environmental support to the Baltic States, Poland and Russia (Hassler, 2003)	(+) FI, SE, EE, LV, LT, PL, RU, DK, DE (-) (none)
8. Regulatory synergies	Member of the EU, bound by EU directives (Hassler, 2016)	(+) 8 EU countries (-) Russia

[a] Note that both SE and FI have worked previously with nutrient trading systems.
[b] (+) indicates that these countries are more likely to collaborate while, while a (–) indicates less likely.

Despite the heterogeneity across countries in many respects, a pattern emerges in terms of incentives that tend to divide the nine countries into two groups: *Group One* represents the more affluent countries (DK, FI, DE, SE) and *Group Two* represents the less affluent countries (LV, LT, PL, RU, EE). Countries in *Group One* show a higher willingness to pay for new initiatives to reduce eutrophication, are richer (more resources available reduction of nutrient pollution) and are better able to compensate their own farmers for reduction of pollution. Further, all countries in *Group One* except DE have a relatively long Baltic Sea coastline. Finally, all countries in *Group One* had, albeit in various ways and extent, environmental support programmes to address problems in Group Two countries after the collapse of the Soviet Union in the early 1990s (Hassler, 2003). Thus, historical precedents for supporting environmental investments and transnational collaboration targeting the countries in *Group Two* exist – which could, to some extent, facilitate future cooperation on reduction of nutrient pollution.

In short, incentives to reduce nutrient pollution tend to diverge more than they converge. Although incentives do not, in themselves, determine national strategies, they nonetheless impact collaboration. Thus, they provide an important foundation for analysing and proposing

13 All Gross National Income (GNI) data based on Purchasing Power Parity in current international dollar (a similar amount of goods and services in any country that a US dollar would buy in the United States in that year). The GNI per capita according to World Bank (2020) in the Baltic Sea countries was in 2019: Denmark: 62 000, Estonia: 38 000, Finland: 52 000, Germany 58 000, Latvia 30 000, Lithuania: 37 000, Poland: 33 000 and Russia: 28 000.

negotiation strategies for a future nutrient trading system in the Baltic Sea, as described in the next section.

14.2.1 How to increase likelihood of collaboration

To recommend pathways forward that increase the likelihood of collaboration in a future nutrient trading system, we combine the best available information about incentives and win-sets.

Since a win-set covering all nine Baltic Sea countries is unlikely to exist, two key implications arise: First, side-payments or issue-linkage will likely be necessary to increase overall participation (see Figure 14.1); and second, shared win-sets may only exist for a smaller subgroup of countries. This, in turn, offers three possible paths forward for a Swedish negotiation strategy:

I. Universal participation of countries enticed through side-payments or issue-linkage,

II. Subset of countries where side-payments are not needed, or

III. Gradual enlargement where a domestic trading system is established in Sweden, then gradually enlarged using side-payments or issue-linkage when needed.

These paths are summarized in Table 14.2 and are based on a trade-off between two criteria: *practical feasibility* (which argues for a path of least resistance by only inviting countries that are likely to participate) and *efficiency gains* (which argues for including all, or nearly all, countries in order to leverage the differences in marginal cost of abatement across countries). Path III represents a compromise based on a strategy of gradual enlargement.

Path I aims at the primary objective of a trading system; namely, to include a diverse set of countries that face variable costs of abatement. The rationale is that wealthier countries that expect large net benefits from reduced eutrophication can finance reduction in other countries with lower marginal abatement costs and still benefit. Although there are no guarantees of improved efficiency, this pathway provides the greatest possibilities. By including all countries, the agreement would help to avoid “leakage” of emissions from countries that choose not to participate. However, this pathway is expensive (will likely require significant compensatory payment contributions from the countries that stand to benefit from the participation) and risks never getting off the ground due to challenges of negotiating with so many actors.

Path II is the easiest way forward from a practical feasibility perspective, as it encompasses a limited number of countries with similar interests and, therefore, does not require compensatory payments (e.g., Sweden-Finland). It offers the possibility to explore future constellations and work out challenges in a nutrient trading system before expanding it at a later stage; or to experiment with different types of trading systems within a controlled setting. A drawback is that when marginal costs for pollution abatement are similar, efficiency gains are likely to be limited.

Path III offers a strategy of gradual enlargement focusing first on a national trading system in Sweden, second on enlargement to countries with strong incentives to collaborate, and finally, on countries with low marginal costs for pollution abatement (likely involving side-payments or issue-linkage). Importantly, this path focuses on building trust and acceptance from countries that are initially sceptical of a trading system but may nonetheless be enticed to join with future compensatory payments if their reservations could be addressed through evidence that the system works. Another possible objective could be to test a pilot project for e.g., formats for side-payments and/or issue linkage, which can then be elaborated and tested on a larger scale as other countries are invited to join.

Table 14.2 Possible paths forward, based on analysis of countries' incentives and win-sets

Attribute	Path I: Universal Participation	Path II: Subset of countries	Path III: Compromise
Focus criteria	Efficiency gains	Practical feasibility	Compromise between practicability & efficiency
Motivation	Focus on achieving the primary benefit of a trading system: overall cost efficiency	Focus on what is feasible today, while also capturing some efficiency gains	Focus on feasible coalition that includes countries with differences in marginal costs of abatement
Initial size of coalition	Large (SE, FI, DE, DK, EE, LV, LT, PL, RU)	Small (e.g., SE, FI)	Gradual enlargement (SE first, followed by FI, and later LT and/or PL)
Time horizon	Go "all in" – invite all countries from the start, and handle challenges incrementally	Take it slow – invite incentive compatible countries, demonstrate system and attract interest, aim for subsequent expansion	Build trust – Start with pilot where formats for side-payments and/or issue linkage are elaborated and tested. Focus on building trust and acceptance before expansion
Cost	High: Financing countries must cover compensatory payments/issue linkage	Low: No need for compensatory payments/issue-linkage	Medium: Time-consuming to build trust for robust participation + possible compensatory payments/issue linkage
Benefits	Large: Can potentially lead to overall efficiency	Low: Exclusion of countries with low abatement cost implies low efficiency gains.	Medium: enlargement can provide benefits but must be undertaken in successive steps (may be difficult to meet key deadlines).
Risk	High: May never get off the ground if countries refuse to join; high risk for free riding	Low: May be functional but never grow into a fully cost-efficient mechanism for reducing pollution	Medium: Use of compensatory payments/issue linkage that may, in the end, fail

This chapter shows that mapping countries' diverging incentives to participate – even if somewhat imprecise – can shed light on possible ways ahead. Our analysis implies that invigorated collaboration on reduction of nutrient pollution, including a nutrient trading system, is possible but is likely to require side-payments and possibly issue linkage. The scope of collaboration is likely to be limited to a sub-set of countries, at least in the short run.

The most reasonable path forward might be the gradual enlargement path where Sweden first develops a national trading system, and then invites Finland for bilateral collaboration on provision of side-payments etc to Poland and/or Lithuania. Both Sweden and Finland have high willingness to pay to obtain benefits (i.e., similar incentives), suggesting they are important players (Denmark and Germany may be worth considering as late-medium stage additions). Further, they both stand to benefit from lower overall costs of abatement for society by leveraging efficiency gains from either Poland and/or Lithuania. By including Poland, the economic and environmental benefits of a future trading system may be large, given the size of the country, its current contribution to eutrophication, and the potentially large efficiency gains; on the other hand, Lithuania might be easier to attract with compensatory payments given their relatively greater willingness to pay for environmental improvement. Another possibility with large potential efficiency gains would be to invite Russia, but since it not a member of the EU it may prove more challenging than inviting Poland and Lithuania.

While this analysis is helpful in identifying *general* considerations from an international perspective, these recommendations do not account for, or consider, a specific design of a future trading system. A subsequent, more detailed empirical assessment based on win-set analyses could offer more specific recommendations in terms of which actors to include in a future trading system, when to invite them and which types of side-payments or issue linkage may be needed.

15 CONCLUSIONS – CURRENT INSTRUMENTS AND POSSIBLE ROLE FOR A TRADING SYSTEM

This chapter summarizes the possibilities for a trading system, given the challenges associated with existing instruments and the incentives faced by each of the countries in terms of future collaboration.

15.1 CURRENT POLICY INSTRUMENTS

Pollution levels in the Baltic Sea make it one of the most polluted and sensitive inland seas. To address pollution, countries have cooperated, agreed to common goals, and established national/regional strategies. The Baltic Sea Action Plan sets nutrient reduction targets, with the overall goal to reach good environmental status of the Baltic Sea. Further, the Water Framework Directive and the Marine Strategy Framework Directive set high requirements on the quality of fresh water and marine waters in the EU countries. In response, all EU countries have developed strategies to achieve the common goals.

The nine coastal countries of the Baltic Sea address the problem of nutrient pollution in their national environmental strategies (although Russia's national strategy for improving the status of water bodies does not mention the Baltic Sea). Denmark and Sweden have specific goals to achieve water quality unaffected by pollution. All nine countries have a goal of increasing competitiveness of agricultural production and all except Russia explicitly acknowledge that this may conflict with environmental goals by noting the importance of moderating agricultural goals with respect to nutrient pollution.

The nine countries rely on slightly different types of policy instruments, with a tendency toward subsidies and regulation for the agricultural sector and regulation for the wastewater sector. The wide use of regulation is probably due to the long history of this approach, while the use of agricultural subsidies is mainly an effect of the agri-environmental subsidies of the EU's common agricultural policy. Information instruments seem somewhat more common among wealthier countries, which could be due to stricter regulations, or perhaps to a broad acceptance of information instruments. Five countries tax nutrient pollution in wastewater, but the use of taxes/fees in agriculture is more limited and tends to rely on taxing inputs (e.g. the Danish phosphorus tax on animal feed). Despite a wide variety of available approaches, few countries rely on economic instruments generally and none rely on markets specifically. The mapping of current policy instruments suggests that countries are not using all the "tools in the toolbox".

15.2 CHALLENGES WITH EXISTING POLICY INSTRUMENTS

The current policy instruments are likely inadequate for reaching water quality goals. Results from the Baltic Sea Action Plan assessment suggest that existing instruments and collaboration have not been sufficient. In short, HELCOM has admitted that many of the water quality goals set for 2021 are not going to be met. Our analysis and data collection suggest that "minor adjustments" to existing instruments is most likely not enough.

The wide use of command-and-control measures suggests policy implementation is more expensive than necessary. Administration of subsidies and lengthy processes to renew environmental permits are significant drivers of high transaction costs. Additionally, subsidies to farmers for reducing nutrients fail to consider where such measures are likely to have the greatest environmental effect, partly because the information required is costly. Today's instruments impose a skewed distribution of costs and benefits across individual actors and across countries, which could be addressed through a future trading system.

Some argue that existing instruments simply need to be implemented and communicated more effectively. For example, many actors do not accept that there is a problem, which underscores the need for effective communication about the causes of nutrient pollution. Others suggest that voluntary measures should be made mandatory. Further, comparing tax levels with abatement costs in wastewater treatment plants suggests that low levels of phosphorus taxes in Latvia and Lithuania are not enough to increase abatement, while the opposite holds for similar taxes in Denmark, Estonia and Germany.

It has also been suggested that the problem lies in the organization of environmental control authorities or the political will, rather than the existing instruments (or lack thereof). For example, investigations in Sweden have suggested re-organization of the divided responsibilities between agencies to address the problem of eutrophication. In some cases, there is a lack of political support to improve water pollution control or a lack of studies to determine whether instruments are effective.

Importantly, the latest assessment of the Swedish environmental goals concludes that eutrophication reduction will not be achieved due to *both* an implementation gap *and* a gap in policy instruments. Five countries tax nutrient pollution from point sources. Further, both interviews and previous studies question the effectiveness of current taxes on nutrient pollution – not only the gap in tax level between countries (see above), but also the fact that they are not cost-effective since they do not treat point- and non-point sources equally.

The introduction of a nutrient trading system is not the only alternative for addressing some of the challenges we identify with current policy instruments. As noted, increasing the level of nutrient taxes could improve efficiency and cost-effectiveness, as would equal treatment of point and non-point sources. Another alternative could be to re-design current subsidies to farmers by basing payments on results rather than costs, thus achieving better environmental outcomes. Since result-based payments rely on biophysical modelling, any future experience from testing these payments through a pilot would also provide important input to a future nutrient trading system.

15.3 COUNTRIES' MOTIVES TO PARTICIPATE IN A TRADING SYSTEM

Collaboration on reduced pollution is likely to result in net benefits at the aggregate level, but for a trading system to be robust, all participating countries must expect net benefits. The nine Baltic Sea countries have diverging national interests and thus different incentives to collaborate in a nutrient trading system. We map nine factors that affect incentives including environmental aspects (e.g., public support for reducing pollution), economic aspects (a countries economic reliance on the Baltic Sea as a resource) and others (e.g., competition between environmental and other policy goals). Analysis of these factors suggests two groups of countries can be identified – the more affluent countries (DK, FI, DE, SE) and the less affluent countries (LV, LT, PL, RU, EE), where the former shows a higher willingness to pay for new initiatives to reduce eutrophication, are richer (more resources available reduction of nutrient pollution) and are better able to compensate their own farmers for reduction of pollution.

Full collaboration among all nine countries is unlikely according to an analysis of "win-sets", which suggests that compensatory payments or issue linkage will be needed to enlarge the coalition of participating countries. A more limited scheme of collaboration among affluent countries with strong incentives to reduce Baltic Sea eutrophication would probably be easier to establish but lead to relatively small gains related to efficiency (i.e., when marginal abatement costs across countries are similar it results in only small gains from trade).

Thus, a suggested path forward referred to as "gradual enlargement" could be most promising. This path would focus on countries likely to join a coalition, which also contains some variation in marginal costs of abatement. For example, limited compensatory payments from Sweden and/or Finland to either Poland and/or Lithuania could be a start (Another possibility could be to invite Russia, but this would be more challenging since it is not an EU member).

15.4 THE ROLE FOR A TRADING SYSTEM

The review and assessment of existing policy instruments suggest a possible role for a future trading system. Given that few countries currently rely on economic policy instruments, along with the fact that some of the current challenges can be addressed theoretically through a "market" trading system, this type of system could play an important role. The benefits of a trading system are (1) total costs of measures are likely to decline (2) the burden of financing measures is likely to shift from public to private actors, (3) negative distributional impacts can be addressed through flexible mechanisms for cost sharing and (4) transaction costs will likely decline over the long run (even if they increase slightly initially). Importantly, by using resources more efficiently through a trading system, other administrative resources will be freed up to use in other regulatory areas that are currently underfinanced.

Importantly, not all challenges with existing policy instruments can be addressed by a trading system (or other economic policy instrument). For example, potentially burdensome reporting requirements will remain since this information is needed regardless of policy instrument. A country's institutional set-up may not be resolved either with a trading system.

Although some existing policy instruments can be merged with a future trading system – in some cases they are necessary prerequisites – other instruments may have to be modified or removed before implementing a trading system. Economic policy instruments should either be removed or reoriented to support the functioning of the nutrient trading system. Taxes should be removed or re-oriented. In case of reorientation, taxes should be re-designed to become price-floor/price-ceiling to control price volatility. Subsidies may be re-oriented to support the functioning of the trading system by reducing the risk of thin markets. It is most probable, current quantity-based regulation cannot be removed, because of low acceptance among policy makers. Still, quantity-based regulation is relatively easy to integrate provided that the design of the trading system certifies that the trading system is binding. While a more detailed and comprehensive analysis of how and if to replace existing instruments will be needed before proceeding, information and regulation through environmental permits may be relatively easier to integrate than economic policy instruments.

