The Baltic Sea and the valuation of marine and coastal ecosystem services

Background Paper for the Regional Workshop on the Valuation of Marine and Coastal Ecosystem Services in the Baltic Sea
Stockholm, 7-8 November, 2013
The Baltic Sea and the valuation of marine and coastal ecosystem services - A background paper for the Regional Workshop on the Valuation of Marine and Coastal Ecosystem Services in the Baltic Sea, 7-8 November 2013, Stockholm

Authors: Heini Ahtaiinen¹, Marcus C. Öhman²

Acknowledged persons contributing to this report: Kerstin Blyh, Minna Pyhälä, Mikhail Durkin, Siv Ericsdotter, Jorid Hammersland, Anna-Stiina Heiskanen, Kari Hyytiäinen, Holger Janßen, Soile Kulmala, Christian Neumann, Monika Stankiewicz

This work was coordinated by the Stockholm Resilience Centre (SRC) in a partnership with the UNEP Regional Seas Programme, Baltic Marine Environment Protection Commission – Helsinki Commission (HELCOM) and the Ministry of the Environment of Sweden with financial support provided from the Nordic Council of Ministers and the Swedish Presidency of the Nordic Council of Ministers within 2013.

¹ HELCOM, Baltic Marine Environment Protection Commission, Katajanokanlaituri 6 B, FI-00160 Helsinki, Finland
² Stockholm Resilience Centre, Stockholm University, 10691, Stockholm, Sweden
**Contents**

Summary ................................................................................................................................................. 4  
1. Introduction ......................................................................................................................................... 5  
2. Ecosystem services – defining the concept ......................................................................................... 5  
3. Valuation of ecosystem services ......................................................................................................... 7  
   3.1 Monetary valuation ......................................................................................................................... 9  
   3.2 Valuation methods .......................................................................................................................... 9  
4. Ecosystem services as a global priority .............................................................................................. 11  
5. Baltic Sea environment and human impact ....................................................................................... 13  
6. Ecosystem services provided by the Baltic Sea ............................................................................... 14  
   6.1 Provisioning Ecosystem Services .................................................................................................. 15  
   6.2 Cultural Ecosystem Services ......................................................................................................... 16  
   6.3 Supporting Ecosystem Services .................................................................................................... 16  
   6.4 Regulating Ecosystem Services .................................................................................................... 17  
   6.5 Economic valuation studies of ecosystem services in the Baltic Sea ........................................... 17  
7. Baltic Sea governance and ecosystem services ............................................................................... 18  
8. Future perspectives ............................................................................................................................. 21  
References ................................................................................................................................................ 24  
Annex 1. Background on valuation methods .......................................................................................... 32  
Annex 2. Background information on Baltic environment and human impacts .................................. 34  
Annex 3. Valuation studies of ecosystem services in the Baltic Sea area .......................................... 37
Summary

The Baltic Sea provides many ecosystem services that contribute to human well-being, such as nutrient cycling, fish stocks, water quality, biodiversity, raw materials, and climate regulation. However, the understanding of the function of the Baltic Sea ecosystems that provide the services and the resulting benefits to human societies is still limited, and the value of the natural environment is not appropriately incorporated into marine decision-making. Valuation of the benefits provided by ecosystem services can aid in designing more efficient policies for the protection of the Baltic Sea and in reaching the environmental objectives for the sea. Well covered information on the benefits provided by marine and coastal ecosystems is essential to reach the objectives of the HELCOM Baltic Sea Action Plan and the European Union Marine Strategy Framework Directive, as well as the EU Biodiversity Strategy 2020 (Target 2, Action 5). There are some existing studies on the value of improved marine environment, which can be used to assess the importance and value of marine ecosystem services. However, further work is still needed on identifying and describing Baltic Sea ecosystem services and their interactions, evaluating how policy changes affect these ecosystem services and assessing the effect of changes in ecosystem services to human welfare. In this report background information is given on how to evaluate ecosystem services and an overview of ecosystem services provided by the Baltic Sea is described.

Main challenges in assessing the ecosystem services in the Baltic Sea include:

- Accurately describing ecosystem services and how they are linked with the ecosystem structures.
- Trade-offs and interactions of ecosystem services.
- Finding relevant indicators for the assessment of ecosystem services and ecosystem improvement.
- Evaluating how measures to improve the marine environment impact the provision and trade-offs of ecosystem services and further their value.
- Assessing the effects of changes in ecosystem services to human well-being, taking into account possible future developments.
- Taking ecological thresholds and non-linearities into account in valuation.
- Providing internationally comparable information on the value of ecosystem services.
- Incorporating uncertainty about ecosystem services into value estimates.
- Translating ecosystem services information so it becomes relevant to policy and decision-making.
1. Introduction

The Baltic Sea provides many goods and services that contribute to human well-being. These include, for example, fish stocks, biodiversity, water quality and climate regulation, which in turn create human welfare in terms of food, recreation opportunities and inspiration. Ecosystem services are ecosystem functions and processes that are beneficial to humans, either directly or indirectly. The concept of ecosystem services can be used to analyze the interaction between nature and humans, and assess the significance of ecosystems and biodiversity.

Many benefits provided by nature are not recognized by markets and market prices, thus being ignored in decision-making. This leads to undervaluation of nature and ecosystem services, and loss of biodiversity (TEEB 2008). The purpose of valuation is to capture the numerous values people derive from nature, which can be integrated into decision-making.

Better understanding of the value of ecosystem services increases the awareness of the benefits provided by nature, and makes the trade-offs between the protection of the marine environment and other economic actions visible. Ecosystem valuation can thus assist in designing more efficient policies. Benefit estimates can be compared with the costs of environmental protection measures in cost-benefit analyses to assess the economic efficiency of nature conservation projects or programs. Such analyses can also be useful in setting environmental targets and in deciding how to allocate public spending. In addition, valuation is one of the ways to take into account public values and encourage public participation.

Despite recent initiatives and efforts to study ecosystem services, the understanding of the function of the Baltic Sea ecosystems that provide the services and the resulting benefits to human societies is still limited. There is a need to improve the knowledge of ecosystem services to produce comparable information for the Baltic Sea region. The knowledge of ecosystem services and their value to society can aid in achieving the regional and national environmental objectives set for the Baltic Sea. Information on the benefits provided by marine and coastal ecosystems can support reaching the objectives of the HELCOM Baltic Sea Action Plan. Such information is also needed for the implementation of the EU Marine Strategy Framework Directive.

This document provides information on ecosystem services in the Baltic Sea, the valuation of ecosystem services and the links between the management of the marine environment and ecosystem services.

2. Ecosystem services – defining the concept

Working with ecosystem services requires a clear and consistent understanding of their definition and typology. Several different definitions and classification schemes of ecosystem services have been suggested (Daily 1997, Costanza et al. 1997, MA 2005, Fisher et al. 2009). One of the most widely used definitions is the one developed by the Millennium Ecosystem Assessment (MA 2005) which has
been applied in analyzing the situation in the Baltic Sea (Garpe 2008, Söderqvist et al. 2012).

Millennium Ecosystem Assessment (MA) classification of ecosystem services:

- **Regulating**, e.g., pollination and the regulation of climate and erosion.
- **Provisioning**, that are products from the ecosystems, e.g. food, genetic resources and energy sources.
- **Cultural**, e.g. recreation, inspiration, aesthetic and educational values.
- **Supporting**, that are needed to maintain other services, e.g. primary production and nutrient cycling.

Since the MA, the classification of ecosystem services has been developed to be applicable to different decision contexts (e.g. Boyd & Banzhaf 2007, Wallace 2007, Fisher et al. 2009, UK NEA 2011). It has been noted that some ecosystem services contribute to the provision of others, and that double-counting needs to be avoided in the valuation of ecosystem services. Therefore, ecosystem services are often divided into intermediate and final services, and also separated from the goods or benefits they provide (Fisher et al. 2009, Turner et al. 2010, UK NEA 2011).

Figure 2 presents a classification for the valuation of ecosystem services. It is based on the key idea that ecosystem services provide goods and benefits to humans that can be valued (Fisher & Turner 2008, Fisher et al. 2009). In the definition, ecosystem services are considered to be ecological in nature, and they do not have to be utilized directly. Intermediate services support final services but are not directly linked to human welfare, and final services directly deliver welfare gains to people. UK NEA (2011) also separates between goods that include all outputs from ecosystems that are valued by people, and benefits that represent the value of welfare improvements.