There will be several challenges and risks when introducing a trading system, not the least being the pedagogical challenge of explaining the benefits and purpose among potentially sceptical actors. Input from interviews suggests that introducing a market represents a communication challenge, as it requires simple and easy-to-understand language to combat misinformation and misperceptions about market-based instruments.

PART C: LEGAL CONTEXT

Part C reviews the legal context that will impact the design of the trading system, including conventions, legal competence, the Water Framework Directive (WFD) and the Marine Strategy Framework Directive (MSFD).

- **Chapter 16** describes the environmental policy in the Baltic Sea Region.
- **Chapter 17** presents EU and national competencies to legislate and the issue of conflicting legislation.
- **Chapter 18** describes EU's legal powers to negotiate and conclude international agreements.
- **Chapter 19** presents HELCOM.
- **Chapter 20** presents and analyzes the Water Framework Directive.
- **Chapter 21** presents and analyzes the Marine Strategy Framework Directive.

16 ENVIRONMENTAL POLICY AND THE BALTIC SEA

Environment policy is a significant social challenge facing public authorities and all sectors of the economy today. It is also a subject of public concern since it directly affects society's health and welfare. Since the 1970s, environmental concerns led to a series of EU initiatives that framed the environment as an important EU policy area. This has led to a large accumulated legislation, legal acts, and court decisions that today constitute the body of European Union law.

All countries around the Baltic Sea, except for Russia, are EU members, which means EU legislation and obligations must be considered. EU legislation to protect the marine environment has been implemented in many areas, most notably the Water Framework Directive (WFD), which controls the input of nutrients and chemicals into waters, and the Marine Strategy Framework Directive (MSFD) focusing on the protection of the marine environment and natural resources and creating a framework for the sustainable use of our marine waters. Figure 16.1 presents some of the legislation and the tools to deal with the problem of eutrophication in a given geographical area

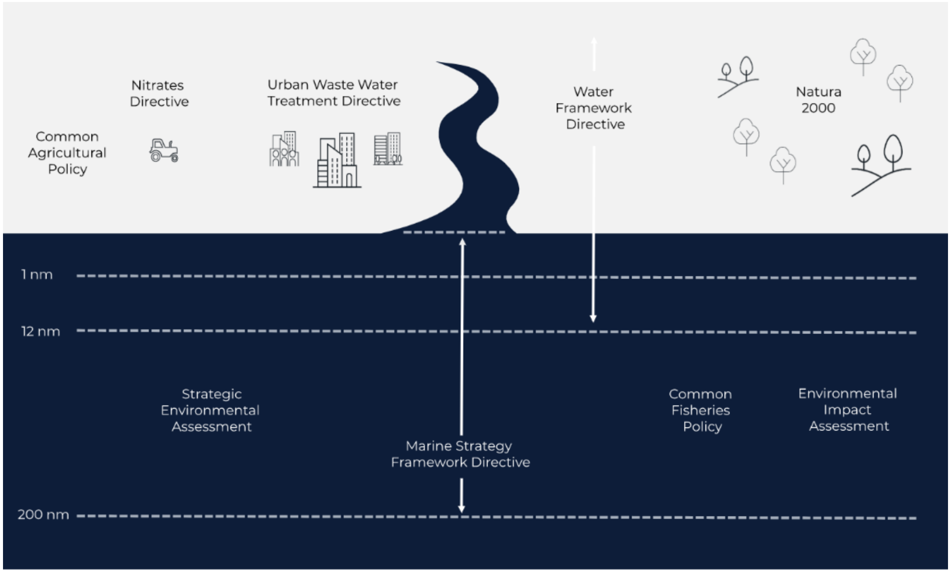


Figure 16.1 Geographical scope and competencies (powers) of some examples of EU legislation. Source: (Boyes, et al., 2016).

The EU Strategy for the Baltic Sea region covers a wide range of issues including prosperity, safety, accessibility, but foremost is the recovery of the Baltic Sea environment. Environmental actions are directly supporting this work in HELCOM. Actions on sustainable agriculture and fishery, maritime safety and Baltic Sea research are closely linked to HELCOM.

In 2007 the HELCOM Baltic Sea Action Plan (HELCOM, 2007) was adopted, with four priority areas for the sea:

- should be unaffected by eutrophication
- should be undisturbed by hazardous substances
- should achieve favourable status in terms of biodiversity
- should support environmentally-friendly maritime activities

There are however a number of challenges at different governance levels, including (Wulff, et al., 2007):

- differences between coastal countries in terms of environmental conditions including environmental awareness
- overlaps of policies between different levels
- a lack of adequate spatial and temporal specification of policies
- a lack of policy integration

The historically rooted differences between the countries within the Baltic Sea region, including socioeconomic factors and the ability to adapt different measures, is a challenge for effective governance of the Baltic Sea region and eutrophication mitigation.

17 DIVISION OF COMPETENCES WITHIN THE EUROPEAN UNION

The EU has only the competences (powers) conferred upon it by the Treaties (Principle of Conferral) which, in this context include all the areas where the EU can propose new legislation or make decisions.

Under this principle, the EU may only act within the limits of the competences conferred upon it to attain the objectives provided therein. Competences not conferred upon the EU in the Treaties remain with the member states. The Treaty of Lisbon clarifies the division of competences between the EU and member states and includes three main categories: exclusive competences; shared competences; and supporting competences.

17.1.1 Exclusive competences

According to Article 3 of the TFEU (Treaty on the Functioning of the European Union), exclusive competences include areas in which the EU alone is able to legislate and adopt binding acts (European Court of Auditors, 2016). In these cases EU countries are able to do so themselves only if empowered by the EU to implement these acts. The EU has exclusive competence in the following areas: customs union; establishing competition rules necessary for the functioning of the internal market; monetary policy for euro area countries; conservation of marine biological resources under the common fisheries policy; common commercial policy; conclusion of international agreements under certain conditions.

17.1.2 Shared competences

According to Article 4 of the TFEU, shared competences are those in which the EU and EU countries are able to legislate and adopt legally binding acts. EU countries exercise their own competence where the EU does not exercise, or has decided not to exercise, its own competence. Shared competence between the EU and EU countries applies in the following areas: internal market; social policy, but only for aspects specifically defined in the Treaty; economic, social and territorial cohesion (regional policy); agriculture and fisheries (except conservation of marine biological resources); environment; consumer protection; transport; trans-European networks; energy; area of freedom, security and justice; shared safety concerns in public health matters, limited to the aspects defined in the TFEU; research, technological development, space; development cooperation and humanitarian aid.

17.1.3 Supporting competences

According to Article 6 of the TFEU, supporting competences are those in which the EU can only intervene to support, coordinate or complement the action of EU countries. Legally binding EU acts cannot require the harmonisation of EU countries' laws or regulations. Supporting competences relate to the following policy areas: protection and improvement of human health; industry; culture; tourism; education, vocational training, youth and sport; civil protection; administrative cooperation.

17.1.4 Specific institutional features

The EU can also take measures to ensure that EU countries coordinate their economic, social and employment policies at the EU level.

The EU's common foreign and security policy is characterized by specific institutional features, such as the limited participation of the European Commission and the European Parliament in the decision-making procedure and the exclusion of any legislation activity. That policy is defined and implemented by the European Council (consisting of the Heads of States or Governments of the EU countries) and by the Council (consisting of a representative of each EU country at the ministerial level). The President of the European Council and the High Representative of the Union for Foreign and Security Policy represents the EU in matters of common foreign and security policy.

The exercise of EU competences is subject to two fundamental principles laid down in Article 5 of the TFEU:

- Proportionality: the content and scope of EU action may not go beyond what is necessary to achieve the objectives of the Treaties;
- Subsidiarity: in the area of its non-exclusive competences, the EU may act only if — and in so far as — the objective of a proposed action cannot be sufficiently achieved by the EU countries, but could be better achieved at the EU level.

17.2 CAN A MEMBER STATE PROPOSE COMPETING LEGISLATION?

Article 4 TFEU introduces legal constraints on the Member States, depending on the maturity of the EU interest expressed by them. This can be observed in the Case C-129/96 *Inter-Environment Wallonie* [1997] ECR 7411, paras 45, which prohibits Member States from 'taking any measures liable to seriously compromise the result prescribed' in the directive. It has been pointed out that a conflict with national legislation can occur only after a certain point in time, i.e., at the end of the period of transposition and the exercise of Community competence. This should not be a problem with a future nutrient trading system since there are no legislative acts pending among member states, or on-going legislative work at the Council, regarding nutrients. However, a national legislative act cannot go against an EU legislative act, which means a future trading system must be in line with EU *acquis*.

18 INTERNATIONAL AGREEMENTS

The following articles establishes the EU's legal powers to negotiate and conclude international agreements, and its competence, whether exclusive or shared, to enter into such agreements: Article 3 of the Treaty of the Functioning of the European Union (TFEU); Article 4 TFEU; Article 207 TFEU; Article 216 TFEU.

International agreements with non-EU countries or with international organisations are an integral part of EU law. These agreements are separate from primary law and secondary legislation and form *a sui generis* category. According to some judgments of the Court of Justice of the European Union (CJEU), they can have direct effect and their legal force is superior to secondary legislation, which must therefore comply with them.

International agreements are treaties under public international law and generate rights and obligations for the contracting parties. Unlike unilateral acts, conventions and agreements are not the result of a legislative procedure or the sole will of an institution. Article 216 TFEU cites the cases in which the EU is authorised to conclude such agreements. After having been negotiated and signed, and depending on the subject matter concerned, agreements may require ratification by an act of secondary legislation.

International agreements must be applied consistently throughout the EU. They have a legal force superior to unilateral secondary acts, which must therefore comply with them.

The EU has a legal personality and is therefore a subject of international law that is capable of negotiating and concluding international agreements on its own behalf, i.e. it has competences (or powers) in this field conferred upon it by the treaties. The distribution of competences between the EU and EU countries also applies at an international level. When the EU negotiates and concludes an international agreement, it has either exclusive competence or competence that is shared with EU countries.

Where it has exclusive competence, the EU alone has the power to negotiate and conclude the agreement. Article 3 TFEU specifies the areas in which the EU has exclusive competence to conclude international agreements, including trade agreements.

Where its competence is shared with member states, the agreement is negotiated and concluded both by the EU and by the member states. It is therefore a mixed agreement to which EU countries must give their consent. Mixed agreements may also require that an internal EU act is adopted to share out the obligations between the EU countries and the EU. Article 4 TFEU sets out which competences are shared. The 1992 Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention revised in 1992) is an example of a mixed agreement.

19 HELCOM

The Convention on the Protection of the Marine Environment of the Baltic Sea Area ("the Convention") was signed on 9 April 1992 and entered into force on 17 January 2000. The objective of the Convention is to establish a framework of regional cooperation in the Baltic Sea in order to reduce and prevent pollution in this region and promote the self-regeneration of its marine environment and preservation of its ecological balance. In accordance with the precautionary principle and the principles of the "polluter pays" and sustainable management, the parties agreed to adopt legislative, administrative or other relevant measures to achieve these objectives.

The Convention was concluded through Council Decision of 21 February 1994, on behalf of the Community, regarding the Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention as revised in 1992); OJ L73 of 16/03/1994, p.19. The Convention was published in Official Journal, L73, 16/03/1994, p. 20, on 16 March 1994. The Legal Basis was Article 130r in the Treaty and the competence is mixed.

The international organisation established by the treaty is called the Helsinki Commission and the managing body is called Baltic Marine Environment Protection Commission - referred to as HELCOM or Helsinki Commission (Article 19). The Helsinki Commission (HELCOM) – is an intergovernmental organization (IGO) consisting of ten Contracting Parties: Denmark, Estonia, the European Union, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden.

The Convention covers the whole of the Baltic Sea area, including internal waters, the water body and the seabed. Measures shall also be taken in the entire Baltic Sea catchment area to reduce pollution from land-based sources.

The Baltic Sea Action Plan (BSAP), adopted in 2007, is a regional programme of measures and action for a healthy marine environment. The BSAP is further backed by the HELCOM Nutrient Reduction System, a regional approach to sharing the burden of nutrient reductions to achieve the BSAP goal of a "Baltic Sea unaffected by eutrophication". There are two main components of the nutrient reduction system:

- Maximum Allowable Inputs (MAI) of nutrients, indicating the maximal level of inputs of water- and airborne nitrogen and phosphorus to Baltic Sea sub-basins that can be allowed while still fulfilling the targets for non-eutrophicated sea;
- Country-Allocated Reduction Targets (CART), indicating the nutrient inputs each HELCOM countries need to reduce compared to a reference period (1997-2003).

Although the overall goal of the current BSAP to reach good environmental status of the Baltic Sea by 2021 will not be reached, the plan has nonetheless delivered a reduction in nutrient inputs to the sea, which has resulted in improved biodiversity and a decrease in maritime incidents and spills. In 2018, the HELCOM Ministers have therefore decided to update the plan by the end of 2021 at the latest, offering the possibility to adjust it and consider previously unaddressed challenges.

For the BSAP update in 2021, the current proposition is that the environmental objectives, the targets and the maximum allowable inputs remain the same as in the current plan, but the Country-Allocated Reduction Targets will be exchanged for Nutrient Input Ceilings (NICs) for all countries. Nutrient Input Ceilings are proposed to address the re-occurring problem of comparing nutrient reduction over time, including the need to have a stable baseline of comparison. Existing baselines keep changing as new data and new models reveal new results. By relying on Nutrient Input Ceilings instead, the focus is on maximum ceilings for how much countries are allowed to emit, irrespective of baselines (Baltic Marine Environment Protection Commission, presented by Germany, 2020), (Baltic Sea Center, Stockholm University, 2020)

19.1 IMPLICATIONS OF SHARED COMPETENCE REGARDING PROPOSALS ON CONVENTION ON THE PROTECTION OF THE MARINE ENVIRONMENT OF THE BALTIC SEA AREA, 1992

Since the Competence is shared (mixed) with EU countries, and there is an internal EU act adopting the Convention, EU-countries are obliged to consider its possibilities to act on its own regarding the Convention. The Advocate General in the case *European Commission v Kingdom of Sweden*, Breach of Articles 10 EC and 300(1) (ECJ, 2010), stated that neither Member States nor the EU can block the other from pursuing a higher level of environmental protection, as the distribution of competences operated by the Treaty is biased towards action. The Advocate General reasoned that both the Community's regulatory framework on which the Commission relies (Regulation No 850/2004 'the Persistent Organic' Pollutants regulation and Directive 76/769 approx. of the laws, regulations and administrative provisions to restrictions on the marketing and use of certain dangerous substances and preparations), as well as Sweden's accession to the Convention, are based on Title XIX of the EC Treaty with respect to the environment (Articles 174 EC to 176 EC). As such, the Community regulatory framework in question should be understood as introducing minimum standards, which in no way prevents further (stricter) action by Member States. Since this framework did not at the time cover perfluoroctane sulfonate (PFOS), the substance at question, the Community could not have acquired exclusive competence over their regulation.

However, in the field of mixed agreements, the Court of Justice of the European Union stated that a Member State has a duty to inform and consult the Community institutions prior to engaging in individual action (Case C-459/03 *Commission v Ireland* [2006] ECR I-4635, paragraph 179). If fulfilling that duty triggers a Community decision-making process, or is integrated in an ongoing process, the consequence must be that the Member State should engage fully and in good faith in such process.

The implications of the duty of loyal (or genuine) cooperation are twofold: first, that Member States cooperate with the EU decision-making process; and, second, that they refrain from taking individual action, at least for a reasonable period of time, until a conclusion to that process has been reached.

the *European Commission v Kingdom of Sweden* ruling stated that it is essential to ensure close cooperation between the Member States and the EU institutions. The Court stated that in all the areas corresponding to the objectives of the Treaty, Article 10 requires Member States to facilitate the achievement of the Community's tasks and to abstain from any measure that could jeopardise the attainment of the objectives of the Treaty (Opinion 1/03 [2006] ECR I-1145, paragraph 119, and Case C-459/03 Commission v Ireland [2006] ECR I-4635, paragraph 174).

The Court held that that duty of genuine cooperation is general and therefore does not depend on whether the EU competence concerned is exclusive nor does it depend on any right of the Member States to enter into obligations towards Non-Member States (Case C-266/03 Commission v Luxembourg [2005] ECR I-4805, paragraph 58, and Case C-433/03 Commission v Germany [2005] ECR I-6985, paragraph 64).

Where it is apparent that the subject matter of an agreement or convention falls partly within the competence of the EU and partly within that of its Member States, it is essential to ensure close cooperation between the Member States and the EU institutions, both in the process of negotiation and conclusion and in fulfilling the relevant commitments. The obligation to cooperate flows from the requirement of unity in the international representation of the EU (Ruling 1/78 [1978] ECR 2151, paragraphs 34 to 36 (by analogy with the EAEC Treaty); Opinion 2/91 [1993] ECR I-1061, paragraph 36; Opinion 1/94 [1994] ECR I-5267, paragraph 108; and Case C-25/94 Commission v Council [1996] ECR I-1469, paragraph 48). The court also raised the issue that a unilateral proposal can have consequences for the Union (Klamert, 2014).

The conclusion is that any proposal regarding a trading system should be communicated with the Commission in order to be aligned with the EU's decision-making process. A trading system developed through unilateral action may become difficult to administer, while also making later expansion into the Baltic Sea region more challenging.

The Swedish Agency for Marine and Water Management describes in a report that the existing action program for water management under the Water Framework Directive covers most of the necessary measures for addressing external load in the Baltic Sea Action Plan, but notes the challenge of finding measures to reduce internal load (Swedish Agency for Marine and Water Management, 2015). Since many measures already exist within the action program under the Water Framework Directive, a question arises as to whether this action plan can be altered/expanded to include a trading system. For example, how might a trading system affect the fact that eutrophication substances are already regulated with existing instruments for point sources? (This is not necessarily a major problem if trade takes place with credits for reduction measures). Another issue is how a trading system may affect existing subsidies, such as programs that pay farmers to construct wetlands with the aim of absorbing nutrients? Do government reduction measures also provide credits? If the credits from implemented measures are then traded, there is a risk that state funding to buy reductions via credits (e.g. support for wetlands) is seen as impermissible state aid, as it may violate the principle of not giving companies financial support to meet regulatory requirements.

20 EU WATER FRAMEWORK DIRECTIVE

This chapter identifies some of the major aspects of the Water Framework Directive that are relevant for introducing a nutrient trading system. The chapter also includes an illustrative example of water management in Sweden, a review of a significant court decision (the *Weser Case*) and discusses compensatory measures. Finally, we conclude with a discussion of key considerations for designing a trading system to ensure it would fit within the legal boundaries of the Water Framework Directive.

The "Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy" or, Water Framework Directive (WFD) was adopted in 2000. It establishes a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater (Article 1), where water bodies shall be managed through an adaptive water governance system based on river basins or catchments. In this report we will address surface water and not groundwater.

The main purpose of the Directive is to achieve good status or good potential of all waters concerned, to protect human health, water supply, natural ecosystems and biodiversity. The environmental objectives in Article 4 of the Water Framework Directive enact two main obligations on EU Member States: (1) to prevent deterioration of the status of all surface and groundwater bodies within the Union and (2) to protect, enhance and restore all water bodies, to achieve "good water status" (for surface waters, "good status" is determined by a "good ecological status" and a "good chemical status").

The aim is to achieve good surface water status 15 years after the Directive entered into force (Article 4 (1) (a) (ii)), which suggests that this objective should have been reached by 2015. However, there are possibilities to extend this up to a maximum of two additional periods for river basin management plan. Since these management plans have a duration of 6 years, then the objectives must be fulfilled by 2027 at the latest. There are no more possibilities for extensions according to the Directive other than when natural conditions do not allow timely improvement in the status of the body of water.

Article 258 of the Treaty on the Functioning of the European Union (TFUE) gives the Commission, acting as Guardian of the Treaties, the power to take legal action against a Member State that is not respecting its obligations under EU law. The Commission may decide to refer the Member State to the European Court of Justice. If the Court rules against a Member State, the Member State must then take the necessary measures to comply with the judgment.

An example of this is the infringement case against Germany regarding the Nitrates Directive (Council Directive 91/676/EEC of 12 December 1991). The Nitrates Directive aims to protect water quality across Europe by preventing nitrate pollution from agricultural sources from affecting ground and surface waters, and by promoting the use of good farming practices. It requires Member States to monitor their waters and identify those affected by pollution as well as set up appropriate action programs aimed at preventing and reducing such pollution. The Directive forms an integral part of the Water Framework Directive (Directive 2000/60/EC) and is one of the key instruments in the protection of waters from agricultural impacts. The European Commission referred Germany to the European Court of Justice for failing to take stronger measures to combat nitrate pollution. The figures submitted by Germany in 2012, as well as other recent reports from the German authorities, showed worsening nitrate pollution in groundwater and surface waters, including the Baltic Sea. According to the Commission, Germany did not take sufficient additional measures to address nitrate pollution and revise its relevant legislation to comply with the EU rules on nitrates. The Court (Case C-543/16) ruled in 2018 that by failing to adopt supplemental or enhanced measures when it became apparent that current measures were inadequate, and by failing to review that action program, Germany failed to fulfil its obligations under Article 5(5) and (7) of the Nitrates Directive. If Germany does not comply with this ruling the Commission may open another infringement case under Article 260 of the TFEU, with only one written warning before referring the Member State back to the Court.

If the Commission does refer a Member State back to the Court, it can propose that the Court impose financial penalties depending on the duration and severity of the infringement and the size of the Member State. There are two elements that can be considered: (1) A lump sum depending on the time elapsed since the original Court ruling; and (2) a daily penalty payment for each day after a second Court ruling until the infringement ends.

20.1 DEFINING THE WATER BODIES

All surface waters (including rivers, lakes, estuaries and stretches of coastal water) and groundwaters have been divided up into discrete units called water bodies, which are the basic unit used to assess the quality of the water environment and to set environmental targets.

The objectives in Article 4 apply to a "Body of surface water," which means a discrete and significant element of surface water such as a lake, a reservoir, a stream, river or canal, part of a stream, river or canal, a transitional water or a stretch of coastal water. The application of the definition requires the sub-division of surface water in a river basin (districts) into “discrete and significant elements”. According to Article 3.1 of the Water Framework Directive, the Member State shall identify the individual river basins lying within their national territory and assign them to individual river basin districts, which is the main unit for management. Small river basins may be combined with larger river basins or joined with neighbouring small basins to form individual river basin districts when appropriate. Coastal waters shall be identified and assigned to the nearest or most appropriate river basin district or districts.

The Water Framework Directive does not provide explicit guidance for identifying elements that should be regarded as “discrete and significant”, and hence “water bodies”. For example, it does not specify how to identify whether part of a river, stream or canal represents a “discrete and significant element”. However, “discrete and significant” in the definition of “surface water body” means that “water bodies” are not arbitrary sub-divisions of river basin districts. Each water body should be identified on the basis of its “discreteness and significance” in the context of the Directive’s purposes, objectives and provisions. (Working group on water bodies, 2003) The purpose of delineating separate water bodies is to enable the accurate description of the status of surface waters through a division into homogenous and manageable entities, and ultimately to achieve the objectives of the Water Framework Directive as outlined in Art 4 (good status of all waters within the Union). A water body is first identified by *category* as “a discrete and significant element of surface water such as a lake, a reservoir, a stream, river or canal, part of a stream, river or canal, a transitional water or a stretch of coastal water” (art 2.10). A surface water body can only include one category of water bodies such as river or a lake (WFD Annex II 1.1(i)). This means e.g., that there cannot be both a river and a lake within the same water body. If a stretch of a river includes a lake halfway down its course, the river upstream of the lake, the lake, and the river downstream of the lake makes up different water bodies.

Likewise, if a certain stretch of a river is categorized as an artificial or heavily modified water body, this stretch of the river is differentiated from the stretches of river upstream and downstream, constituting a separate water body (European Commission, 2003a). According to the Water Framework Directive (Annex II), Member States shall determine the location and boundaries of surface water bodies and carry out a characterization of all such bodies in accordance with the method set out in the Annex. As a result, waters in Sweden and other EU Member States have been divided into water bodies. In 2003, a guidance document was published on how these delimitations could take place (European Commission, 2003a). This guideline, which interprets WFD writings on surface water bodies, resembles the method used in Sweden for establishing water bodies. This guidance stresses that the Directive only requires sub-divisions of surface water and groundwater that are necessary for a clear, consistent and effective application of WFD objectives. Sub-divisions of surface water and groundwater into smaller and smaller water bodies that do not support this purpose should, according to the guidance, be avoided (European Commission, 2003a).

Geographical or hydro morphological features can significantly influence surface water ecosystems and their vulnerability to human activities. These features can also differentiate discrete elements of surface water. Why a lake, a river or a stream may need to be divided into smaller sections in order to meet the objectives in Article 4, shown in Figure 20.1. By dividing a river into smaller sections, it takes into account that the conditions and status differ along the river, which affects the need for follow-up and action. According to Annex V: 1.2 “Normative definitions of ecological status classifications" the following applies in order to achieve a "high status" classification: no, or only very minor, anthropogenic alterations to the values of the physico-chemical and hydro morphological quality elements for the surface water body type from those normally associated with that type under undisturbed conditions. The following applies for "good status" classification: the values of the biological quality elements for the surface water body type should show low levels of distortion resulting from human activity but deviate only slightly from those normally associated with the surface water body type under undisturbed conditions.

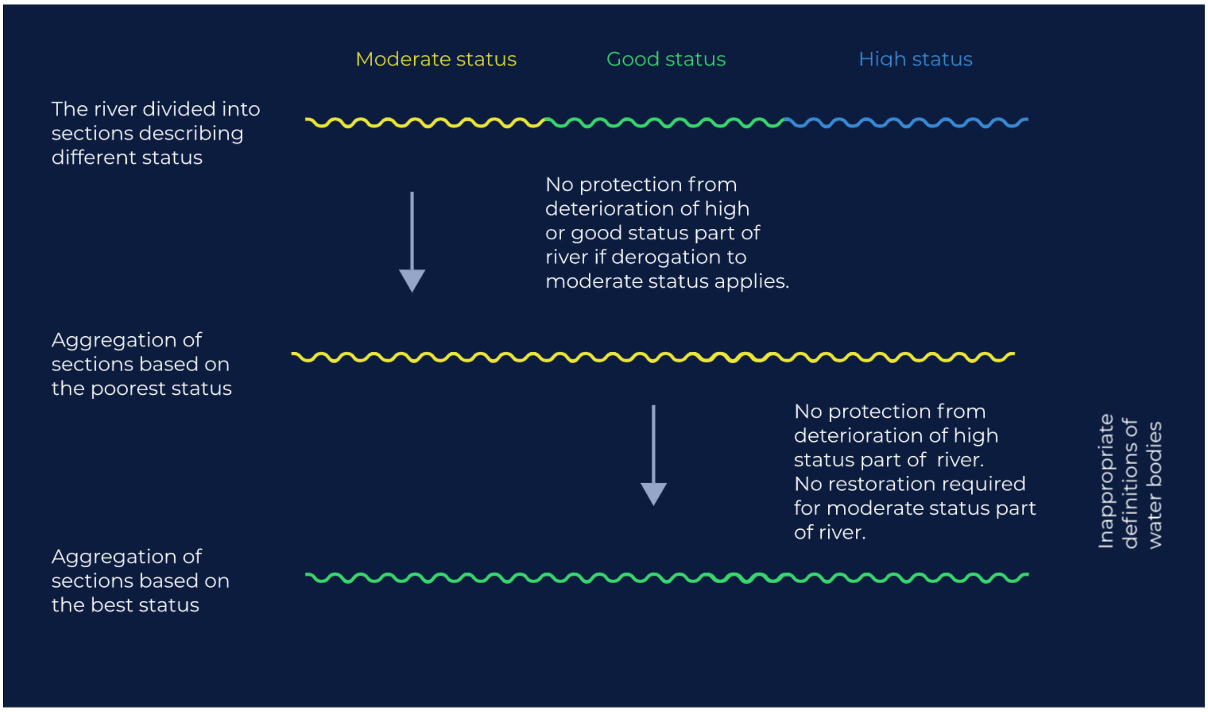


Figure 20.1 Illustration of the implications for the objectives of the directive if "water bodies" do not provide an accurate description of surface water status. Source: (Working group on water bodies, 2003)

20.2 DEFINING THE TYPE OF WATER BODY

To be able to group and compare water with similar natural conditions, a typing of the water body is performed. The division is made, for example, based on water depth, humus content and the ecological region in which the water bodies are located. Based on the characterisation criteria, lakes and watercourses are then given a type designation. Annex II of the Water Framework Directive sets out two alternative systems for type characterisation: system A and system B.

Excerpts from the Water Framework Directive pertaining to water body types:

- Annex II: 1.1 (ii) For each surface water category, the relevant surface water bodies within the river basin district shall be differentiated according to type. These types are those defined using either "system A" or "system B" identified in Section 1.2.
- Annex II: 1.1 (iii) If system A is used, the surface water bodies within the river basin district shall first be differentiated by the relevant ecoregions in accordance with the geographical areas identified in section 1.2 and shown on the relevant map in Annex XI.

The water bodies within each ecoregion shall then be differentiated by surface water body types according to the descriptors set out in the tables for system A.

- Annex II: 1.1 (iv) If System B is used, Member States must achieve at least the same degree of differentiation as would be achieved using System A. Accordingly, the surface water bodies within the river basin district shall be differentiated into types using the values for the obligatory descriptors and such optional descriptors, or combinations of descriptors, as are required to ensure that type specific biological reference conditions can be reliably derived.

The Directive requires that Member States establish reference conditions for these water types. The main purpose of typology is to enable type-specific reference conditions to be defined which in turn is used as the anchor of the characterisation system. Both systems use the same obligatory factors: geographic position, altitude, size, geology and, for lakes, depth. The difference is that System A prescribes how water bodies shall be characterized spatially (ecoregions) and with respect to specific altitude, size and depth intervals, while System B, besides lacking this prescription, permits the use of additional factors (Working Group 2.3 – REFCOND, 2003). It is up to Member States to decide on what system to use, and most Member States have used System B.