![Figure 2](image_url)

**Figure 1.** Classification of ecosystem services for valuation

This division of ecosystem services aids in considering all significant services to human well-being (European Commission 2010), and it also helps avoiding the problem of double-counting (Fisher et al. 2009, UK NEA 2011). Double-counting occurs when underlying ecosystem services that contribute to final service benefits are valued separately and the values are aggregated to obtain estimates of ecosystem value (Turner et al. 2010). For example, valuing nutrient cycling and recreation in marine areas separately and summing the values up leads to double-counting, as nutrient cycling contributes to having usable water for the
purposes of recreation. Thus, the value of nutrient cycling is already embodied in
the recreation benefits. The double-counting problem can be avoided by having a
clear understanding of the interactions of ecosystem services and valuing only
goods provided by final ecosystem services.

The MA classification and the division of ecosystem services into intermediate
and final services and benefits can be used together (see Figure 3). In that case,
provisioning and cultural services are always final ecosystem services, regulating
services may be either final or intermediate services and supporting services are
always intermediate services (UK NEA 2011). Also, some ecosystem services can
be either intermediate or final depending on the context.

As the existence of multiple classification schemes of ecosystem services compli-
cates comparisons between studies, a standard classification that is consistent
with other classification schemes has been proposed (Haines-Young & Potschin
2011, 2013). The Common International Classification of Ecosystem Services
(CICES) has been developed to facilitate comparisons between different defin-
itions. The starting point of the CICES classification is the MA (2005) typology of
ecosystem services, but it has been developed further to make a distinction
between final ecosystem services, goods and benefits, with similarity to the UK
NEA (2011) definition.

The existing classification schemes for ecosystem services do not necessarily
take into account the special characteristics of the Baltic Sea, and therefore it is
important to adapt these to the conditions of the area.

3. Valuation of ecosystem services

The purpose of valuation of ecosystem services is to assess the socio-economic
benefits (or losses) resulting from changes in the market and non-market goods
provided by ecosystem services. This view is essentially anthropocentric and
focuses on human well-being. In addition to human benefits, nature is often
considered to have intrinsic value, i.e. value in itself (e.g. Ehrenfeld 1972).

Valuation of ecosystem services is inherently interdisciplinary, and it entails
combining the approaches of natural and social sciences to characterize the
relationships between ecosystems and the provision of ecosystem services and
to identify how these affect human well-being. Steps in the valuation of ecosys-
tem services include assessing how the policy change affects the ecosystem and
the provision ecosystem services, how the changes in ecosystem services impact human welfare, and what is the value of the changes in ecosystem services (Defra 2007).

The effects of biodiversity conservation on ecosystem services and further on human well-being can also be assessed in relation to human well-being targets (Conservation Measures Partnership 2012). According to MA (2005), these targets include necessary material for good life (such as income, food and shelter), health, good social relations, security, and freedom and choice. Conservation projects can provide direct benefits to humans while achieving conservation goals, or provide ecosystem services that contribute to human well-being (Conservation Measures Partnership 2012). It is also possible to set goals for human well-being targets in conservation projects.

According to White et al. (2011), valuation of ecosystem services can be done at three levels: qualitative, quantitative and monetary. Qualitative valuation means identifying the effects of changes in the provision of ecosystem services on human well-being. An example could be qualitatively describing the changes in the recreational use of a certain nature area after implementing a policy to improve its state. Quantitative valuation involves estimating the changes in ecosystem benefits in numbers, e.g. determining the increase in the yearly number of visitors to the area. Monetary valuation entails expressing the values in monetary terms, e.g. estimating the willingness to pay per visit and based on this, the change in the annual value of the recreational visits to the area.

In addition to double-counting, economic valuation of ecosystem services should consider marginal valuations, spatial explicitness and threshold effects (Turner et al. 2010). Marginal valuation entails that marginal changes in value are estimated instead of total values. Estimating the total economic value of ecosystem services is considered neither useful nor advisable for several reasons (Brouwer et al. 2013). First, marginal value reflects the value of an additional unit of ecosystem services, and it changes with the level of provision of ecosystem services. Therefore, multiplying marginal values with quantities may lead to biased estimates of total value. Second, for ecosystem services that are fundamental to human well-being, total value is argued to be infinite. Third, policy decisions rarely consider total losses of ecosystem services, and therefore valuing marginal changes is more useful.

Spatial explicitness means that it is important to take into account the spatial heterogeneity of ecosystem services provision and benefits (Turner et al. 2010). Provision of ecosystem services is affected, for example, by the ecosystem area, quality and the scale of delivery (Brouwer et al. 2013). Benefits depend on the number of affected people, distance to the ecosystem and availability of substitutes, among others (Brouwer et al. 2013). Interdisciplinary work is needed to account for spatial variability.

Nonlinearities are often present in ecosystem services, meaning that there are certain thresholds after which the system changes dramatically into another steady state. Possible thresholds should also be considered in valuation to produce appropriate benefit estimates. In situations with high ecological uncertainty or irreversible changes in ecosystems, other policy guiding principles, such as the precautionary principle, can be more useful (TEEB 2010).
3.1 Monetary valuation

Many environmental or ecosystem goods do not have a market price or the price does not represent the total value, and therefore specific valuation methods have been developed to estimate their monetary value. Two concepts that are used are willingness to pay (WTP) and willingness to accept compensation (WTA), with the former being more commonly used. WTP measures the amount of money a person is willing to pay to obtain the ecosystem good. Hence, it is a measure of the economic benefits from the good. WTA is the amount of money a person is willing to accept to give up ecosystem goods, i.e. it measures the economic losses of forgoing the good.

Values are typically categorized into use values and non-use (or passive use) values. Use values refer to the direct and indirect benefits from the actual use of the ecosystem service, whereas non-use values are not related to the use of the service. For example, people may value the existence of a healthy marine ecosystem although they do not visit the sea.

3.2 Valuation methods

Preference-based valuation methods are currently most commonly used to assess the economic value of ecosystem services (Kettunen et al. 2012). These include stated preference and revealed preference methods, and also direct market valuation. Stated preference methods (SP) are based on carefully constructed surveys that ask people's willingness to pay for a well-defined change in the provision of ecosystem services. Revealed preference methods (RP) are based on observing people's behavior in markets. They rely on the assumption that people's expenditure on travelling or housing reflects also environmental values. In addition to stated and revealed preference methods, some techniques have been developed to make use of existing studies. These include benefit transfer and meta-analysis. Benefit transfer involves transferring values estimated in one site to another unstudied site. Meta-analysis is used to summarize the existing data on the value of a specific ecosystem good.

Besides monetary value estimates, preference-based valuation studies typically collect information on public knowledge, attitudes and opinions on ecosystem services and the environment. This information can be used to complement the benefit estimates in ecosystem service assessments.

In addition to the above-mentioned methods, economic values are sometimes based directly on market prices or costs. These approaches capture only part of the total value of the good. However, they are typically simpler and less resource intensive to use.

In addition to preference-based monetary valuation, it is possible to assess the importance of ecosystems goods and services using qualitative and quantitative approaches, i.e. without producing monetary estimates. These can be used when monetary valuation of ecosystem goods is difficult or even not possible. This is typically the case at least for some cultural ecosystem services, such as inspi-
ration and spiritual values. Qualitative and quantitative descriptions can be used to complement monetary valuations and vice versa.

Methods to value ecosystems services are listed in Table 1 with examples of applications in the Baltic Sea area, and more detailed information of each method can be found in Annex 1.