This additional differentiation of each surface water category is based on hydro morphological and physicochemical conditions (Annex II 1.1(ii)) and 1.3). The differentiation into water types is further based on the ecological region in which the water is situated, water depth and water size etc. In Sweden, 56 water types have been identified for watercourses and 112 for lakes (The Water Authorities, 2020c). A watercourse or lake can be further divided into separate surface water bodies depending on lake-internal variability such as depth, natural nutrient content and vulnerability (European Commission, 2003a). If part of a lake is of a different type to the rest of the lake, the lake must be sub-divided into more than one surface water body (European Commission, 2003b).

The purpose of identifying water bodies is to enable the status of surface waters and groundwater to be accurately described. A water body consequently should not contain significant elements of different status - waters with different status shall be differentiated into separate water bodies (European Commission, 2003a). Different uses of the waters (e.g. drinking waters) as well as existing or new protected areas (e.g. Natura 2000 sites) may be used in the refinement of the water body identification, as well as considerations regarding pressures and impacts vulnerability (European Commission, 2003a).

According to Annex II: 1.3 (i-vi) type-specific hydro morphological and physico-chemical conditions should be established for each surface water body type representing the values of the hydro-morphological and physicochemical quality elements specified for that surface water body type at high ecological status. Type-specific biological reference conditions shall be established, representing the values of the biological quality element for that surface water body type at high ecological status. Type-specific biological reference conditions may be either spatially based, based on modelling, or a combination of both. Where it is not possible to use these methods, Member States may use expert judgement to establish such conditions. Type-specific biological reference conditions based on modelling may be derived using either predictive models or hindcasting methods. The methods shall use historical, palaeological and other available data. The values of the biological quality elements for the surface water body shall reflect those normally associated with that type under undisturbed conditions and show no, or only very minor, evidence of distortion. Hence, the directive's requirement is that that reference condition should represent totally, or nearly totally, undisturbed condition (Working Group 2.2 - HMWB, 2003). The reason is that assessment of ecological status should be comparable within each water type. In Sweden, reference values for assessment of ecological status have not been stated at the water type level. Instead, assessments of status are based on developed assessment criteria (HVMFS 2013: 19) and are based on other geographical, hydro morphological and physico-chemical divisions (Vattenmyndigheten Södra Östersjön, 2016).

20.3 DEFINING THE STATUS OF A WATER BODY

Good surface water status is the default objective for all water bodies. The status is achieved by a surface water body when both its ecological status and its chemical status are at least good. The general objective of good status in Article 4 is specified in relation to individual water bodies in accordance with the status classification set out in Annex V of the Water Framework Directive.

The first step in achieving the objectives in Article 4 is defining the current status for each waterbody. For surface waters, this status is "the general expression of the status of a body of surface water, determined by the poorer of its ecological status and its chemical status" (Article 2.17). Ecological status is determined by biological quality elements, supported by hydro morphological and physico-chemical quality elements (Annex V).

Annex V, Table 1.1 explicitly defines the quality elements that must be used for the assessment of ecological status (e.g. composition and abundance of phytoplankton). Quality elements include biological elements and elements supporting the biological elements. These supporting elements are in two categories: "hydromorphological" and "chemical and physicochemical". When considering the physico-chemical quality elements for high status classification, nutrient concentrations shall remain within the range normally associated with undisturbed conditions.

Good surface water chemical status means the chemical status required to meet the environmental objectives for surface waters established in Article 4(1)(a), i.e., the chemical status achieved by a body of surface water in which concentrations of pollutants do not exceed the environmental quality standards established in Annex IX and under Article 16(7), and under other relevant Community legislation setting environmental quality standards at Community level. Since neither nitrogen nor phosphorus is regarded as a pollutant, they are not regulated under this part or by the Environmental Quality Standards Directive (2008/105/EC).

The ecological status is classified using a five-graded scale according to different quality factors set out in appendix II and V to the Water Framework Directive. The point of reference is given by "undisturbed" conditions showing no or only "very minor" human impacts (European Commission, 2003c). This is defined as "high status". The reference conditions are type-specific, so they differ between different types of rivers, lakes or coastal waters to take into account the broad diversity of ecological regions in Europe. Assessment of quality is based on the extent of deviation from these reference conditions, following the definitions in the Directive. Member States divide the ecological quality ratios for each surface water category into the five classes by means of a limit value for the biological quality elements, which shows the boundary between those different classes: high, good, moderate, poor and bad (Weser Case, 2015).

The limit values are to be established following an intercalibration exercise, which involves comparing the classification results of the national monitoring systems for each biological element and for each common surface water body type among Member States in the same geographical intercalibration group and assessing the consistency of the results with the normative definitions set out in Section 1.2 of Annex V (Weser Case, 2015).

However, the intercalibration exercise serves only to define the limits of the classes for high, good and moderate status. The Member States' limit values are set out in Commission Decision 2013/480/EU of 20 September 2013 establishing, pursuant to Directive 2000/60/EC of the European Parliament and of the Council, the values of the Member State monitoring system classifications as a result of the intercalibration exercise and repealing Decision 2008/915/EC (OJ 2013 L 266, p. 1).

Furthermore, according to point 1.4.2(i) of Annex V, for surface water categories, a body of water is to be classified in the class immediately below as soon as the ratio of one of the quality elements falls below the level for the current class. This "one out - all out" rule is linked to the definition of "surface water status" in Article 2(17) of the Directive, which must be determined by the poorer of the ecological status and the chemical status of the body of surface water (Weser Case, 2015).

According to the general definition of ecological quality in annex V, good status is when the values of the biological quality elements for the surface water body type show low levels of distortion resulting from human activity, but deviate only slightly from those normally associated with the surface water body type under undisturbed conditions. There is a confusing terminology situation. The term environmental objectives mentioned in Article 4 is formulated in Sweden as "environmental quality standards". Environmental quality standards according to Water Framework Directive and Environmental Quality Standards Directive (Directive 2008/105/EC) are foremost used to determine good surface water chemical status. Annex VIII of the Water Framework Directive covers the determination of the ecological status for pollutants. However, neither nitrogen nor phosphorus are regarded as pollutants and therefore are not included in the Environmental Quality Standards Directive. Hence, "environmental quality standards" are not synonymous with the environmental objectives in art. 4 of the Water Framework Directive. In Sweden, environmental quality standards for water are established on the basis of Chapter 5 in the Swedish Environmental Code, in accordance with the Water Management Ordinance and the Swedish Marine and Water Authority's regulation HVMFS 2013: 19 and HVMFS 2015: 4. These standards are a legal tool and set requirements for the quality of the water at a certain time, for example "good status in 2027". The water authorities' status classification describes the existing water quality, the environmental quality standard for the desired water quality and the latest time at which it must be achieved – in other words, the environmental objective of art. 4 in the Water Framework Directive.

Some water bodies may not achieve this objective for different reasons. Under certain conditions the Water Framework Directive permits Member States to identify and designate artificial water bodies (AWB) and heavily modified water bodies (HMWB) according to art. 4(3). The assignment of less stringent objectives to water bodies, and an extension of the timing for achieving the objectives, is possible under other circumstances. These derogations are laid out in art. 4(4) and 4(5). HMWB are bodies of water which, as a result of physical alterations by human activity, are substantially changed in character and cannot, therefore, meet good ecological status. AWB are water bodies created by human activity. Instead of good ecological status, the environmental objective for HMWB and for AWB is good ecological potential, which has to be achieved by 2027. The possibility for derogation was established to allow for the continuation of specified uses that provide social and economic benefits but at the same time allow mitigation measures to improve water quality. Art. 4(3)(a) in the Water Framework Directive lists the types of activities that likely would result in the HMWB or AWB designation. Example of types listed in Article 4(3) are: activities for the purposes of which water is stored, such as drinking-water supply, power generation or irrigation; water regulation, flood protection and land drainage. Water bodies impacted by soil drainage from agriculture can be declared HMWB and be relevant for other requirements designed to reach good ecological potential. If this is not done, then action is required for that water body to achieve good status. The designation of HMWB and AWB is optional for Member States (Working Group 2.2 - HMWB, 2003). If this alternative is not chosen, the authorities must establish the reference conditions for the water bodies.

The environmental objectives for natural, artificial and heavily modified water bodies are set in relation to reference conditions. For HMWB and AWB the reference is the maximum ecological potential, which is the state where the biological status reflects, as far as possible, the closest comparable surface water body, taking into account the modified characteristics of the water body. With regards to its biological status the good ecological potential designation accommodates “slight changes” from the maximum ecological potential. (Working Group 2.2 - HMWB, 2003).

20.4 THE EXAMPLE OF THE SOUTHERN BALTIC WATER DISTRICT

20.4.1 Delimitation of surface water bodies

This section illustrates through example the implementation of the legal requirements for classifying and designating water bodies. Using the Southern Baltic Water District as an example, we show the large number of water bodies, different types and the limited number of surface water bodies designated as a result of physical alterations by human activity.

Almost all water bodies in the Southern Baltic Water District should have an assessment of the reference conditions and an action plan to achieve good status (the level below undisturbed condition of the surface water body). Since no soil drainage for agriculture is declared as heavily modified (HMWB), then the existing constructions in the district should be remedied, for example by removing the soil drainage. Although this could have a positive impact on nutrient leakage, it would be costly and negatively impact the amount of productive agricultural land. Even if waterbodies were designated HMWB, it does not mean avoiding ecological and chemical objectives, since good ecological potential is an ecological objective that may, in itself, be challenging to achieve (Working Group 2.2 - HMWB, 2003).

The Swedish Water Authorities are responsible for ensuring that the Water Districts' lakes, watercourses, coastal waters and groundwater are sustainably managed. In the proposed action plan, the Water Authority describes how the District's water needs should be managed to achieve this during the forthcoming six-year period (2021-2027). The action program is legally binding according to Environmental Code (1998:808). For each action the dedicated authority and municipality is responsible for implementing its measures. This may involve developing guidance, prioritizing resources such that water measures are implemented where they will achieve the greatest effect or, through supervision, setting requirements for an activity that discharges environmentally hazardous substances into water.

The Water Authority can only prescribe measures to other authorities and municipalities in their capacity as authorities, not as operators. This applies according to Chapter 5 in the Environmental Code (1998:808) and was clarified in the Government's decision during review of the action programs in 2016. An operator in this context is defined according to the Environmental Code and includes anyone who conducts, or has conducted, an activity or taken a measure that has contributed to pollution or serious environmental damage, and therefore is responsible for the remediation in accordance with the Environmental Code. This means that any authorities that receive these decisions from the Water Authority have to impose action on the operators and citizens to accomplish the goals of the water management plans. All proposed actions should aim to reach good water quality according to the Water Framework Directive by 2027, including good status regarding eutrophication.

The Southern Baltic Water District consists of 10 counties, 91 municipalities and 2.9 million inhabitants, and is located in the southeast corner of Sweden. It stretches along the Baltic coast from Bråviken in the north to the tip of Kullen in the west. Gotland is the eastern border and Smygehuk is the southernmost point. The district includes Sweden's second largest lake, Lake Vättern, as well as the following designated water bodies: 478 lakes, 968 watercourses, 177 coastal waters and 580 groundwater. It includes 30 main catchment areas, including Motala ström, Emån and Helge å, which stand out as large for this part of Sweden (The Water Authorities, 2021).

Figure 20.2 Southern Baltic water district, Source: Map produced by Lantmäteriet, SMHI, NVDB, ESRI Inc published in (VISS, 2021a)

For lakes and watercourses, the division of surface water bodies in the Southern Baltic Water District has followed the criteria in the Swedish Agency for Marine and Water Management's regulations (HVMFS 2017: 20; HVMFS 2019: 24). The Water District has delimited 1,873 surface water bodies, of which 506 are lakes, 1,189 are watercourses and 178 are coastal water bodies (Table 20.1). The district includes six offshore areas. The Southern Baltic Sea District appears to have very few designated Heavy Modified Water Bodies (4 HMWBs) and Artificial Water Bodies (7 AWBs) compared to Sjælland, Denmark, which in 2016 had designated 11 percent of the water length of all watercourses as HMWB and AWB and 1,5 percent of all surface water bodies of lakes (Styrelsen for Vand-og Naturforvaltning, 2016). Although the Swedish figures may not be directly comparable to Denmark, they indicate that the length of the HMWB and AWB watercourses in the Southern Baltic Sea is limited.

Table 20.1 Number of surface water bodies in the Southern Baltic Water District, divided into different water categories. Source: (VISS, 2021a)

Type of water body	Number	Area
Lakes	506	4 089,88 km^2
Watercourses	1189	10 169,98 km^2
Coastal water bodies	178	10 067,65 km^2
Total surface water bodies	1873	24327,51 km^2

In the most recent assessment of the environmental impact type "Eutrophication due to load of nutrients" showed following classification of 1873 surface water bodies in the Southern Baltic Sea. 26 percent of surface water is considered eutrophicated.

Table 20.2 Number of surface water bodies in the Southern Baltic Water District, Source: (VISS, 2021a).

Classification	Number of surface water bodies
No classification	375
Eutrophication	486
No eutrophication	677
Data missing	335
Total	1873

However, in the proposal for a management plan 2021-2027 the information stated that the Water District has 717 surface water bodies effected by eutrophication, which corresponds to 38 percent of the district's surface water bodies (Vattenmyndigheten Södra Östersjön, 2020).

20.4.2 Type characterisation of surface water bodies in the Southern Baltic water district

In the Southern Baltic water district, 12 types of lakes and 8 types of watercourses are represented, and some water bodies have not yet been completely "type characterised." In the District, the coastal water has 178 water bodies and among these there are 11 coastal water types represented (Swedish Agency for Marine and Water Management, 2020a).

20.5 THE APPLICATION OF ARTICLE 4 IN INDIVIDUAL CASES – SWEDEN AND THE *WESER CASE*

The Water Framework Directive sets out the framework, the objectives and the time limit for achieving the objectives, but it is left to the discretion of each Member State to implement the national laws and regulations needed to comply with the Directive. Sweden has essentially implemented the Directive in national legislation through the following three statutes: Chapter 5 of the Environmental Code (1998.808); Ordinance (2004: 660) on the management of the quality of the aquatic environment and; Ordinance (2002: 864) with instructions to county administrative boards.

The environmental objectives for water in Sweden are guided by the biological quality elements, hydro morphological and physico-chemical quality elements, and they derive their normative content from Annex V of the Water Framework Directive. They apply to each water body while the descriptors of the Marine Strategy Framework Directive apply to marine waters. Previously, the environmental objectives for water were not considered legally binding in permitting. Instead, obligations on operators that impact waters were subject to a cost-benefit analysis under the Environmental Code. Following an amendment of the Code as of 1 January 2019, the environmental objectives are legally binding insofar as the Code exempts the requirement of reasonable permit conditions (Kostamo, et al., 2020).

The objectives in Article 4 of the Water Framework Directive are not legally binding for individuals in Sweden. Instead the competent authorities[14] have an obligation not to permit projects that lead to deterioration or jeopardise the achievement of the environmental objectives.[15] This obligation was clarified in Swedish law following a case decided in the Court of Justice of the European Union (CJEU) in 2015, the *Weser Case* (2015). In that case, the Court explained how the environmental objectives in Article 4 of the Water Framework Directive shall be interpreted and applied in individual authorisation processes.

The Court first established that all environmental objectives of the Water Framework Directive are legally binding and equally important to follow in individual processes.[16] The Court thereafter held that the Water Framework Directive "entails obligations which must be complied with by the competent authorities when approving individual projects in the context of the legal regime governing the protection of waters".[17]

Member States are thus required to refuse authorisation for individual projects that might result in deterioration or might jeopardise the accomplishment of the environmental objectives. Deviating from this will be considered an infringement of the Water Framework Directive. The only exception is if the particular project can be granted under the derogation regime of Article 4(7) of the Water Framework Directive,[18] which provides EU Member States with flexibility regarding new modifications to the physical characteristics of a surface water body, or new sustainable human development activities (Söderasp & Pettersson, 2019).[19] However, it is questionable if this derogation regime can be useful for a cap-and-trade system, as projects under such a system are unlikely to meet the required standard of "overriding public interest" set out in Article 4.7(c).

The Directive does not define the concept of deterioration. The Court has, however, made a clarification in the *Weser Case*, stating that "there is 'deterioration of the status' of a body of surface water, within the meaning of Article 4(1)(a) … as soon as the status of at least one of the quality elements … falls by one class, even if that fall does not result in a fall in classification of the body of surface water as a whole."[20] Further, the Court states that, if the quality element concerned is already in the lowest class, any deterioration of that element constitutes a "deterioration of the status" of a body of surface water.

By doing this the Court linked deterioration to individual quality elements, instead of the overall water quality status. The Court clarified that the environmental objectives of the Water Framework Directive are legally binding on EU Member States when permitting new developments and that a drop in any biological quality element is considered an infringement of the Directive.

14 The Swedish Environmental Code ch 5 sec 3.
15 The Swedish Environmental Code ch 5 sec 4.
16 Ibid para 31-32.
17 Ibid para 33.
18 Ibid para 51.
19 See also Case C-346/14 Commission v Republic of Austria [2016] ECR I-322 ('Schwarze Sulm').
20 Weser case para 69.

The *Weser Case* has implications for a future nutrient trading system since the Court clarified that deterioration is not allowed at any time, even if a short-term deterioration may lead to long term improvements in status. These types of short-term deteriorations in status, followed by long-term improvements, are likely under a trading system. The Court states that “unless a derogation is granted, any deterioration of the status of a body of water must be prevented, irrespective of the longer term planning provided for by management plans and program of measures”, and that the “obligation to prevent deterioration of the status of bodies of surface water remains binding at each stage of implementation of Directive 2000/60 and is applicable to every surface water body type and status for which a management plan has or should have been adopted”.[21]

The Swedish Environmental Code clarifies that the obligation not to authorize individual projects that may result in deterioration, or jeopardise the accomplishment of the environmental objectives, applies to both new projects and changes to existing ones.[22] Furthermore, this applies regardless of whether the new activity, measure or change is examined after an application for a permit, after a notification, or if it is discovered within the framework of supervision. The responsible authority is required to take the necessary measures to ensure that the activity or project is not permitted in violation of the provision.[23]

The implication is that the Swedish competent authorities have a far-reaching obligation under many circumstances to ensure that projects and activities do not lead to deterioration or jeopardise the accomplishment of the environmental objectives.

20.6 WATER FRAMEWORK DIRECTIVE AND ADDITIONALITY

The Water Framework Directive allows for compensation measures to help achieve environmental goals, but the requirements are complicated. One of the main principles in biodiversity offsetting / environmental compensation is that the measures themselves need to be additional, which means any improvements should be “over and above” the baseline, i.e., what would have happened in the absence of such measures. In practice, additionality may be difficult to demonstrate. For example, if a best available technique is already required in the baseline scenario, then offsetting/compensation is not additional. Further, the mitigation hierarchy already requires best available techniques for mitigation (Kostamo, et al., 2020).

According to the mitigation hierarchy environmental compensation needs can be reduced by avoiding and minimizing the environmental impact. The mitigation hierarchy is well-established in legal literature and, in some cases, also enshrined by EU environmental law such as Article 6 of the Habitats Directive (Soininen, et al., 2019). In the so-called *Briels Case* (C-521/12), the European Court of Justice highlighted the importance of the precautionary principle when applying derogations under the Habitats Directive and that only measures contributing to additionality may be approved as compensation. These conclusions have been re-endorsed by later case law (C- 387/15 and C-388/15) (Kostamo, et al., 2020) involving the application of the so-called two-step assessment of the mitigation hierarchy, when compensating the loss of natural values. The two-step assessment means that compensation can only be considered in the second step, after the project is deemed permissible through

21 Weser Case para 50.
22 The Swedish Environmental Code ch. 5 sec 4.
23 Prop. 2017/18:191.

an exemption in the first step (Kostamo, et al., 2020). The possibility to achieve an exemption in the case of a trading system involving nutrients is limited due to Article 4(7) of the Water Framework Directive, which means it is doubtful that the two-step assessment will be applicable. A nutrient offset aims to increase the status of a receiving water body and can be thus permitted without an exemption. However, the compensatory action must be done in the same water body as where the source is situated. It is important to keep in mind that there can be other consequences that can affect the authorization of a project.

One model to incorporate "additionality" in a future trading system is to adhere to the Water Framework Directive and implement actions in order to reach the type-specific biological reference conditions established for the water bodies in order to achieve good status. The trading system would be additive, meaning that a trading system would add another level to accelerate development and raise the level to a higher status or the reference level. In other words, one objective for a trading system could be to exceed the objective in Article 4 in the Water Framework Directive.

20.7 THE SCOPE FOR A TRADING SYSTEM WITHIN THE BOUNDARIES OF THE WATER FRAMEWORK DIRECTIVE

The legally binding character of Article 4 of the Water Framework Directive – together with the Swedish legislation – restrains the available leeway for a future trading system. Furthermore, since the objectives of good status and non-deterioration are set in relation to specific water bodies, the interpretation is that individual projects that might result in deterioration, or jeopardize the accomplishment of the environmental objectives of a water body, cannot be authorized, even if they improve the environment in other water bodies through compensation. Therefore, the implementation of any compensatory measure would have to be limited to the actual water body. In short, if the aim of the trading system is to reach good ecological status in areas covered by the Water Framework Directive, then the measure can only be implemented in individual water bodies. However, this restriction could be lifted if the trading system is decoupled from direct physical actions required to fulfil the Water Framework Directive. In other words, if the trading system is instead based on a system that allocates emissions/loads and requires operators to reduce emissions/loads in the specific water bodies, it should be regarded as aligned with the Water Framework Directive. In this system, operators would not be required to reduce their emissions per se, but rather required to ensure an equivalent reduction in each water body via the trading system. This system, referred to as an ambient trading system, is described briefly below (see the details of such a system in Part A).

One question that arises is whether water bodies can be redefined into larger units in order to better accommodate a trading system, where actions to reduce emission of nutrients are allocated between operators under a cap. There is, in fact, some possibility for adjusting the definition of water bodies since each new management cycle allows for the review of the division of the water bodies and possible changes. However, adjustments to the divisions must still follow the categorization described in the Water Framework Directive and its annexes, meaning the scope for adjusting existing water bodies into significantly larger entities is considered very limited.

However, national legal solutions should be possible – including the use of compensation measures – as long as the status of a water body does not deteriorate and good status can be achieved. The most likely solutions would be either: (1) additive as described in the previous section, where the objective in Article 4 is regarded as a baseline that cannot be undercut or (2) to develop a system (ambient trading system) with economic incentives to comply with the objectives in Article 4, with a clear reduction path for each waterbody.

The ambient trading system (described in Part A) is based on the principle that each operator/actor is given a certain amount of "rights" and that these are reduced until the environmental objective and good status are achieved. The meaning of the word "rights" should be understood as a right to release nutrients up to a certain level. This "right" can be issued in the form of a permit or an obligation to create a credit showing a decrease in emissions.

Under the ambient trading system all data are collected to ensure compliance with the Water Framework Directive and the objectives in Article 4, which then become the target to achieve. It will be compulsory to have the correct amount of rights every year, according to the reduction path allocated to the operators in the waterbody. This can be achieved by requiring the operators to present reduction credits/units every year. The credits can be issued when the action is accomplished and handed back to the authorities in the same year – i.e., a token of the operator's compliance toward the reduction path. The trading system would induce emissions/loads reductions since the alternative for the operator will be sanctions if they fail to hold the correct amount of rights. Operators can trade these rights with others in the system, but it only "helps" them in the short term. Note that, if an actor (including an operator) within the water body achieves their reductions, including the reduction of other actors in the water body, it would be possible for some individual operators to have higher nutrient loads. This is aligned with the concept of compensatory actions. With the trading system, there will be no deterioration in any water body when the "rights" are traded. The initial need to adhere to the regulations are intact and represent a prerequisite in the allocation of rights. It will be necessary for the operators at some point to reduce their emissions/loads, i.e. the development will not be driven by the authorities but by the operators and their desire to reduce their costs. The trading system will, in the end, lead to compliance of the Water Framework Directive.

21 MARINE STRATEGY FRAMEWORK DIRECTIVE

The purpose of the EU's Marine Strategy Framework Directive (MSFD, 2008/56/EC) is to achieve or maintain good environmental status in the seas of Europe. For HELCOM Contracting Parties that are also EU Member States, this Directive establishes a framework for taking the necessary measures to achieve or maintain good environmental status of the marine environment by the year 2020 at the latest (Article 1). Member States are required to follow a common approach in reiterative six-year cycles.

HELCOM is the coordinating platform for the regional implementation of the Marine Strategy Framework Directive in the Baltic Sea for EU Member States. This should lead to harmonized national marine strategies for achieving good environmental status according to the HELCOM Baltic Sea Action Plan and the Marine Strategy Framework Directive with the full cooperation of the HELCOM Contracting Parties.

In comparison with the Water Framework Directive's good ecological status, the Marine Strategy Framework Directive's objective of good environmental status is more vaguely framed. Unlike the Water Framework Directive's goal of good ecological status, good environmental status has not been interpreted by the *Weser Case* judgment, which makes it somewhat unclear the precis legal character of this objective (Kymenvaara & Eklund, 2019)

(Soininen, et al., 2019). In other words, “taking the necessary measures” as per Article 1 to achieve or maintain good environmental status in the marine environment by the year 2020 appears to be a similar obligation on Member States as “implementing the necessary measures” under Article 4 of the Water Framework Directive. It appears to include all the steps of the mitigation hierarchy, including compensation measures, in connection with environmental permitting of activities with impacts on marine waters (Kostamo, et al., 2020).

Marine Strategy Framework Directive uses nutrient levels, chlorophyll a and dissolved oxygen, as indicators of eutrophication, using the ecosystem as the reference. The new BSAP, will change from country-allocated reduction targets to nutrient input ceilings (NICs) for all countries. This should be a valuable contribution to achieve the objective of the Marine Strategy Framework Directive. The directive defines environmental targets, monitoring programmes and programmes of measures, which means it could be used as a base for a future trading system, whereby legal cause is provided for the open sea beyond the 1 nautical mile coastal limit that is covered by the Water Framework Directive.

For Russia, the delivery of good environmental status is met by the Maritime Doctrine of the Russian Federation. The principles of the national maritime policy include integrated marine scientific research, the development of systems for monitoring the marine environment and coastal areas, and the protection and conservation of the marine environment in the interests of the Russian Federation. Compliance with international obligations and possibilities for international cooperation are important elements for achieving the goals of the Doctrine.

The proposed trading system described above for the Water Framework Directive, which includes a system that is decoupled from regulatory actions and instead focuses on incentives for achieving environmental goals, should also be in compliance with Marine Strategy Framework Directive. In short, that system could be used to achieve both the Water Framework Directive and Marine Strategy Framework Directive objectives.

22 CONCLUSIONS REGARDING THE LEGAL CONTEXT

The Water Framework Directive (Directive 2000/60/EC) establishes a framework for the protection of all waters including rivers, lakes, estuaries, coastal waters and groundwater. The main purpose of the Directive is to achieve good status or potential of all waters concerned, to protect human health, water supply, natural ecosystems and biodiversity. The environmental objectives in Article 4 enact two main obligations on the EU Member States: (1) to prevent deterioration of the status of all surface and groundwater bodies within the Union and (2) to protect, enhance and restore all water bodies, to achieve “good water status” (for surface waters, “good status” is determined by a “good ecological status” and a “good chemical status”).

Article 4 from the Treaty on the Functioning of the European Union (TFEU) introduces legal constraints on the Member States, depending on the maturity of the EU interest expressed by them. For example, the Article regulates a “shared competence” – those in which the EU and EU countries are able to legislate and adopt legally binding acts. This means that EU countries exercise their own competence where the EU does not exercise, or has decided not to exercise, its own competence. A national legislative act cannot go against an EU legislative act, meaning a proposed trading system must be in line with the EU *acquis* -- in this case, the Water Framework Directive and other relevant legislative acts.

The aim of the Water Framework Directive is to achieve good surface water status 15 years after the Directive entered into force (Article 4 (1) (a) (ii)), which suggests that this objective should have been reached by 2015. However, there are possibilities to extend this up to a maximum of two additional periods. The management plans have a duration of 6 years, meaning the objectives must be fulfilled by 2027 at the latest. There are no more possibilities for extensions according to the Directive other than when natural conditions do not allow timely improvement in the status of the body of water.

The objectives in Article 4 are not legally binding for individuals in Sweden. The obligation to follow the objectives under the Water Framework Directive is instead placed on the member states and competent authorities. They have an obligation not to permit projects that lead to deterioration or jeopardise the accomplishment of the environmental objectives. This obligation was clarified following a case decided in the Court of Justice of the European Union in 2015, the *Weser Case* (2015).

In the *Weser case*, the Court explained how the environmental objectives in Article 4 shall be interpreted and applied in individual authorisation processes. The Court stated that "there is 'deterioration of the status' of a body of surface water, within the meaning of Article 4(1)(a)..., as soon as the status of at least one of the quality elements, ..., falls by one class, even if that fall does not result in a fall in classification of the body of surface water as a whole." The court CJEU continued by stating that, if the quality element concerned is already in the lowest class, any deterioration of that element constitutes a "deterioration of the status" of a body of surface water. By doing this the Court linked deterioration to individual quality elements, instead of the overall water quality status. The Court clarified that the environmental objectives are legally binding on the Member States when permitting new developments and that a drop in any biological quality element is considered an infringement of the Directive.

If a Member State fails to ensure compliance with EU law, the Commission may then decide to refer the Member State to the Court of Justice of the European Union. If the Court rules against a Member State, it must then take the necessary measures to comply with the judgment.

The interpretation of Article 4 of the Water Framework Directive in the Weser Case constitutes a restriction on the design of a trading system. If the trading system is decoupled from the permit system and instead constitutes a system for allocating discharges / loads and with a condition that the operators in the water bodies must reduce their discharges / loads (or permits), it should be considered in line with the Water Framework Directive. A trading system would benefit from redefining water bodies in larger units. However, adjustments must comply with the Water Framework Directive and the possibilities of adapting water bodies to larger units are considered very limited.

PART D: A PROPOSED STRATEGY FOR IMPLEMENTING A NUTRIENT TRADING SYSTEM IN THE BALTIC SEA REGION

In this part we present a concrete suggestion for an ambient trading system and a strategy for how to implement it.

- Chapter 23 presents more concrete details, including a plan and strategy, for introducing the ambient trading system presented in Part A.
- Chapter 24 describes a plan and strategy for anchoring and commissioning the trading system, with a focus on structuring a future governmental investigation.
- Chapter 25 provides concluding remarks for Part D.