**Table 1. Methods to value ecosystem services**

<table>
<thead>
<tr>
<th>Method</th>
<th>Data source</th>
<th>Applicability and examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stated preference methods</strong></td>
<td>surveys</td>
<td>recreation, aesthetic benefits, non-use/existence values, e.g. recreation and existence benefits from reduced eutrophication¹</td>
</tr>
<tr>
<td>Contingent valuation, choice experiment</td>
<td>surveys, choice experiment</td>
<td>recreation, aesthetic benefits, e.g. recreation and existence benefits from reduced eutrophication¹</td>
</tr>
<tr>
<td>Revealed preference methods</td>
<td>surveys, statistics</td>
<td>recreation, aesthetic benefits, e.g. recreation benefits from increased fish catch², benefits of residential properties from improved water quality³</td>
</tr>
<tr>
<td>Travel cost method, hedonic pricing</td>
<td>existing valuation studies</td>
<td>based on primary studies, recreation, aesthetic benefits, non-use/existence values, e.g. the benefits from reduced eutrophication⁴</td>
</tr>
<tr>
<td>Methods using existing studies</td>
<td>existing valuation studies</td>
<td>data on replacement or avoidance costs available, e.g. value of coastal zones as nutrient filters⁵</td>
</tr>
<tr>
<td>Cost-based methods</td>
<td>cost data</td>
<td>goods traded in markets, e.g. the value of fish landings⁶</td>
</tr>
<tr>
<td>Market prices</td>
<td>market data</td>
<td></td>
</tr>
<tr>
<td>Non-monetary methods</td>
<td>statistics, focus groups, interviews, workshops</td>
<td>when obtaining monetary estimates not appropriate/possible, e.g. describing the recreational use of marine areas⁷, shared values for reducing eutrophication⁸</td>
</tr>
</tbody>
</table>

¹ Ahtiainen et al. (2013b); ² Håkansson (2008); ³ Artell (2013); ⁴ Turner et al. (1999); ⁵ Gren (2013); ⁶ Kulmala et al. (2012); ⁷ Ahtiainen et al. (2013a); ⁸ BalticSTERN (2013).

The choice of valuation approach depends on the context and the ecosystem benefits in question and the level of ambition of the examination. Ecosystem service assessments can begin with qualitative and quantitative descriptions followed by monetary valuation in later phases. Monetary valuation makes sense especially for major issues or large-scale projects, when large benefits or costs are at stake.
Some considerations also apply to choosing the monetary valuation method. Market prices are only applicable when such data are available, and even then prices need to be adjusted for distortions such as taxes and subsidies (UK NEA 2011). It is also possible that the market price does not capture wholly the social costs and benefits, giving an underestimation of the value of the good. Cost-based methods rely on the availability of cost data, and they typically tend to either overestimate (replacement cost) or underestimate (avoidance costs) the value of ecosystem services (Turner et al 2010). Stated preference methods are widely applicable to different kinds of ecosystem services, and are the only methods that are able to capture non-use values. However, they have been criticized on the grounds of relying on survey responses and not on actual behavior. Revealed preference methods can be used for estimating recreation and aesthetic values, based on statistics or survey data. When time and resource constraints preclude conducting new studies, e.g. collecting survey data, methods using existing valuation studies (benefit transfer and meta-analysis) can be considered. More information on the suitability of valuation methods to different ecosystem services can be found in Table 3 in Brouwer et al. (2013).

**Questions to consider/discuss, e.g.:**

1. How to make the value of ecosystem services visible and easy to understand?
2. What kind of ecosystem valuation is most useful to decision-makers?
3. How can the credibility of values be improved?
4. How can human welfare targets be used in ecosystem services valuation?
5. How to avoid double-counting in ecosystem services valuation?
6. When to apply qualitative, quantitative and monetary valuation?
7. What is needed to apply valuation methods for ecosystem services of the Baltic Sea?
8. What are the limitations and caveats in ecosystem services valuation?

**4. Ecosystem services as a global priority**

A major initiative taken by the United Nations (UN) to highlight the important role ecosystems play for the well-being of humanity was the Millennium Ecosystem Assessment (MA 2005). It compiled information on what the consequences may be when ecosystems change and provide recommendations for the future on how to deal with these changes. It was concluded that over the past 50 years, ecosystems have changed more than ever before. These changes correlate with the economic development of the world, but they come with a cost most notable in environmental degradation and biodiversity loss and with that the impoverishment of ecosystem services. The MA noted that ecosystem services will most likely continue to degrade, making it difficult to achieve the Millennium Development Goals, which would also concern the Sustainable Development Goals of the future (Griggs et al 2013, Rockström et al 2013, Schultz et al 2013).
The Economics of Ecosystems and Biodiversity (TEEB) initiative takes a global perspective on the valuation of ecosystem services by studying the economics of biodiversity loss. The aim is to incorporate the value of ecosystems services into decision-making. TEEB is organized in three phases, of which the third one is ongoing. The findings of the first phase were summarized in an interim report in 2008, highlighting the continuing decline in biodiversity and related losses of ecosystem services, discussing the economic valuation of biodiversity and ecosystem services, and describing how policies could be improved to better conserve biodiversity (TEEB 2008). The second phase of TEEB produced several reports directed to policy-makers (e.g. TEEB 2009), and the ongoing third phase focuses on communication, maintaining the TEEB network and supporting national TEEB studies (TEEB 2013). Several countries in Europe, such as Germany, the Netherlands and Poland have initiated national TEEB studies, and Nordic countries (Finland, Sweden, Norway, Denmark and Iceland) have published a synthesis on the socio-economic role and significance of biodiversity and ecosystem services (TEEB Nordic, Kettunen et al. 2012). TEEB Nordic lists ecosystem services in the Nordic countries, including marine areas. The report provides information on the status and socio-economic value of marine fisheries. According to TEEB Nordic, there are considerable knowledge gaps related to marine ecosystem services, with the exception of fisheries. Another initiative related to the marine environment is TEEB for Oceans and Coasts, which draws attention to the economic benefits of ocean and coastal ecosystems and aims to provide examples and guidance on incorporating ecosystem values into policy decisions (TEEB for Oceans and Coasts 2013).

United Nations Environment Programme (UNEP) has developed several global background studies and reports for economic valuation of ecosystem services, including Guidance Manual for the Valuation of Regulating Services (2010). Importantly, UNEP’s activities inter alia covered coastal and marine ecosystems (e.g. wetlands in Sri-Lanka, reefs in St. Lucia, Tobago, Belize, Jamaica, and the Dominican Republic). Ecosystem valuation is a priority for UNEP. With their Ecosystem Services Economics (ESE) program they aim at building stakeholder capacity to make scientifically based information to integrate an ecosystem-service based approach into national administration. According to UNEP there is a need to develop the understanding of how ecosystem services influence and relate to the well-being of humanity. They have three focus areas including (1) Economic Valuation and Natural Wealth, (2) Equity in Ecosystem Management and (3) Disaster Risk Management. The ESE program also relates to Millennium Ecosystem Assessment (MA 2005). There is great interest to apply the concept of ecosystem services into UNEPs Regional Seas Programme. This programme that was launched in 1974 aims at improving the environmental status of the worlds seas and coastal areas by facilitating collaboration among neighboring coastal countries.
5. Baltic Sea environment and human impact

The marine environment is under pressure by anthropogenic inputs of nitrogen, phosphorus, organic matter and hazardous substances originating from land-based sources and activities at sea. Commercial fishing is also a strong and widespread pressure affecting the marine ecosystem. The sea bed is further under pressure by constructions, dredging and disposal of dredged materials which can have large impacts locally. And releases of oil not only cause pollution effects but also directly threaten biodiversity such as marine birds and mammals.

The Baltic marine environment represents unique brackish water ecosystem which is highly fragile and sensitive to anthropogenic impacts. More specific background information about it is presented in Annex 2.

According to a HELCOM assessment of ecosystem health of the Baltic Sea marine environment, the entire sea area is generally impaired (HELCOM 2010). None of the open basins of the Baltic Sea has an acceptable environmental status and only very few coastal areas along the Gulf of Bothnia can be considered healthy.

Eutrophication, caused by nutrient pollution, is a major concern in most areas of the Baltic Sea. According to a recent HELCOM assessment (HELCOM 2013a), almost the entire open Baltic Sea was assessed as being eutrophied and only the open sea parts of the Bothnian Bay was assessed as being unaffected by eutrophication. Coastal areas in Orther Bucht (Germany) and the outer coastal Quark (Finland) were the only coastal areas assessed by national authorities as being in good ecological status in terms of eutrophication.