23 STRATEGY FOR IMPLEMENTING AN AMBIENT TRADING SYSTEM

Regardless of whether Sweden develops a national trading system or seeks support for an international trading system for the Baltic Sea region, an ambient trading system presents environmental, economic and political advantages relative to other policy instruments. Nonetheless, it also presents challenges. The benefits and challenges on a general level are discussed in more detail in Chapter 4, while specific challenges with an ambient trading system are discussed in more detail below (Section 23.1).

A significant challenge is political acceptability. Acceptance of a nutrient trading system requires that it can achieve the intended targets of the Water Framework Directive and achieve a cost-efficient allocation of measures at the lowest possible transactions costs for regulated entities (sources) and regulatory authorities. Our comparison of different types of trading systems (in Section 7.8), together with the experiences from the international overview (in Section 0), conclude that an ambient trading system offers the stronger opportunity to achieve this (see Section 7.5.1 for description). In the ambient trading system, no computer simulations are needed before each transaction takes place, and each source faces a single price.

In order to successfully overcome challenges associated with launching an ambient trading system, the government should proceed strategically and organise its internal process for communicating and guiding the ambient trading system through design, legislation and implementation. This involves coordinating decision-making across multiple central and regional agencies that will participate in the operation of the system, engaging stakeholders, and preparing for the political legislative process.

In the following sections we describe a strategy for implementing and designing an ambient trading system for the Baltic Sea region. The 10-step process covers how to build political support as well as technical decisions regarding design and data. The steps are summarized below, with details provided in the following chapters. Figure 23.1 provides a set of recommended actions based on our analysis.

1. **Build political support.** Develop support for the ambient trading system by educating and building capacity among actors that will operate within the system.
2. **Decide the scope.** Decide the extent of the ambient trading system, including nutrients/sectors to include, which legal entity provides reporting requirements, etc.
3. **Decide ambient trading unit.** Select the most effective unit of measurement for ambient trading.
4. **Decide on ambient offsets.** Determine whether or not to allow ambient offsets for compensatory measures that go beyond what is mandatory in the system.
5. **Set the ambient caps.** Determine total allowable loads of nitrogen and phosphorus to receiving waters.
6. **Define the size of ambient markets.** Decide on the optimal market size, which varies with the number of sources in a given area/watershed.
7. **Define an efficient geographical area.** Decide the extent of the geographical area for an ambient trading system, which depends on the number of sources and the magnitude of the reduction required.
8. **Set up institutional arrangements.** Establish the regulatory framework (rules) under which buyers and sellers operate, including who does what and when.

9. **Generate verified data for operating the system.** Verify measurements of emissions or load reductions per year, together with parameters from hydrological modelling and maximum allowable loads from the water and the marine management units.
10. **Expand internationally.** Expand the ambient trading system to an international system, making possible additional benefits.

The full legislative process for introducing a trading system in Sweden may take 6-7 years and is further described in Chapter 24.

23.1 BUILD POLITICAL SUPPORT

A strategy for implementing an ambient trading system in Sweden needs to thoroughly consider the process of educating policymakers, lawmakers, regulated entities, the public and media about the pros and cons of an ambient trading system. To provide advice to the government, a broad multi-stakeholder group should be consulted consisting of governmental leaders, industry leaders, representatives from environmental non-governmental organizations and academia.

Sweden has a limited, but rich, domestic experience in producing legislation for trading systems in the Swedish Act (2020:1173) on greenhouse gas emissions and the Swedish Act (2011:1200) on electricity certificates. Relevant law-making lessons should be derived from these schemes and brought into the legislation work of a future ambient trading system.

Before and during implementation it is essential that the government and the research sector facilitate the capacity and knowledge needed in the public bodies that will be involved in operating the ambient trading system; similarly, outreach should ensure that regulated entities and other market participants understand the principles behind ambient nutrient trading.

Enabling an informed national and international debate and developing broad political, industrial, and public support for an ambient trading system will be a critical first step in a strategy for Sweden, as well as for potential member countries around the Baltic Sea region. While Chapter 4 considers general benefits and challenges with a nutrient trading system, the following sections present five specific features of an ambient trading system that serve as supporting arguments for implementing such a system in the Baltic Sea region.

23.1.1 Increased precision in fulfilment of environmental objective

An ambient trading system takes a predictable approach by regulating the total inflow of load to each water body from the group of sources that emit pollutants. The regulated reductions of inflow load to each water body until the target year gives a clear signal to sources about necessary reductions required until the target year. This predictable path will also be a crucial guide in sources' long-term planning of investments in measures.

Regulating the sum of loads to each water body while allowing for trade among the sources in the area entails more flexibility and opportunities for the sources to reduce their emissions. Since the group of sources in the water body shares the burden under the flexibility from trade, a relatively larger reduction per year could be justified compared to a scenario where each source is regulated individually with equal stringency in permit licences. Overall, the target year of the trading system can be established earlier compared to a scenario with manual administration and individual permit licenses.

23.1.2 Faster implementation by shifting incentives to sources

Under the current system (according to the Swedish Environmental Code), the source is responsibility for ensuring that its activities fulfil the requirements. However, sources have no financial incentives to initiate new measures fulfilling stricter requirements, rather, the cost of taking measures makes it rational for sources with licenses issued a long time ago (e.g., requiring old technology or lax performance standards) to wait out the authority until it initiates enforcement actions.

Thus, authorities must initiate the permit processes to enforce implementation of measures. This binds administrative resources for enforcement, resulting in slower implementation rates for a given administrative effort than if the incentives to initiate had been borne by the sources themselves. In sectors with many sources, this can become significantly time consuming during transformative changes. For instance, with the current implementation rate, it will take municipalities almost 50 years to initiate enforcement actions for implementations on all individual wastewater disposal systems (IWDS) (VVS-fabrikanternas råd, 2020).

A trading system creates incentives for sources themselves to act, rather than wait on public authorities designated in the action programs of Water Framework Directive. Under a trading system, it will be costly for sources to wait out enforcement by authorities, as this will require that they buy more permits or credits every year. This cost increase is two-fold; first, since the number of permits or credits that must be purchased increases every year, the stringency of the system increases over time; and secondly, as the prices increase as a result of increasing demand for permits or credits. The increasing costs eventually shifts the incentive to initiate the process for environmental licenses for new measures from authorities to sources. The authorities' administrative resources can instead be used for administrating the increased number of new licenses initiated by sources and increasing enforcement actions in areas where the trading system is not introduced.

23.1.3 Opportunity to attract external actors and external capital inflows

There are two ways that external actors can be involved (external actors are actors that do not generate emissions themselves). First, they may want to voluntary generate external capital inflows by buying permits or credits. The sources that have fulfilled common obligations through their own measures will then receive external financing for these. In the Baltic Sea region, there are already actors with such types of incentives that are active in combating eutrophication. One group is philanthropic individuals who choose to spend their money on environmental protection, such as participants in Baltic 2020 - a foundation that aims to fund measures and research projects that contribute to a healthier Baltic Sea.

Second, and perhaps more importantly in an ambient credit system, external actors can voluntarily implement verified measures to reduce the nutrient emissions and get paid for this by selling their generated credits on the market. This will be a new way of attracting external actors voluntarily implementing measures for reductions in e.g. agriculture and the forest sectors.

23.1.4 Flexibility in handling distributional effects

An ambient trading system will end up in the same cost-efficient allocation of emissions reductions across sources, regardless of the initial allocation of permits or credits. This property makes it possible to choose an initial allocation that generates distributional outcomes that are more likely to lead to acceptance among other countries, thus increasing potential participation over time. For instance, when potential sectors or countries have the power to block implementation, they can be offered free allocations of permits or credits, to entice participation. In the case of countries, this can help them build the necessary political support for joining the trading system.

23.1.5 Improved cost-effectiveness within the Water Framework Directive

According to the Water Framework Directive (Annex III, b), members states shall make judgements about the most cost-effective combination of measures to address water uses in the programme of measures (Article 11). Under the current system, regional authorities identify cost-effective measures in the action programs. With a trading system, however, cost-effective local measures are automatically identified as a result of the trading system that covers mandatory regulation of restrictions on input loads to water bodies. This will automatically lead to cost-effective allocations within each water body.

23.2 DECIDE THE SCOPE

A key step is deciding the overall scope of the trading system, which is the result of choices about the following issues: the sectors and nutrients to be covered, the legal entity that will be subject to reporting requirements, the criteria for excluding any sources (e.g. small sources, the most upstream sources in river basins, sources in areas where environmental status is already good or close to good, etc). Other criteria to consider include comprehensive coverage, the ability to monitor emissions or load reductions, administrative feasibility, transaction costs and interaction with existing policies.

The largest sources of nutrient emissions to water in the Baltic Sea – and thus the relevant sources to consider including in a future trading system – are agriculture, public sewage treatment plants, forestry, fishery and certain industries. Agriculture is the largest sector when it comes to total load and thus one of the most important to include. The ability to include external actors (including their capital inflows), together with the ability to incentivize them to implement compensatory measures, improves political acceptability of including agriculture in a trading system. Future investigations could consider the risks and possibilities of including other actors – e.g., aquaculture, on-site sewage systems, stormwater, etc – which would depend on, among other things, the possibilities for generating data as well as defining the actors and delineating the relevant jurisdictions.

External actors are actors not emitting nutrients themselves in the system and are thus not forced to own credits generating load reductions. These actors may be buyers with the aim to increase scarcity by buying and retiring permits for philanthropic reasons. For the Baltic Sea region, there are already actors with these types of incentives active in combating the eutrophication. One group of such actors are philanthropic individuals who choose to spend their money on environmental protection.

Other external actors may take own actions in measures and generate credits by implementing verified measures to reduce the nutrient emissions and making these credits available on the market, thus getting paid for voluntary measures. This is a new way of financing measures for reductions in the agriculture and the forest sectors.

23.3 DECIDE ON AMBIENT TRADING UNIT

Nutrient emissions from point sources allows regulation at emissions points by installing improved flow measurement techniques which is transformed to loads at receptor points in the receiving waters, and hence load permits (Swedish EPA, 2012). Emissions from non-point sources can be covered provided there exists verified methods for connecting certain measures with reduction potentials. There are studies suggesting that some measures qualify for the requirements on result-indicators (see Section 6.4). These measures include e.g., catch crops, spring cultivation, buffer strips, adaptive buffer strips, structural liming, wetlands and ponds. These types of measures qualify today for Agri-environmental payment and some of them are also eligible for funds for Local Water Treatment Project (Lokala vattenvårdsprojekt, LOVA).

With agriculture being the largest source of nutrient emissions, load reduction credits for verified measures with result indicators become the natural trade unit since there is no straightforward way to measure total emissions from each source. Measures leading to emissions reductions can be translated into credits (reductions taking place after the start of the system). Trade in credits imply that trade occurs in load reductions rather than total emissions, which also implies that the distributional effects of trade in credits will be the same as free allocation of load permits. While both can work, it is worth noting that point source sectors have significant lobbying power and in the past have preferred trading in credits rather than of load permits (see e.g., the trading system for certificates (credits) used in the proposed CEASAR trading system for nitrogen emissions from Swedish wastewater treatment plants (Swedish EPA, 2012).

23.3.1 Decide on ambient offsets

External actors generating credits by voluntarily making verified measures to reduce the nutrient emissions (and getting paid for it, see "offsets"), can help attract external capital financing measures, primarily reductions at non-point sources. To be able to report compensatory measures in the mandatory system, these ambient load offsets also need to be verified and accounted in the same way as credits, with shares in a portfolio determined by the geographical location of the offsets. Offsets traded as ambient credits implies that offsets are traded and verified as any ordinary credit.

23.3.2 Suggestions for selecting the scope of sectors and ambient trading units

The sectors and the trading units discussed previously are summarised in Table 23.1, which suggests further analysis of the following options for coverage and trade units:

Since a load permit and a load reduction credit have the same unit, they can be linked within the same system. One option is therefore a combination in which point sources are using load permits for total emissions while non-point sources are using credits, trading in load reductions. The coverage of the system could also change over time as acceptance and other circumstances change.

Table 23.1 Suggestions for the scope of the market (sectors) and trading units.

Potential sector coverage	Ambient trading units		Coverage
	Load permits	Load reduction credits	
Public sewage systems (wastewater treatment)	Yes	Yes	Mandatory
Industry	Yes	Yes	Mandatory
Agriculture	No	Yes	Mandatory and/or voluntary
Forestry	No	Yes	Mandatory and/or voluntary
External actors buying permits or credits	Yes	Yes	Voluntary
External actors generating credits by implementing verified measures and selling generated credits	No	Yes	Voluntary

23.4 SET THE AMBIENT CAPS

The government(s) will need to decide on targets levels (over time) for maximum loads, or minimum load reductions, in the ambient trading system, as well as a target year when targets should be reached. An ambient trading system allows for several local targets – i.e., authorities can have a combination of objectives and decide which should take precedence and where.

We suggest that targets of the ambient trading system are set in accordance to fulfil environmental objective in the Water Framework Directive and environmental targets[24] in Marine Strategy Framework Directive. The major reason is that for any other choice of targets, the system would risk violating the fulfilment of environmental objective and environmental targets. These are measured by several indicators, each of which must reach predetermined target levels to fulfil environmental objective of a water body or a coastal water or environmental targets of a basin. In the Swedish implementation of the Water Framework Directive and the Marine Strategy Framework Directive, concentration rates of nitrogen and phosphorus in the waters are indicators that have target values that need to be achieved in order to fulfil environmental objective. Thus, these are the most natural indicators for targeting the ambient trading system.

An ambient trading system regulates emission flows at the sources, and therefore indirectly regulates the inflow loads to waterbodies, coastal waters and basins. Thus, when implementing an ambient trading system, the regulator needs to specify limits for the inflow load to each water body, coastal water and basin that are expected to achieve the target concentration rates of nitrogen and phosphorus of the indicators that will be needed to fulfil the environmental objective of the Water Framework Directive and environmental targets in the Marine Strategy Framework Directive. Sweden is one of few member countries within EU which implemented environmental quality standard as legally binding targets at the water body level. This is becoming an advantage for an ambient trading system whose markets will work more efficiently with stable and predictable caps for each receptor point.

We suggest that targets of the ambient trading system should not be set to achieve only BSAP targets or other targets covering a large area of the Baltic Sea region, even if this would create

24 In Sweden, environmental targets in the Marine Strategy Framework Directive are implemented as environmental quality elements as in the Water Framework Directive.

incentives to reduce emissions and equalize marginal abatement costs across the region. The reason is that this would not be a cost-efficient allocation of measures to achieve the local targets of the Water Framework Directive and the Marine Strategy Framework Directive. Even though trade in reductions would not violate environmental objective initially, it could eventually endanger the fulfilment of environmental objective when measures are chosen over time to equalize retention-adjusted marginal abatement costs across sources, rather than the cost-efficient allocation for achieving the local targets of indicators of the Water Framework Directive or the Marine Strategy Framework Directive. The latter cost-inefficiency in the allocation of measures could for instance incentivize a slowing down of implementation rates in regions with already poor status in Water Framework Directive and Marine Strategy Framework Directive.

23.5 DEFINE THE SIZE OF AMBIENT MARKETS

In the ambient trading system, the default is one "ambient market" with a local cap for each water body, coastal water or basin in offshore waters, which means that such a system covering the Baltic Sea region would consist of several thousand local ambient markets. An operator of a source is required to buy a specified portfolio of ambient permits or credits covering every water body, coastal waters or basin in offshore waters which are the receivers of its emissions. Still every source would only face a single price of its own emissions unit which is simply the weighted average of the prices of all the permits or credits in the specified portfolio.