Inputs of nutrients to the Baltic Sea have decreased since the late 1980s. Especially inputs from direct point source such as municipalities, industries and fish farms have decreased markedly from 1994 to 2010; by 43% for nitrogen and 63% for phosphorus. For the whole Baltic Sea, flow-normalized inputs of total nitrogen and phosphorus to the Baltic Sea have decreased by 16% and 18%, respectively, from 1994 to 2010 (HELCOM in prep). Currently, the level of nutrient inputs equals the levels of loads in the early 1960s (Gustafsson et al. 2012).

Although some improvements can be noted in some areas as a result of reductions in nutrient inputs, the concentrations of nutrients at sea have not declined accordingly. The long residence time of water in the open Baltic Sea as well as feedback mechanisms such as internal loading of phosphorus from sediments and the prevalence of blooms of nitrogen-fixing cyanobacteria in the main sub-basins of the Baltic Sea are processes that slow down the recovery from a eutrophied state (HELCOM 2013b).

Questions to consider/discuss, e.g.

1. How can international experiences and approaches be utilized in the Baltic Sea Region?
2. What are the similarities/differences in the approaches applied for ecosystem services valuation globally/Europe-wide and the Baltic Sea?
Living organisms and bottom sediments are affected by hazardous substances in all parts of the Baltic Sea (HELCOM 2010). Despite targeted abatement strategies, measures, and also significant reductions of inputs of hazardous substances, only very few coastal sites presently seem undisturbed by hazardous substances. However, several management actions have proved to be successful, for example, reducing atmospheric inputs of mercury, lead, and cadmium, and reducing the inputs of certain persistent organic pollutants, such as DDT, PCBs and TBT, by banning their use in the Baltic Sea region. Concentrations of radioactive substances originating from the Chernobyl fallout are still high in the northern, eastern, and central parts of the Baltic Sea, but the concentrations of the radionuclide cesium-137 are decreasing in all areas of the Baltic Sea.

The status of biodiversity appears to be unsatisfactory in most parts of the Baltic Sea. Alarming shifts and unbalances appear in many habitats and at all levels of the food chain, particularly at the level of large fish (HELCOM 2010). Promising signs of successful remediation include an improvement in the status of top predators such as grey seals and white-tailed eagles in recent decades.

The number of Baltic Sea Protected Areas (BSPAs) has also increased and currently 163 sites have been established as BSPAs. In the past ten years good progress has been made in enlarging the network of protected areas: between 2004 and 2013 the protected marine area has increased from 3.9 to 11.7% (HELCOM 2013c).

In addition to anthropogenic pressures such as over-fishing and eutrophication, climate-related changes in precipitation, run-off patterns and biogeochemical cycles of the Baltic Sea may erode the resilience of the ecosystem. At present, it is not clear how climate change will influence eutrophication conditions and productivity in the Baltic Sea (HELCOM 2013d).

### Questions to consider/discuss, e.g.
1. What are the most important pressures affecting ecosystem services in the Baltic Sea?
2. Is there enough information on the effect of human activities on ecosystem services?
3. Is there enough information on the effect of ecosystem services on human activities?

### 6. Ecosystem services provided by the Baltic Sea

Figure 3 lists some examples of intermediate and final ecosystems services provided by the Baltic Sea environment and the resulting goods or benefits. It is useful to note that some of the ecosystem services can be intermediate or final depending on the context.
6.1 Provisioning Ecosystem Services

Fish is a major provisioning ecosystem service of the Baltic Sea used for consumption (Garpe 2008). It provides people not only with food but also with employment opportunities. Fish is also used as fish meal for fodder for farmed fish, pigs and poultry. The main species caught on a commercial basis are cod, sprat, herring and salmon. Although it is an important resource that raise a lot of political attention it is in comparison to other industries a fairly small activity. As an example, in Sweden there were around 1600 professional fishermen in 2012, and the catch was approximately 160,000 tons with the value of 110 million euros (Kettunen et al. 2012, p. 142). If the fishery is related to other values the net benefits from the fishery has been questioned as shown with an example from the cod fishery (Waldo et al 2010).

As mentioned above, another provisioning ecosystem service used for human consumption as well as for resource enhancement is aquaculture. Fish farming is carried out in the Baltic Sea and has the potential to increase (Aquabest 2012). A common species used is rainbow trout.

Genes and genetic resources are important aspects of ecosystem services (Bailey 2011). The Baltic Sea is estimated to host more than six thousand species (Ojaveer et al. 2010). Loss of biodiversity and genetic resources is a problem also in the Baltic Sea. For example, a majority of the original wild Baltic salmon populations have become extinct, and much of the original genetic variation in Baltic salmon has already been lost due to extinction of individual populations and reduction in population sizes (Palmé et al. 2012).

Further provisioning ecosystem services of the Baltic Sea are energy as well as space and waterways. Here especially space for various anthropogenic activities on and in the Baltic Sea has become more important over the last years. For example, the Baltic Sea is becoming increasingly interesting for off shore wind power (Lumbreras and Ramos 2013); notably this may support other ecosystem services such as providing habitat for fish and mussels (Andersson and Öhman 2010). A strong competition about marine space in parts of the Baltic (Janßen et al. 2013) is one of the drivers for the implementation of Marine Spatial Planning.
6.2 Cultural Ecosystem Services

The Baltic Sea is an important recreation area for the people living in the surrounding countries. According to a survey conducted in the coastal states in 2010, over 80% of people have spent leisure time at the sea in all countries except Russia (Swedish EPA 2010). In Denmark, Estonia, Finland, Latvia and Sweden, the majority of people have visited the Baltic Sea during the last 12 months. The most common activities at the Baltic Sea in all countries are swimming and spending time at the beach. Sport fishing is also common in Baltic Sea countries. In Sweden, the number of recreational fishermen is estimated to be one million (Swedish EPA 2009).

In terms of revenue, tourism is of vast importance in the Baltic Sea region. The tourism industry is estimated to have an annual turnover of 90 billion euros, and it provides employment for some 2 million people (Swedish EPA 2009). In Germany, there were more than 33 million overnight stays along the Baltic coast in 2009, with the majority having the beach as the main reason for choosing the destination (Haller et al. 2011).

The value of the Baltic Sea for education and research is difficult to estimate, but given the large number of educational institutions in the region, it clearly plays an important role. Given that there are almost 5000 scientific publications listed in the “ISI Web of Science” database, with the word “Baltic Sea” in the title, it is very important for research.

6.3 Supporting Ecosystem Services

The various ecosystem services in themselves depend on supporting ecosystem services. As they are not used by humans in a direct manner they are usually not given sufficient attention. The living nature depends on the flow of materials including nitrogen, phosphorus, carbon, water and oxygen. The cycling of these materials is necessary for marine life. If they are disturbed it may come with a cost such as eutrophication (enhanced levels of N and P), climate change (raised levels of carbon dioxide), changes in salinity (freshwater inflow) and anoxic conditions in the deeps of the sea (oxygen depletion due to decomposition of high levels of organic matter).

Primary production, i.e. the production of plant material through photosynthesis, is a basic ecosystem function in the Baltic Sea. It is the basis for the food chain. Primary production also regulates oxygen levels in the sea and in the atmosphere.

Habitat is a supporting ecosystem service. It is defined as the place where living organisms occur and the Baltic Sea provides a great variety of habitats. Important habitats are for example the beds of mussels, areas of macro-algae such as Fucus, and sea-grass beds.

Another supporting ecosystem service of profound importance is biodiversity maintenance. Higher levels of biodiversity usually support a larger variety of ecosystem services. It not only opens up a larger choice of interactions within an ecosystem it may also have a buffering function protecting against disturbance.
6.4 Regulating Ecosystem Services

The Baltic Sea is also a provider of a range of regulating ecosystem services. One is the sink function for carbon dioxide (CO\textsubscript{2}). Indeed, the oceans of the world store approximately half of the carbon dioxide humans have produced (Sabine et al. 2004). However, it should be noted that CO\textsubscript{2} sequestration also increases ocean acidity which can have a negative impact on marine life (Hoegh-Goldberg et al. 2007). Another ecosystem service of significance is sediment retention. This is clearly illustrated in the presence of beaches (well-known cultural ecosystem service used by many people (Klein et al 2004)). However, beach erosion is a problem (European Commission 2004). As stated above eutrophication, is one of the most critical threats to the Baltic Sea. In that context an ecosystem service of vast importance is the mitigation of eutrophication. Organism and sediment may store nutrients. For example, sea grass beds have multiple functions: they provide important nursery habitats for commercial species, may serve as a sediment trap stabilizing coastal erosion and are important in sequestration of carbon (Duarte et al. 2005). The effects of hazardous substance may also be buffered.