The small size of each ambient market might, at a first glance, seem to be worrisome. When a market is thin, finding a potential seller/buyer imposes search costs on actors. However, the frequency of transactions will not be any lower in an ambient trading system than in a single-cap system, since a buyer must, in every transaction, buy a portfolio containing permits or credits from many markets. For instance, a buyer in a river basin that needs to buy a specified portfolio of permits from say 100 downstream markets, will generate 100 transactions in 100 different markets for each of his transactions. Thus, the number of transactions in the system increases proportionally with the number of markets. Transparency about prices and traded volumes is beneficial as it provides information to all market participants. Allowing intermediaries and brokers to be active in an ambient trading system is important as they increase transparency by channelling prices, demand and supply in each area.

In sparsely populated river basins, there will be situations when a market in the ambient trading system can contain several water bodies with only a few sources. In this case, one market can contain all these water bodies as a group. The cap on the inflow load to this group is set to the load reduction needed in the worst polluted water body of the group.

This means that the number of sources per area primarily determine the size of markets in river basins. In rural areas, a market can sometimes contain a big number of water bodies, while markets close to urban areas with many sources often will take the size of a single water body. Upsizing of markets in sparsely populated river basins may save significant administrative costs at no loss of control, and neither cost-efficiency in allocation. To what extent this design feature can be used without losses also when upsizing markets in coastal waters and basins depends on the nature of the transport of nutrients between coastal waters and basins in the specific case.

23.6 DEFINE GEOGRAPHICAL AREA FOR THE SYSTEM

An economically efficient size of geographical area for an ambient trading system stems from a combination of the number of sources in river basins (see above) and the magnitude of the reduction needed in the river basin to fulfil objectives within Water Framework Directive and the Marine Strategy Framework Directive. There is no net benefit of extending the ambient trading system to geographical areas with very few sources and/or where good or high status is already achieved in many water bodies. The system would not require any measures from these sources (They are simply "idling" in the system).

When sources are few and the needs for reduction are small in an area, the administrative costs of the trading system may outweigh the benefits it provides (see Chapter 23.1). When the sources are few in an area, existing instruments may achieve targets at lower administrative burden – in such cases it may be worth excluding mandatory coverage from the ambient trading system and instead allowing for voluntary participation. Areas in Sweden for exploring such conditions may for instance be Västerbotten, Jämtland or the forests of Småland and (for nitrogen) the regions north of Ålands hav. It needs to be further investigated from a legal perspective whether some areas can be excluded from the system. Note also that administrative fixed costs are already paid by the implementation of the system in one geographical area. Hence, the decision to include another area should compare the marginal administrative costs with the marginal benefits of including the new area.

The benefits from a trading system will be the largest in areas with many sources, high total load and poor status. In practise, these three factors often coincide - where there are many sources, there are often also high loads and poor status. These conditions usually apply to coastal landscapes, agricultural areas, and around larger inland cities (see green quadrant in Tabell 23.2). In contrast, the risk of thin markets in the red quadrant suggests very little gain from a trading system. The remaining yellow quadrants may have limited gains and should be considered on a case by case basis.

Tabell 23.2 Suggested criteria for defining efficient geographical areas in the ambient trading system. Green represents scenarios with the greatest gains from a trading system, yellow represents possible gains that should be evaluated on a case-by-case basis, and red represents very limited gains.

	Low status	Good or high status
Few actors	High risk of thin markets. Consider upsizing markets in the ambient trading system in the area or consider excluding mandatory coverage from the ambient trading system and instead allow for voluntary participation. Typical areas: Close to large point sources, agricultural areas in sparsely populated areas.	Extremely high risk of thin markets. Exclude area from the ambient trading system. Typical areas: Forest areas in sparsely populated inland areas.
Many actors	Low risk of thin markets. Include area in the ambient trading system with mandatory coverage. Typical areas: Downstream river basins, coastal areas, agricultural regions, larger inland cities.	Risk of lower frequency in transactions. Consider excluding mandatory coverage from the ambient trading system and instead allow for voluntary participation.

23.7 SET UP INSTITUTIONAL ARRANGEMENTS

The development and implementation of market instruments such as the ambient credit system requires a regulatory framework that can provide signals to entities covered and assign clear responsibilities for various market functions. The institutional arrangements of an ambient credit system should provide the following steps (for a similar description relating to an ambient permit system, see Chapter 10).

1. The regulator sets a minimum reduction of inflow of load (kg/year) to each water body, coastal water and offshore water basin (or groups of these). These reductions set the annual floor, i.e. minimum number of credits for each water body, coastal water or basin submitted by operators.
2. The regulator requires each operator to submit credits in terms of individual quotas. The sum of Individual quotas in each water body, coastal water or basin equals the floor in each of these waters.
3. Each operator must submit credits corresponding to its individual quotas for each water area by the end of each year; these are credits that are either (1) generated by own verified reductions, (2) bought from other actors with verified reductions during the same trading period, or (3) bought at an auction held by the regulator.
4. Penalties and/or persecution are administered for actors that fail to submit the individual quotas.
5. The floors – i.e., regulated number of credits submitted for each water body, coastal water and offshore water basin (or groups of these) – is increased annually according to an announced plan towards the target year when environmental objective are to be fulfilled.

The regulatory framework must also provide a credible enforcement system (e.g. penalties for non-compliance) and be accompanied by effective governance to ensure transparency and enhance stakeholder participation. As part of ambient trading system design, the government should map out the long-term institutional obligations for implementing an ambient trading system and evaluate which of these can be assigned to existing authorities and which could require the development of new administrative entities.

23.8 GENERATE VERIFIED DATA FOR OPERATING THE SYSTEM

An ambient permit system requires flow measurements at the emission points for point sources and verified measures for non-point sources with result-indicators for the reductions generated by the measures. For assessing the loads to receiving waters, parameters from water quality models are needed for describing average retention and nutrient transport between the sources and affected water bodies, coastal waters and offshore water basins. A water quality model (or hydrological model) is a simulation of a hydrological system that can predict the impacts of emissions of nutrients at different locations in terms of eutrophication levels. The key data needed for operating an ambient trading system are:

- Accredited flow measurements at the emission points for point sources
- Accredited and verified measures for non-point sources with result-indicators describing reductions in per unit of the measure on the agricultural field (kg nutrients per Ha).
- Estimates of average retention and nutrient transport between each emission source and the receiving water bodies or group of water bodies, coastal waters and offshore water basins. These estimates are the fixed transfer coefficients between each emissions source and receiving water.
- Maximum allowed nutrient loads per year for each water body (or group of water bodies), coastal waters and offshore water basins, based on the target indicators for nutrients that affect environmental objective.
- Reduction paths for the maximum allowed nutrient loads per year until the target year when the environmental objective should be fulfilled.

The Swedish Meteorological and Hydrological Institute (2010) has created models that can calculate and predict nutrient loads in rivers and lakes and coastal waters based on retention and nutrient transport. These models are operative and have been used by Swedish authorities. In addition to estimates of average retention and nutrient transport between sources and receiving waters from water quality models, the nutrient trading system requires robust models and methods for connecting measures at non-point sources to the resulting total nutrient in the receiving waters.

23.9 EXPAND INTERNATIONALLY

In an international ambient trading system individual sources still buy and sell portfolios of permits or credits. A source in Sweden will buy and sell a portfolio with shares from Swedish inlands waters in its river basin, coastal waters and offshore basins in the Baltic Sea. A source in, for instance, Poland will buy and sell a portfolio with shares from the same coastal waters and offshore basins (in addition to Polish inlands waters in its river basin). Thus, the Swedish source and the Polish source "partially" trade with each other since their portfolios contain the same coastal waters and offshore water basins in the Baltic Sea. However, the size of the shares will differ in the portfolios. The portfolio of the Swedish source has most shares in Swedish coastal waters closest to its river basin and the least shares in distant coastal waters of other countries. The opposite holds for the portfolio of the Polish source.

Expanding the ambient trading system to an international system allows for additional benefits related to cost-effectiveness and external capital inflows. Further, an ambient trading system based on the Water Framework Directive and the Marine Strategy Framework Directive makes it natural to include other EU member countries in future expansions.

But it also raises challenges due to differences between countries with respect to e.g., attitudes among voters, economic growth, technological development and changes in stakeholder pressures. As described in the analysis of countries' incentives (Chapter 14) there are three possible paths forward for a Swedish strategy in negotiating an international nutrient trading system. The first one is based on universal participation of all nine countries; the second focuses on a smaller coalition of countries with similar interests; and the third path suggests Sweden as a first mover that demonstrates possibilities via a national trading system, followed by gradual enlargement to other countries (see Table 14.2).

The third path – "gradual enlargement" – might be the most promising (see details in Chapter 14). In this scenario Sweden develops a national trading system and then invites Finland for bilateral collaboration on provision of side-payments, and possibly other forms of support, to Poland and/or Lithuania. By including a country like Poland, the economic and environmental benefits may grow due to the size of the country and its current contribution to the eutrophication problem.

Initial allocations of ambient permits or credits may be used as compensatory payments to attract other countries to participate in an international system. Initial allocation for distributional purposes does not necessarily need to be bound to local caps. For instance, in the case of ambient permits, it is only the permits in the specified portfolio of each operator that can be reported for compliance. If the operator has bought permits in other geographical areas than those specified in his portfolio for compliance, then these permits cannot be used for reporting by the operator. Hence, the operator would be an external actor with regards to other permits than those specified in his portfolio. Therefore, one side-payment mechanism could be to "over-allocate" ambient permits to a reluctant country (i.e., provide more than what the sources in the country would suggest for compliance) and then the local surplus could be sold to other sources in a neighbouring country. The reluctant country could use the revenue from these sales to finance other activities that are important for it. This example underscores how the ambient trading system can achieve a cost-efficient allocation from trade regardless of the starting point for the initial allocation.

Figure 23.1 Summary of 10-step process for implementing an ambient trading system in Sweden.

1. Build political support

- Allocate budget resources for outreach and communication with e.g., policymakers, lawmakers, regulated entities, the public and media
- Emphasize five attractive features of an ambient trading system
- Make use of Sweden's domestic experience for trading systems on greenhouse gas emissions and electricity certificates.

2. Decide the scope

- Consider including agriculture, public sewage treatment plants, industries, forestry
- Consider including external actors who buy permits for pro-environmental reasons
- Consider Including external actors generating credits by implementing verified measures

3. Decide ambient trading unit

- Consider the following options:
  - For point sources: trade in loads using permits or trade in load reductions using credits
  - For non-point sources: trade in load reductions using credits for non-point sources based on methods for connecting measures by non-point sources and load reductions

4. Decide on ambient offsets

- Include ambient offsets in the system, which will attract external actors as well as sources in the system that provide both influx of capital financing and also the possibilities for implementing verified measures beyond what is mandatory in the system.

5. Set the ambient caps

- Target levels should be set in accordance with indicators for environmental objective in the Water Framework Directive and Marine Strategy Framework Directive, rather than those established by the Baltic Sea Action Plan.

6. Define the size of ambient markets

- The default is one market with a local cap for each receiving water with a target indicator.
- Upsizing markets in sparsely populated areas is possible to reduce administrative costs without loss of load control or loss of cost-efficiency in allocations
- Allow for intermediaries and brokers to be active in the system to increase transparency

7. Define an efficient geographical area

- Focus on geographic areas with many sources, high total load and poor status.
- In areas when sources are few and needs for reduction are small an ambient trading system may bring larger costs than benefits

8. Set up institutional arrangements

- Five key responsibilities:
  - establish number of permits/credits for each receiving water
  - require submission of annual permits/credits by operators.
  - operator submits permits/credits corresponding to own reductions or purchase of permits/credits
  - enforce penalties for non-compliance
  - adjust the caps annually according to an announced plan.

9. Generate verified data for operating the system

- Verified measures for non-point sources with corresponding result-indicators from approved models or methods
- Estimates of average retention and nutrient transport from water quality modelling
- Maximum allowed nutrient loads per year for each water body from the water and marine managements
- Reduction paths for the maximum allowed nutrient loads per year until the target year

10. Expand internationally

- Expand the system gradually, maybe in this order: 1 Sweden, 2 Finland, 3 Poland/Lithuania
- Rely on initial allocations of permits/credits as compensatory payments to entice participation

24 PLAN AND STRATEGY FOR ANCHORING AND COMMISSIONING THE TRADING SYSTEM

Effective implementation of this report's strategy requires clear information about who will be affected and what decisions need to be made. The government and relevant agencies have a central role in the decision-making process before the system is in place, while other actors should also be involved (operators, citizens, municipalities, interest groups, etc). There will most likely be discussions of the financial consequences for different actors since this system will induce investments in abatement technologies. The use of subsidies or exemptions could be considered if the government wishes to ease the financial burden on certain sectors or to limit exposure based on an operator's size.

Since the ambient trading system is primarily a national system, with the possibility to expand internationally, it is not compulsory to inform other countries or organisations. The exception is the EU and the EU-Commission due to the potential breach of the Water Framework Directive's goal of achieving good status by 2027. The process of implementing a trading system will take approximately 6-7 years, which means that the environmental improvements of the system may not be seen before 2027. Note, however, that this is only an approximated time horizon and the actual achievement of good status will depend on several issues ranging from the quality of data to political will. If there is a political will to introduce a trading system, the Swedish government is advised to enter into a dialogue with the European Commission about the trading system and how it will be designed to achieve the objectives of the Water Framework Directive and that the trading system will respect the non-deterioration requirement.

Figure 24.1 shows the necessary legislative steps to implement the proposed nutrient trading system. We provide details of each step below.

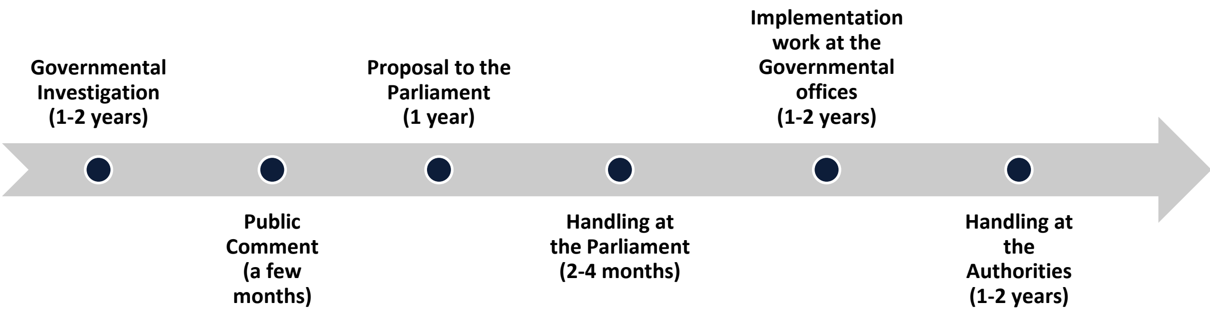


Figure 24.1 Legislative steps for implementing the proposed nutrient trading system.

1. Governmental Investigation

An important step in implementing the trading system in Sweden is to start a governmental investigation by appointing an investigator. This investigation must have clear instructions for a proposal as well as a mandate to propose legislative text for the Parliament. This investigation will play a crucial role for future implementation since several aspects have to be prepared before the system can work (see Chapter 24.1). This will likely take 1-2 years.