6.5 Economic valuation studies of ecosystem services in the Baltic Sea

At present, there are a few dozen studies that have been conducted on the benefits of ecosystems services and improvement of the environment in the Baltic Sea. These studies have mainly focused on recreation, aesthetic values, existence values and food (fisheries). Söderqvist and Hasselström (2008) present a comprehensive review of the available literature on the economic value of ecosystem services provided by the Baltic Sea. In addition, they discuss the knowledge gaps related to different ecosystem services and environmental problems and made suggestions for future research.

The review included some 40 studies on the value of the Baltic Sea environment (see Annex 3). Most of the studies were local or regional, with only few international studies. Of environmental issues, eutrophication and fisheries were studied the most. Detailed information of each study can be found in Söderqvist & Hasselström (2008). Based on existing knowledge, the review assessed ecosystem services coverage in the Baltic Sea area and the need for future studies (see Table 5 in Söderqvist and Hasselström 2008). Previous research had focused on habitats, diversity, food, recreation and aesthetic value, and these were seen as most important for future studies as well. In addition, the report suggested studying the benefits of decreased nutrient loads to the Baltic Sea, assessing the gains of a cod-stock recovery program, valuing recreational fishing and valuing the risk of oil spills.

Since the review in 2008, further research on the value of the marine environment has been conducted in the Baltic Sea area, in part addressing the gaps identified in the report by Söderqvist & Hasselström (2008). Focus has mainly been on eutrophication (Kosenius 2010, Ahtiainen et al. 2013b) and oil spills (Tegeback & Hasselström 2012, Depellegrin & Blažauskas 2013). In the ecosystem services framework, Kulmala et al. (2012) have studied the economic value of provisioning and recreational services of Baltic salmon, and Kosenius & Ollikainen (2012) the benefits from habitats and species, recreation, and food
and raw materials. The importance of cultural ecosystem services, mainly recreation, has been studied by Ahtiainen et al. (2013a) and Lewis et al. (2013). Some of these studies have been conducted in all Baltic Sea coastal countries (Ahtiainen et al. 2013a, 2013b), providing comparable information for the whole region. More information on these studies can be found in Annex 3.

The benefit estimates from Ahtiainen et al. (2013) have been utilized further in a cost-benefit analysis studying the economic efficiency of reducing eutrophication in the Baltic Sea according to the HELCOM Baltic Sea Action Plan (2007) targets (BalticSTERN 2013, Hyytiäinen et al. 2013). The findings indicated that the benefits of reducing eutrophication exceed the costs by 1-1.5 billion euros annually. The study is an example of how the value of ecosystem services can be compared to the costs of taking actions to improve the environment and how valuation can support marine decision-making.

**Questions to consider/discuss, e.g.**

1. On which ecosystem services of the Baltic Sea should future research focus on?
2. Are there ecosystem services that have not been addressed yet?
3. Which are the most important topics where ecosystem services valuation could be applied in the Baltic Sea Region?
4. How the work towards good environmental status in the Baltic Sea would benefit from better knowledge in ecosystem services valuation?

**7. Baltic Sea governance and ecosystem services**

The following issues have been identified as being relevant for further discussion in relation to the use of ecosystem services valuation in the Baltic Sea context:

- Application of ecosystem valuation in Marine Spatial Planning.
- Internalization of environmental costs and examples how it could be applied in solving regional environmental problems in the Baltic Sea Area.
- Valuation of ecosystem services in the context of reaching Good Environmental Status in the MSFD.
- Identifying important and crucial knowledge gaps to enable to sufficient economic valuation of marine and coastal ecosystem services in the Baltic and other regional seas.
- Economic valuation of marine and coastal ecosystem services in the implementation of the HELCOM BSAP, in particular in the policy making processes.
- Ecosystem services measurements and indicators and systems for ecosystem accounting.
- Global, regional and national experiences from UNEP and TEEB that can be applied in the Baltic Sea.
These issues are addressed partly through the existing governance structures/frameworks, as described below.

The Baltic Sea and its ecosystem services are administrated by national governments, governmental agencies, the European Union and a range of international agreements. The Convention on the Protection of the Marine Environment of the Baltic Sea Area is governed by the Helsinki Commission (HELCOM). The contracting parties are all Baltic Sea littoral countries and the EU. The organization was originally founded to protect the Baltic Sea environment from pollution by facilitating intergovernmental collaboration. Its agenda have broadened since then and HELCOM is now a policy maker and focal point for the Baltic Sea covering various issues relating to the marine environment and its natural resources. For decision makers and others it provides information on various issues relating to the marine environment. HELCOM develops recommendations and supervises all parties to secure implementation of environmental standards agreed. The organization also coordinates multilateral response in case of maritime incidents of international proportions. An important contribution is the Baltic Sea Action Plan (BSAP) (HELCOM 2007). It has a strong ecosystem approach in managing the Baltic Sea environment promoting various ecological objectives that are guided by indicators and targets (Backer et al 2010). With its ecosystem approach, the BSAP directly links to issues related to ecosystem services. The BSAP focuses on four priority areas: eutrophication, hazardous substances, maritime activities and biodiversity. Valuation of ecosystem services could involve assessing the changes in the provision of ecosystem services and the associated benefits of reaching the BSAP targets to demonstrate the welfare effects of the Action Plan. It should also be noted that the BSAP has a close linkage to the EU Marine Strategy Framework Directive (MSFD, 2008/56/EC).

Another organization of importance in this context is the Council for Baltic Sea States (CBSS). Following the geopolitical changes in the Baltic Sea regions after the cold war the CBSS was established in 1992. It is an organization that facilitates regional intergovernmental cooperation. There are 12 members including the Baltic Sea states and the European Commission. It has different expert groups with some relating to marine issues such as the expert group on maritime policy and Baltic 21 considering sustainable development.

Nordic Council of Ministers (NCM) also plays an important role in the management of the Baltic Sea. Obviously the committee of senior officials for fisheries and aquaculture shows an interest in a major provisioning ecosystem service. NCM also have a program to fund NGOs in the area which is instrumental in the cooperation with Baltic States and with North western Russia.

There are also various EU directives and policies that influence Baltic Sea management, the most important being the Marine Strategy Framework Directive (MSFD), adopted in 2008 (European Parliament 2008, EC 2012). The aim of the MSFD is reaching a Good Environmental Status (GES), which is interpreted in terms of ecosystem functioning and services provision. The MSFD lists several descriptors that should be considered when establishing the environmental targets for the GES, including biological diversity, alien species, fisheries, food webs, eutrophication, contaminants and litter (European Parliament 2008). The MSFD requires an ecosystem-based approach to the
management of marine waters (Art. 1.3), although it does not specify how the analyses should be undertaken in practice (WG ESA 2010). Therefore, also other approaches are possible e.g. in the Initial Assessment. For example, the ecosystem approach in the analysis of marine uses entails identifying ecosystem services of marine areas, identifying and possibly valuing the welfare derived from these services and also identifying the drivers and pressures affecting ecosystem services (WG ESA 2010). In the analysis of cost of degradation, the ecosystem approach involves identifying the ecosystem services and associated benefits of achieving GES, where the benefits can be interpreted as the losses if GES is not reached (WG ESA 2010). The estimated benefits can later be compared to the costs of reaching GES in the Programme of Measures to be developed by the end of 2015.