2. Public comment on the Governmental Investigation

The results of the investigation will have to be submitted for public comment to different interested parties, such as authorities, enterprises, private citizens, municipalities and interest groups. This will be done by the Governmental offices and can take anywhere from a few weeks to several months. The public comment period may result in stopping the development of a trading system, initiating a new investigation, developing alternative solutions or going forth with the proposal from the investigation.

3. Proposal to the Parliament

The next step is to write a proposal to the Parliament. This process will most likely include consulting the Swedish Council on Legislation ("Lagrådet"). A trading system would mean obligations for individuals and companies and influence personal or financial circumstances. In this case a trading system will result in either increased cost of abatement for actors or lead them to decrease emissions. Both the Emissions Trading Act (2004:1199) and Electricity Certificate Act (2011:1200) were previously examined by the Council on Legislation. The review will address the following types of questions:

- how the proposal relates to the constitution and the legal system in general
- how the provisions of the proposal relate to each other
- how the proposal relates to the requirements of legal certainty
- whether the proposal is designed so that the law can be adopted to meet the purposes stated, and whether there may be problems that may arise in applying it

If the Council on Legislation has substantial objections to the proposal, it could lead to a new investigation to solve the problems. Minor issues can be handled internally within the Governmental offices. It is also possible for the Government to go forth with the criticised proposal and let the Parliament decide, although this latter strategy can be somewhat risky.

If there are no objectives from the Council on Legislation the Governmental offices can finalise the work of the proposal. Before handing over the proposal to the Parliament there will be negotiations between different ministries and political parties within the Government. Only after all the ministries have approved the proposal and the government has made a final recommendation is it possible to submit it to the Parliament. This process could take one year.

4. Handling at the Parliament

When the proposal has been handed over to the Parliament it will take approximately 2-4 months to reach a decision. The proposal will be handled by a Parliamentary committee and then put before a vote in the Chamber. The committee examines the proposal in greater detail and in turn submits a recommended proposal for the Parliament to vote on. In Sweden the Parliament very rarely alters this legislative text, instead, a simple "for or against" vote is made on the proposal "as is."

5. Implementation work at the Governmental offices

If the proposal is accepted by the Parliament a letter to inform will be sent to the Government. A law almost never has direct legal effect from the date of the decision at the Parliament. Instead, there is a period for the Government to decide on specific regulations and hand over the day-to-day operations to an authority. This will be needed regarding a trading system.

There will be several technical issues which should be handled by an authority. This part can take approximately 1-2 years.

6. Handling at the Authorities

The final step is to delegate the work to develop requirements and formulate regulations to the authorities. If the Government is well-prepared this work can be done parallel with the implementation work at the governmental offices. This may take approximately 1-2 years.

24.1 THE GOVERNMENTAL INVESTIGATION

The governmental investigation must be conducted first, which includes consideration of several topics and final communication to the public. Many of the issues associated with a trading system have already been addressed in this report, but many will nonetheless have to confirmed or further developed in an investigation. Key issues to cover include:

- Preparation of a new law on ambient trading of nutrients from certain sources, and changes to existing laws;
- Propose competence and resources for the authority to “lead” the new trading system
- The governmental investigation (or an existing authority) should be appointed to work as a vehicle for implementation as well as dialog with all stakeholders (stakeholders may also be included in a reference group for the investigation)

When formulating a legal system for a trading system several universal principles must be adhered to. Laws should be open and clear, general in form, universal in application, and knowable to all. Moreover, legal requirements should make it easy to guide actors and they should not place undue cognitive or behavioural demands on them. Thus, the law should be relatively stable and comprise determinate requirements that people can consult before acting. Legal obligations should not be established retroactively. Furthermore, the law should remain internally consistent and, failing that, should provide for legal ways to resolve contradictions that may arise (Bevir, 2010).

To establish the new trading system and prepare the legislative text the investigator should address the following:

- Methods for allocating nutrient loads to different water bodies (e.g. water quality model). Importantly the environmental objectives in the water bodies must be the goal that the trading system is designed to achieve.
- The availability of quality data for the underlying models.
- The geographic scope for the trading system– either general and applicable for all of Sweden or geographically differentiated. Apart from environmental and economic issues, legality and competition will be important topics in this part.
- The sources to include in a trading system, including decisions about possible exemptions for certain sectors, actors for whom participation is mandatory, and possible voluntary participation.
- Method for the initial allocation of credits to actors and operators in Sweden (e.g., free allocated or auctioned)
- Design of the registry of actors and the authority that is responsible for it

- Effects on the state budget
- A socio-economic evaluation of the effect of the trading system.
- How to handle possible future expansion towards an international ambient trade with external actors
- Legal issues associated with the fact that a system may impose new restrictions on current land use, compliance and sanctions for non-compliance. This will have to be thoroughly investigated and evaluated if it meets urgent public interests.
- Several issues should be addressed with respect to state aid for nutrient pollution:
    - Will the trading system provide actors "payment" for reduction measures that are already required under current regulations? The investigation should address how an actor's decision to buy credits or make reductions can be designed so that the authorities' other regulatory requirements, which are based on the environmental objectives and best available technology, can also be achieved without conflict. One alternative could be to design a system where measures that are required by regulation can still be traded in the system, but this could be done by making the action itself (the trade) a requirement for participation in the system. This design can be different depending on whether the trading system is based on permits or credits.
    - How might the trading system affect current subsidies for projects that absorb nutrients, e.g., financial support to construct wetlands? Further, will government reduction measures also provide credits? If measures that must be taken are traded, there is a risk that state funding to buy reductions (e.g. subsidies for wetland construction) is seen as impermissible state aid and a violation of the principle of not giving companies financial support to meet regulatory requirements.

24.2 EXPANDING THE GEOGRAPHICAL SCOPE

When the process has started in Sweden it is advisable to inform Finland and HELCOM. One reason is the countries' mutual interests in achieving the environmental targets in the Gulf of Bothnia, where sources on both sides possibilities for achieving these targets. Sweden should present the proposed trading system to a range of actors by highlighting the environmental and socio-economic benefits. It should also present the process in Sweden and explore the possibilities to cooperate regarding the development of a common water quality model approach. A comprehensive model approach is available regarding waters covered by the Water Framework Directive but needs to be developed regarding the waters covered by Marine Strategy Framework Directive.

25 CONCLUSIONS - THE PLAN AND STRATEGY FOR INTRODUCTION OF THE TRADING SYSTEM

Effective government processes will be critical for guiding a Swedish national ambient trading system proposal from design to legislation to implementation. Chapter 23 describes a strategy based on 10 steps for implementing and designing an ambient trading system that can be expanded to the Baltic Sea region. Key steps include building political support and establishing key institutional arrangements. It also discusses several key design considerations like sector coverage, the limit or cap on emissions, the unit of trade, extent of the market, geographic scope, inclusion of ambient offsets, etc.

A strategy for implementing an ambient trading system in Sweden needs to thoroughly consider the process of educating policymakers, lawmakers, regulated entities, the public and media about the pros and cons of an ambient trading system. Before and during implementation it is essential that the government and the research sector facilitate the capacity and knowledge needed in the public bodies that will be involved in operating the ambient trading system. The last part of the strategy addresses the integration of decisions on design and government institutions and the preparative legislative work.

The Water Framework Directive obliges all EU member states to prevent deterioration of the status of all water bodies and to ensure all water bodies achieve "good status" by 2027. All possibilities for extending the deadline have been exhausted (other than when natural conditions preclude timely improvement in water quality status).

Full implementation of a trading system that accomplishes the objectives in the Water Framework Directive is not possible by 2027, due in part to the Swedish legislative time frame: appointing a governmental investigator, establishing and enforcing new laws, implementing the necessary measures. In this complicated case, it could take between 6-7 years before a trading system is functioning. We emphasize, however, a trading system that accomplishes the objectives of the Water Framework Directive is of great value, especially if an infringement case would be brought against Sweden in the future. Note that Sweden must comply with the Water Framework Directive, even if full implementation is delayed beyond 2027.

This report describes a trading system that would comply with the Water Framework Directive, while also being aligned with the Baltic Sea Action Plan at HELCOM. Given the limited time frame, we recommend that governmental offices begin immediately in formulating the directive for a governmental investigation. Importantly, this report provides a key basis for such an investigation, since several of the necessary topics are addressed herein. Other input that may be needed can be gathered by different authorities or during the process of the investigation itself. Importantly, the necessary legislation is not possible without this type of investigation and time lags will affect when the trading system can be in place.

If an investigation is not possible, due e.g., lack of information on a crucial topic or any other reason, an alternative could be to create a governmental assignment for an authority that can continue the work, which can then be including in a future investigation.

CONCLUSIONS

We conclude as follows:

- Eutrophication is regarded as one of the most intricate problems facing the Baltic Sea, resulting in massive algal blooms, extensive oxygen depletion, and recurrent incidences of fish kills. Poland is the largest contributor of nutrients to the Baltic Sea, followed by Sweden and Russia. Nutrients come from both natural sources and, most importantly, anthropogenic sources such as municipal and household wastewater, agriculture and industry. Current policy instruments aimed at eutrophication have proven inadequate to meet regional water quality goals.

- A nutrient trading system has many potential advantages. Efficiency gains from choosing cost-effective instruments occur across time and space and are likely to decrease the costs of achieving water quality goals drastically. Further, a trading system increases the precision of achieving these goals, while the transfer of responsibility from authorities to polluters helps to speed environmental recovery. The system can be designed to allow for influx of private capital to fund reduction measures.

- Design of the trading system is critical for its success. Since the system must guarantee the good ecological status of each individual water body, it precludes explicit trade between water bodies (although there is implicit trade between water bodies since the ambient markets are linked with each other). Our proposed solution is to introduce an ambient system, which focuses on the ambient conditions of the impacted waterbody rather than the quantity of pollution emitted at the source. Each emission source would have a retention and nutrient transport rate determined by a biophysical model and would purchase a portfolio of emission rights that includes all affected (downstream) water bodies. The distribution of emission reduction is determined by trade within the system, while the path of reduction is based on how best to reduce the total load of pollutants.

- In sparsely populated river basins, each ambient market will cover a large number of water bodies with few sources, saving significant administrative costs at no loss of pollution control or loss of cost-efficient allocation between sources. However, an ambient trading system that covers all geographical areas in Sweden is unlikely to be effective since the administrative burden becomes too great in relation to the social and environmental benefits. The optimal scope of individual trading areas would include water bodies that have less than good status and are affected by many emission sources. For Sweden, these conditions are met for the water bodies in the Baltic Sea, along the coasts and in the southern agricultural districts. Although no environmental or efficiency arguments exist for including all water bodies, there may be legal constraints that force water bodies to be included in the system, which should be investigated.

- Each source would report load permits (or credits) corresponding to the emissions after each trading period, making the proposed system compatible with the Water Framework Directive. Further the system would be agile in the sense that it can integrate new sources of emissions, countries, buyers and sectors over time.

- We recommend an ambient credit system that regulates load reductions to receiving waters. This is the only ambient system that can handle non-point sources such as agriculture and forestry, while also easily handling point sources. An alternative is an ambient trading system that uses ambient credits for non-point sources, and ambient permits for point sources (where credits and permits are traded at a one-to-one ratio).

- It is unlikely that all countries will perceive benefits from participating in a nutrient trading system. Even a smaller regional system will require proactive efforts such as transfers from countries with strong incentives to participate to countries with weaker incentives – and this may be costly. The most realistic approach would be to start with a national system in Sweden and then expand it incrementally based on other countries' preparedness and incentives. The initial expansion could include Finland, which has previously investigated a nutrient trading system and faces similar incentives to Sweden. Subsequent expansion could include other countries with high emissions and, relative to Sweden and Finland, lower abatement costs (e.g., Poland and Lithuania), thus increasing opportunities for efficiency gains (although relatively few water bodies are affected by countries with very different abatement cost levels).
- Before transactions can take place between market actors' key decisions are required with respect to integration of existing instruments. Our preliminary analysis suggests that information can be integrated but should be reoriented; regulation cannot be replaced, and integration would require that the trading system is binding. Economic instruments should either be removed or reoriented; taxes could help control price volatility in a trading system while subsidies could address one of the future risks, namely thin markets.
- Introducing an ambient trading system in Sweden may take 6-7 years as it must follow several legislative steps: governmental investigation, public comment, proposal to the parliament, and then comment from parliament, governmental offices, and authorities. Even if the process can be expedited, a trading system that achieves the requirements of the Water Framework Directive by 2027 is unlikely. Nonetheless we recommend that the proposed trading system is implemented for several reasons:
    1. Our assessment is that existing policy instruments are insufficient to achieve the requirements by 2027.
    2. Even if current instruments are tightened, they suffer from time lags that are many times longer than the time lags of market-based measures.
    3. A trading system represents an environmentally effective and cost-efficient instrument.
    4. A trading system that accomplishes the objectives of the Water Framework Directive is critical, especially if an infringement case would be brought against Sweden in the future. Sweden must comply with the Water Framework Directive, even if full implementation is delayed beyond 2027.
- Ensuring acceptance is a challenge when introducing a trading system – by the public, market actors, and other countries. Successful systems are those that stimulate active engagement of market participants and garner a sense of inclusion. The initial allocation of permits represents an important negotiation tool. We recommend that Sweden "owns" the implementation process but engage in early discussions with other countries – both bilateral and within the HELCOM collaboration.

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APPENDICES

Appendix 1 Total load of waterborne and airborne nitrogen and phosphorus to the Baltic Sea in 2014, in tonnes by country. The data include transboundary inputs to the Baltic Sea (Source: HELCOM, 2018).

Country	Nitrogen	Phosphorus
Denmark	56,630	1,802
Estonia	25,011	413
Finland	82,484	3,255
Germany	61,396	520
Latvia	51,970	1,263
Lithuania	56,426	1,076
Poland	169,941	12,776
Russia	92,467	4,449
Sweden	109,596	3,226
Other	119,904	2,169
Total	825,825	30,949

Appendix 2 Baltic Sea Countries that were interviewed as part of our analysis.

Country	Organisation	Respondents
Estonia	Ministry of the Environment, Water Department	2
Estonia	Chamber of Agriculture and Commerce	1
Estonia	Ministry of Rural Development	1
Finland	Ministry of the Environment	1
Finland	Finnish Environment Institute	1
Finland	Ministry of Agriculture and Forestry	1
Germany	The Ministry of Agriculture and the Environment of the State of Mecklenburg-Vorpommern	1
Germany	German EPA, Unit for Marine Protection	1
Germany	Ministry of Energy, Agriculture, the Environment, Nature and Digitalization in Schleswig-Holstein	3
Germany	Federal Ministry for Environment, Nature Conservation and Nuclear Safety, Unit for Nature Conservation and Environmental Protection in Agriculture	1
Latvia	Ministry of Agriculture	1
Latvia	Latvian Environment, Geology and Meteorology Centre	3
Latvia	Farmers' Parliament	3
Latvia	Ministry of the Environment	1
Lithuania	Lithuanian EPA	1
Lithuania	Ministry of Agriculture	2
Lithuania	Ministry of the Environment	1
Poland	Ministry of Infrastructure, Water Protection Unit	3
Poland	Main Inspectorate of Environmental Protection, Department of Water Condition Monitoring and Assessment	1

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