The Common Fishery Policy (CFP) is a clear example of how the EU regulates one of the most important ecosystem services: fish. As all countries surrounding the Baltic Sea, except Russia, are part of the European Union fishery management is mainly regulated through the Common Fishery Policy. Decisions on how fishery resources are allocated are taken by the EU Council of Ministers every year. Before the decision is taken the scientific community through ICES, and the fishery industry and NGOs through the Baltic Sea Regional Advisory Council (BSRAC), give their recommendations (Stohr and Chabay 2010). The CFP is decisive as it in a direct manner influence national law. What is agreed within the CFP has to be followed by all member states. There is a range of methods to regulate fish. A common procedure in the Baltic Sea is to regulate fishing through quotas (in EU total allowable catch) i.e. each country is given a certain amount of fish to harvest. However, fishing is regulated through other means as well such as effort (e.g. number of days fishing), closed areas (e.g. the Bornholm Basin that is closed during summer), monitoring and surveillance, fishing techniques used, mesh size, engine size etc. (see e.g. Madsen 2007).

There are also other EU initiatives that influence Baltic Sea management. The most overarching initiative is the EU Strategy for the Baltic Sea Region (EUSBSR). It is the first strategy within EU in which a macro-region with several countries is defined with the specific objective to enhance collaboration within that certain region (Metzger and Schmitt 2012). With the strategy initiatives from different sectors are brought together and cooperation is promoted. Sectors that relates to ecosystem services include both increased prosperity and improved environmental management.
Questions to consider/discuss, e.g.

1. How do the various management organizations and initiatives consider ecosystem services in their strategies?
2. Which aspects of the various management frameworks would benefit from information on ecosystem services?
3. Which kind of information is most useful in these frameworks?
4. How can economic valuation of marine and coastal ecosystem services support the further implementation of the current policy targets, such as those set by HELCOM Baltic Sea Action Plan and the EU Marine Strategy Framework Directive?
5. How could ecosystem services valuation be utilized for implementing the programs of measures in the EU MSFD?
6. How to develop ecosystem services measurements and indicators and systems for ecosystem accounting?

8. Future perspectives

We are far from understanding the value of ecosystem services in the Baltic Sea. However, several studies have addressed the perceived value of environmental improvements in marine and coastal areas, so there is some knowledge on the potential value of ecosystem services in the Baltic Sea, especially related to recreation, fisheries and non-use or existence values of the marine environment. To date, most studies have not utilized the ecosystem services framework, and therefore it is not necessarily straightforward to link these studies to specific ecosystem services. Despite this, the existing results are useful in ecosystem service assessments, if the results are viewed from the perspective ecosystem services.

For the purposes of valuation, further work is needed on identifying and describing Baltic Sea ecosystem services and their interactions, evaluating how policy changes affect these ecosystem services and assessing the effect of changes in ecosystem services to human welfare. This is required in order to conduct high-quality cost-benefit analysis of programmes of measures for the EU Marine Strategy Framework Directive. It is important to relate the economic values to specific ecological indicators and descriptors that can be measured. Linking values to ecological indicators makes it possible to estimate marginal benefits, e.g. in the context of eutrophication, benefits per reduced kilogram of nitrogen or phosphorus.

Valuation of ecosystem services can support the achievement of current policy targets in the Baltic Sea area, such as those set by the Marine Strategy Framework Directive, the Water Framework Directive and the HELCOM Baltic Sea Action Plan. Usefulness for policy support requires that the value estimates can be connected to the policy objectives, i.e. valuation studies are designed in accordance with current targets. In addition, close cooperation between researchers and policy-makers can increase the relevance of value estimates to marine policies.
International cooperation is important also in the valuation of marine ecosystem services, as the Baltic Sea is shared by nine countries, and many of the environmental issues in the sea are transboundary. Most of the current knowledge originates from studies that are restricted to a certain area of the Baltic Sea and focus on a specific ecosystem service. More attention should be drawn to international studies, especially as international cooperation is required by the EU Marine Strategy Framework Directive. Cooperation could be in the form of exchanging ideas and experiences and implementing joint studies. As in other geographical areas, the ecosystem services provision and the benefits to humans in the Baltic Sea are spatially heterogeneous. There is, however, little knowledge of the spatial variation in ecosystem services and benefits in the area.

An important question is to identify which ecosystem services should be the priority for future research. In the review by Söderqvist and Hasselström (2008), research scientists considered habitats, biodiversity, food, recreation and aesthetic values most important, and suggested studying eutrophication, cod-stocks, recreational fishing and oil spills. Policy-relevance of the values for ecosystem services should be one of the crucial factors in choosing the focus of future research, and descriptors and issues brought forward in HELCOM BSAP and EU MSFD should receive the most emphasis. Also, priority should be given to the largest environmental threats of the Baltic Sea.

Main challenges in assessing the ecosystem services in the Baltic Sea area and integrating them into policy and decision-making include:

- Accurately describing ecosystem services and how they are linked with the ecosystem structures.
- Trade-offs and interactions of ecosystem services.
- Finding relevant indicators for the assessment of ecosystem services and ecosystem improvement.
- Evaluating how measures to improve the marine environment impact the provision and trade-offs of ecosystem services and further their value.
- Assessing the effects of changes in ecosystem services to human well-being, taking into account possible future developments.
- Taking ecological thresholds and non-linearities into account in valuation.
- Providing internationally comparable information on the value of ecosystem services.
- Incorporating uncertainty about ecosystem services into value estimates.
- Translating ecosystem services information so it becomes relevant to policy and decision-making.
Questions to consider/discuss, e.g.

1. What are the most crucial challenges in the ecosystem services valuation in the Baltic Sea Region?
2. What are the knowledge gaps in the valuation of marine and coastal ecosystem services in the Baltic and other regional seas?
3. How could thresholds be taken into account in valuation?
4. How can ecosystem services be addressed and studied in a useful way for the future governance of the Baltic Sea?
5. What kind of value estimates are needed for policy support?
6. What kind of policies would benefit from ecosystem services information?
7. Which policies could be further developed and how, to recognize and capture ecosystem services?
References


Andersson MH, Lagenfelt I, Sigray P 2012. Do ocean-based wind farms alter the migration pattern in the endangered European Silver Eel (*Anguilla anguilla*) due to noise disturbance? *Effects of Noise on Aquatic Life* 393-396.


Madsen N 2007. Selectivity of fishing gears used in the Baltic Sea cod fishery. Reviews in Fish Biology and Fisheries 17: 517-544


Söderqvist T, Hasselström L 2008. The economic value of ecosystem services provided by the Baltic Sea and Skagerrak. The Swedish Environmental Protection Agency Report 5874


Voigt HR 2007. Heavy metal (Hg, Cd, Zn) concentrations and condition of eelpout (Zoarces viviparus L.), around Baltic Sea. Polish Journal of Environmental Studies 16: 909-917


Ö see under “O” above
Annex 1. Background on valuation methods

The following present the basics of the most widely used economic valuation methods. Good reviews can be found e.g. in Turner et al. (2010) and Champ et al. (2003).

Stated preference methods

In stated preference methods, people are asked to express their willingness to pay for a change in the state of the environment. This is done using surveys that can be implemented via mail, interviews or the internet. The advantage of these methods is that they are able to capture also values that are not related to the use of the good (so called non-use or passive use values). However, there is controversy on the reliability of the benefit estimates as they are not based on actual behavior. These methods are also resource-intensive.

Most common stated preference methods are contingent valuation (CV) and choice experiment (CE). Contingent valuation can be used measure the benefits of a change in the provision of ecosystem services (see e.g. Hanemann & Carson 2007). It entails describing the current status and the after-change status of the ecosystem. Contingent valuation is widely used, and it is applicable to many ecosystem goods.

Choice experiment, in turn, asks respondents to make choices between goods that are described in terms of their attributes (see e.g. Hensher et al. 2005). Choice experiment provides more information than contingent valuation, as it captures the value of the good as well as its attributes. However, designing the survey and analyzing the data can be more complicated.

Revealed preference methods

Revealed preference methods are well-established, and their greatest advantage is that they are based on observing people's actual behavior in the markets. However, these methods can only be used to estimate use values, and they are less flexible as they have to be based on actual environmental conditions and behavior.

Most widely used revealed preference methods are the travel cost method (TC) and hedonic pricing (HP) (see e.g. Bockstael & McConnell 2007). The travel cost method is used to estimate the value of recreation based on the costs incurred from traveling to recreation sites. The travel costs are considered to represent the recreational value of visiting a particular site. The limitation of the travel cost method is that it is resource-intensive and only applicable to specific sites.

Hedonic pricing is typically applied to housing markets. It can be used to analyze how e.g. air quality, noise, landscape or water quality affect property prices and thus estimate the price people are willing to pay for these environmental characteristics. The method is only applicable to those environmental attributes that affect housing prices and it may be difficult to obtain the appropriate data.
**Methods based on existing studies**

Benefit transfer (BT) uses an existing valuation study or studies to estimate the value of ecosystem goods in a previously unstudied site (see e.g. Navrud & Ready 2007). The prerequisite is that the sites and the ecosystems goods are similar enough. Recently, the use of benefit transfer has increased due to increasing demand for benefit estimates and limited possibilities to conduct resource-intensive primary studies. Benefit transfer is quick and inexpensive to implement, but empirical studies have found substantial transfer errors in the benefit estimates.

Meta-analysis (MA) takes stock of and summarizes existing studies on a specific ecosystem good, for example, air quality or forest recreation (see e.g. Nelson & Kennedy 2009). Dozens or even hundreds primary valuation studies are analyzed to find which factors affect observed value estimates. Meta-analysis can also be used for benefit transfer. The limitations include the availability of primary studies and the complexities in the statistical modeling.

**Methods based on costs and prices**

Values are sometimes inferred based on costs or market prices. These methods are typically less resource-intensive to use and data is sometimes more readily available.

Cost-based methods include damage costs avoided and replacements cost methods. They estimate values based on the cost of avoiding damages due to lost ecosystem services, or the cost of replacing services or providing substitute services. These costs are considered to provide useful estimates of the value of ecosystem goods, as the value of the services must be at least the incurred costs. However, they are not considered to produce strict measures of economic values as they are not based on willingness to pay.

Some ecosystem values can be based on data on market prices. These include values for e.g. fish, shellfish and timber. Goods with market prices are relatively simple to value, but the prices may represent only a partial value of the good or the prices may be distorted by subsidies or taxes.

**Non-monetary methods**

Non-monetary valuation can be used when monetary valuation is not considered appropriate or possible. This entails different kinds of qualitative and quantitative approaches, including the examination of statistics or using techniques such as focus groups, citizen’s juries, participatory modeling and multi-criteria analysis. The aim can be on identifying relevant ecosystem services and possible values attached to them, the prioritization of ecosystem services, or assessing the importance of ecosystem benefits by examining their magnitude. It is also possible to study the existence of shared values, focusing on what individuals or groups think the society should pay for ecosystem services.
Annex 2. Background information on Baltic environment and human impacts

The Baltic Sea is a unique sea with little comparison to any other sea in the world. Its uniqueness is mainly the result of a salt concentration that is neither marine nor freshwater; it is an intermediate between the both and hence defined as a brackish sea. However, the salinity follows a gradient with almost freshwater in the northernmost part of the sea close to the Torne river, at the border between Sweden and Finland. In the south-western area, in the coastal waters of Denmark, it is approaching marine conditions. The average salt concentration is approximately 7 per mille which is one-fifth of what is typical for oceans. The lower salinity is the result of 200 rivers flowing into the Baltic Sea in combination with a low salt water intrusion from the Atlantic (ICES 2003). The Baltic Sea is divided into seven sub-areas. The Belt Sea is situated in the south-western area, the Baltic Proper is the largest area found in the south, Gulf of Riga to the east is encased by Estonia and Latvia and the Gulf of Finland to the east is surrounded by Estonia, Russia and Finland. The Archipelago Sea, Bothnian Sea and Bothnian Bay stretch out between Sweden and Finland.

As a result of the intermediate salt concentrations the Baltic Sea sustain both marine and freshwater species. As the Baltic Sea in geological terms is a young sea, the time span for more profound evolutionary adaptations is to short. Hence the organisms in the sea proliferate under a certain level of physiological stress that may affect growth and reproduction (Zettler et al 2007). This is also one of the main reasons the Baltic Sea is seen as a vulnerable ecosystem in which human stressors can cause large scale changes. Another reason for making it sensible to stress is that it is a fairly shallow sea with an average depth of 55 m. Given the large catchment area compared to the sea surface there is a limited volume of water that receives an inflow of water from a huge area influenced by human activities.

The catchment area of the Baltic Sea covers 1.7 million km2 (compared to for example the area of Denmark which is approximately 43 000 km2). There are almost 90 million people living in this area with around 50 million having a distance of 150 km or less to the sea. The Baltic Sea coast line stretches along nine countries including Russia, Estonia, Latvia, Lithuania, Poland, Germany, Denmark, Sweden and Finland with eight of them being part of the European Union. In addition to the nine littoral countries Ukraine, Belarus, Czech Republic, Slovakia and Norway are also part of the catchment area. The geography of the land area of the Baltic Sea region varies greatly. The northern part is sparsely populated dominated by coniferous forests. In the south human presence is much more pronounced with a dominance of farmland and urban developments. Hence, the largest inputs in terms of nutrients are found in the south.

Eutrophication is a major problem in the Baltic Sea (HELCOM 2009). It is caused by increased levels of nutrients and affects a broad range of ecosystem services. With large nutrient inputs enhanced growth of algae and cyanobacteria may follow. Before the Second World War, the Baltic Sea water was nutrient poor and much clearer. After the war the nutrient inputs to the Baltic Sea increased due to the increase of agricultural and industrial developments and overall population growth. Today large-scale algal blooms are common. The main substances
causing the eutrophication of the Baltic Sea are nitrogen and phosphorus (Larsson 1985). Important sources are agriculture and urban dwellings as well as air emissions (Archambault 2004). For example, in the eastern Gulf of Finland poultry plants and animal husbandry are major contributors to eutrophication (Kondratyev and Trumbull 2012). Untreated sewage is still a problem in some areas while some countries have a well-developed sewage treatment.

Hazardous substances are anthropogenic substances that are harmful to the environment and/or to humans. Effluents from rivers and seashores as well as from shipping and air emissions may contain such contaminants. In addition, there are also diffuse sources such as long range transport originating from outside the region. Substances include different metals such as cadmium, mercury, lead and zinc as well as persistent organic pollutants (POP) including PCB and DDT. There are large proportions that have been assimilated in organisms such as invertebrates (Hendozko 2010) and fish (Voigt 2007) as well as sediments (Roots et al 2010); they will persist in the system in decades to come. The input from some substances has decreased but the problem remains. Some substances are still found in high levels and there are new contaminants.

A human activity that has a profound effect is fishing given the large number of key species that are removed from the Baltic Sea ecosystem (Österblom et al 2007, Zeller et al 2010). All countries around the Baltic Sea are actively harvesting fishery resources. The complexity that characterizes fishery management is in general poorly understood. The biggest problem to achieve a long-term sustainable fishery in the Baltic Sea is over capacity with an oversized fishing fleet (Eggert and Tveteras 2007). Another problem is the illegal, unregulated and unreported fishing (IUU). Even though fishery is an activity that has such a major effect on the Baltic Sea ecosystem it is also an activity that can be regulated and adequate management schemes can have a fairly quick effect.

Aquaculture is also a provider of fish. It is an activity that has potential for future developments in the Baltic Sea. However, there are also environmental effects to consider such as increased nutrient loads (Saikku and Asmala 2010).

In terms of maritime activities such as shipping the Baltic Sea has a comparable high occupancy of ships; 15% of the world’s cargo ships are found in the area (Swedish EPA 2008). Oil spills, emissions of nitrogen oxides and the introduction of alien species from ballast waters are some environmental issues of concern related to shipping. Oil pollution is largely caused by intentional discharges (Hassler 2011). Notably, chronic oil pollution from intended spills can be a bigger problem than smaller single accidents. However, a larger spill could lead to a major catastrophe given the sensitive ecosystem that characterizes the Baltic Sea.

The Baltic Sea is also a provider of energy. The number of offshore windmills are increasing (Lumbreras and Ramos 2013). This may have environmental effects where wind parks are constructed including reef effects (Andersson and Öhman 2010), sound effects (Andersson et al 2007, 2012) and impacts from magnetic fields (Öhman et al 2007).

Climate change is expected to have a major impact on the Baltic Sea. The temperature has increased by 0.7°C during the past century and with the foreseen climate alteration it will continue to increase. In addition precipitation
is predicted to intensify. A higher nutrient load is further expected. This will all affect various components of the ecosystem including algal blooms (e.g. Hense et al 2013). Another issue that relates to climate change is ocean acidification. Increased levels of carbon dioxide can change the level of acidity in seas around the world including the Baltic Sea. How it may affect the Baltic Sea is difficult to predict (Havenhand 2012).
### Annex 3. Valuation studies of ecosystem services in the Baltic Sea area

This Annex lists the valuation studies mentioned in the summary report by Söderqvist & Hasselström (2008) and describes the recent valuation studies in the Baltic Sea region (see below the table).


<table>
<thead>
<tr>
<th>Issue</th>
<th>Country</th>
<th>Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Eutrophication</strong></td>
<td>international</td>
<td>Markowska &amp; Zylicz 1999, Turner et al. 1999</td>
</tr>
<tr>
<td></td>
<td>Denmark</td>
<td>Atkins &amp; Burdon 2006, Atkins et al. 2007</td>
</tr>
<tr>
<td></td>
<td>Estonia</td>
<td>Gren 1996</td>
</tr>
<tr>
<td></td>
<td>Finland</td>
<td>Siitonen et al. 1992, Kiirikki et al. 2003, Kosenius 2004</td>
</tr>
<tr>
<td><strong>Fisheries</strong></td>
<td>international</td>
<td>Toivonen et al. 2000</td>
</tr>
<tr>
<td></td>
<td>Denmark</td>
<td>Roth &amp; Jensen 2003</td>
</tr>
<tr>
<td></td>
<td>Estonia</td>
<td>Vetmaa et al. 2003</td>
</tr>
<tr>
<td></td>
<td>Germany</td>
<td>Bundesforschungsanstalt für Fischerei 2007, Döring et al. 2005</td>
</tr>
<tr>
<td><strong>Oil and marine debris</strong></td>
<td>international</td>
<td>Hall 2000, Sanctuary and Fejes 2006</td>
</tr>
<tr>
<td></td>
<td>Denmark</td>
<td>Storstroms amt 2002</td>
</tr>
<tr>
<td></td>
<td>Estonia</td>
<td>Etkin 2000</td>
</tr>
<tr>
<td></td>
<td>Finland</td>
<td>Ahtiainen 2007</td>
</tr>
<tr>
<td><strong>Windmill parks</strong></td>
<td>Denmark</td>
<td>Ladenburg 2007, Ladenburg &amp; Dubgaard 2007, Ladenburg 2008</td>
</tr>
<tr>
<td></td>
<td>Germany</td>
<td>Benkenstein et al. 2003, Scharlau et al. 2004</td>
</tr>
<tr>
<td></td>
<td>Sweden</td>
<td>Ek 2002, Liljestam &amp; Söderqvist 2004</td>
</tr>
<tr>
<td><strong>Other/several topics</strong></td>
<td>Denmark</td>
<td>COWI 2007, Visitdenmark 2007</td>
</tr>
<tr>
<td></td>
<td>Estonia</td>
<td>Vetema et al. 2003</td>
</tr>
<tr>
<td></td>
<td>Finland</td>
<td>HELCOM and NEFCO 2007, Siitonen et al. 1992</td>
</tr>
</tbody>
</table>
Several studies have been carried out under the international research network BalticSTERN (BalticSTERN 2012). The network includes partners from all nine coastal countries, making international studies covering the whole Baltic Sea region possible. BalticSurvey examined the recreational use of and public perceptions towards the Baltic Sea marine environment with a coordinated survey across all coastal countries, collecting 9000 responses (Ahtiainen et al. 2013a, Swedish EPA 2010). The findings revealed that the Baltic Sea is an important recreation site in all surrounding countries. Most respondents had visited the sea at some point and the average number of recreation days spent at the sea ranged from 3 (coastal Russia) to 35 days (Sweden) per year. The survey also brought forward the concern people have about the state of the sea, especially regarding marine litter, damage to flora and fauna, hazardous substances and oil spills. Surveys such as this are useful in investigating the general public’s views and also recreation behavior when statistics are not available. Also, international coordination ensures that results are comparable across countries.

Following the survey on recreation and public perceptions in the Baltic Sea countries, a coordinated study was implemented on the monetary benefits of reducing marine eutrophication (Ahtiainen et al. 2012, 2013b). Contingent valuation studies were carried out with identical questionnaires in all nine Baltic Sea countries in 2011. With over 10000 respondents, the study examined public willingness to pay for reduced eutrophication according to the Baltic Sea Action Plan (BSAP) targets from 2007 (HELCOM 2007). The results reveal the monetary benefits of reaching the BSAP targets for eutrophication. The benefit estimates were also compared to the costs of reducing nutrient loads in a subsequent cost-benefit analysis (see e.g. BalticSTERN 2013), making it possible to analyze the economic efficiency of reducing eutrophication. The results also allow for estimating the marginal benefits of reducing nutrient loads, i.e. the benefits per kilogram of reduced nitrogen/phosphorus.

In addition to the above-mentioned Baltic-wide efforts, there are some recent regional studies. Kosenius (2010) estimated the Finns’ willingness to pay for improving water quality in the Gulf of Finland using the choice experiment method. The results can be used flexibly to estimate the benefits of different water quality improvements in the Gulf of Finland and perhaps also other parts of the Baltic Sea. The study provided value estimates separately for changes in water clarity, abundance of coarse fish, status of bladder wrack and occurrence of blue-green algal blooms, and estimated the value of various water quality improvement scenarios.

Kulmala et al. (2012) examined the ecosystem services provided by Baltic salmon and also presented estimates of the economic value of provisioning and recreational services of salmon. Based on data from the Finnish Game and Fisheries Research Institute (2009), the economic value of commercial salmon landings in Denmark, Finland, Poland and Sweden was estimated at 0.9-3.6 million euros per year. The value of recreational fishing was based on several studies on anglers’ willingness to pay for improved quality of recreational fishing and for preserving wild salmon stock (e.g. Håkansson 2008, Parkkila et al. 2011), ranging from 8 to 19 euros per fishing day. The study utilized the ecosystem
service framework, so the results are directly applicable to estimating the value of ecosystem benefits provided by Baltic salmon.

Another study using the ecosystem services framework in the Baltic Sea analyzed the ecosystem benefits from coastal habitats in two areas: the Finnish-Swedish archipelago and Lithuanian coast (Kosenius & Ollikainen 2012). The choice experiment valuation study was implemented in Finland, Sweden and Lithuania in 2011. The state of coastal habitats was described in terms of the amount of healthy vegetation, the preservation of currently pristine environments and the size of fish stocks. The results are useful in assessing the value of marine ecosystem benefits provided by habitats and species, recreation, and food and raw materials.

Tegeback & Hasselström (2012) estimated the costs associated with a major oil spill in the Baltic Sea, including the direct (cleaning beaches), market (tourism, fisheries) and nonmarket costs (environmental costs). They conducted three different case studies of potential spills: two close to the Swedish coast and one in the Polish coast. Depending on the location, the costs ranged from approximately 100 to 400 million euros. These cost estimates can help decide the level of preparedness for future oil spills, assess the effects from oil spills on fishing and tourism industries and also to the general public in the Baltic Sea.

Lewis et al. (2013) studied the monetary value of cultural ecosystem services related to Baltic Sea food webs. With a choice experiment conducted in Poland in 2012, they elicited willingness to pay for four ecological features: algal bloom intensity and timing, local species visibility, regional species population and local fisheries catch consistency and profitability. The findings increase the information on the value of cultural ecosystem services provided by the Baltic Sea in Poland. According to Lewis et al. (2013), a similar case study was also conducted in Finland, but the results have not been published yet.

Depellegrin & Blažauskas (2013) used existing studies and value estimates to assess the losses from oil spills in the Lithuanian coast. The total losses were based on the value of recreational services, marine ecosystem services, commercial fisheries and seabirds, amounting to 524 million €/year. The aggregate estimates included the value of both intermediate and final ecosystem services and goods, and therefore double-counting is possible. Also, the study estimated the total economic value of the Lithuanian coastal zone and not marginal values. Therefore, the applicability of the value estimates is questionable. However, the analysis was spatially explicit, which enables evaluating the spatial distribution of values.