Cost-effectiveness and cost-benefit analysis for the MSFD

Framework for the Netherlands

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Preface

The EU has established the Marine Strategy Framework Directive (MSFD). MSFD requires Member States to develop marine strategies with the aim of achieving Good Environmental Status (GES) in European marine waters. One part of this strategy is a cost-effective set of measures to attain GES. Directorate-General for Public Works and Water, Management Centre for Water Management on behalf of the Ministry of Infrastructure and the Environment has asked LEI and Imares to elaborate a cost-effective set of measures based on a draft version of the Dutch Marine Strategy and a preliminary cost-benefit analysis (CBA) of MSFD to see what is needed to do the formal CBA.

For the assessment of various potential measures the opinion of experts, civil servants and scientists is used during workshop settings and interviews. Based on this information measures were reformulated or regarded as not additional. During this project the Dutch Marine Strategy has been fine-tuned. A draft version of this report has been presented to the Kernteam KRM. We would like to thank everyone for their effort, comments and advice. We also thank Rob van der Veeren (Directorate-General for Public Works and Water, Management Centre for Water Management), especially as commissioner for efficient interaction with the developing Dutch Marine Strategy.

Prof. Dr R.B.M. Huirne
Managing Director LEI

Summary

S.1 Main conclusion

The methodology elaborated is suitable for the MSFD cost-effectiveness analysis. Within the set of measures considered in this report, the largest benefits of the Marine Strategy Framework Directive (MSFD) are related to marine litter.

The biggest financial benefits are related to a reduction of larger litter items. The target set to attain Good Environmental Status (GES) for biota, however, will be reached if the quantity of small plastic items in sea is reduced as these are most frequently ingested. Measures to reduce lost nets and pieces of nets are potentially cost effective. Increasing the awareness of one's own contribution to the marine litter problem will be an important trigger to reduce marine litter, both from tourists at the beach and from mariners and fishermen at sea. International harmonisation of port reception facilities will reduce the amount of litter entering the sea from ships.

S.2 Other conclusions

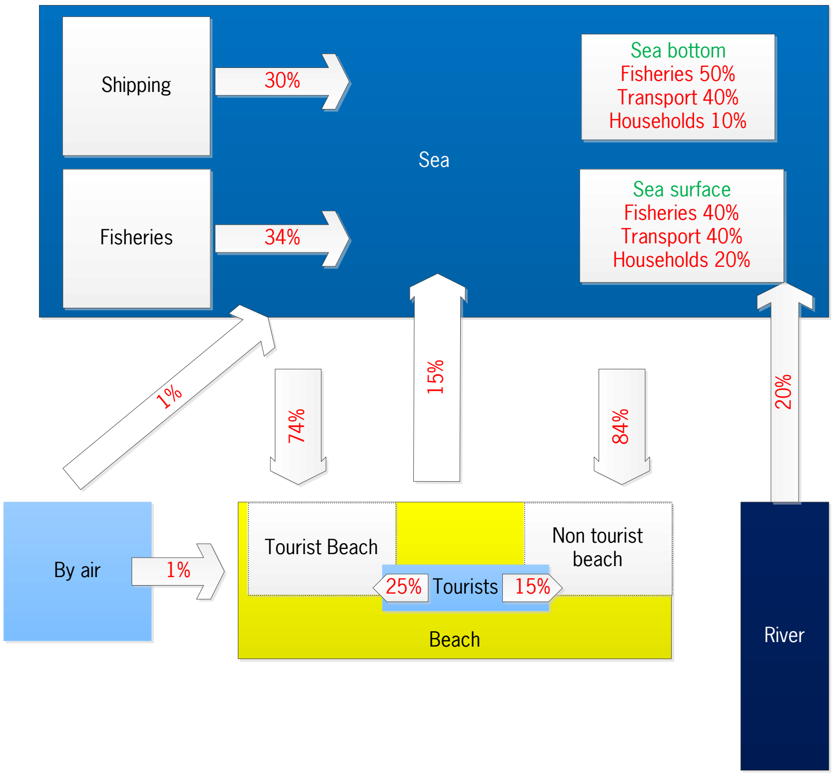
The benefits of a reduction of litter in sea and on the beach are related to specific litter items. Tourists are less interested in nylon wires on the beach, but are deterred by larger items. Also the impact of litter on biota differs with the characteristics of litter items. Hence, litter cannot be treated as one homogenous GES-descriptor (see Section 4.10).

This CEA (Cost-Effectiveness Analysis) and CBA (Cost-Benefit Analysis) revealed useful information to decision-makers. The CEA indicated the ranking of possible measures according to their estimated cost and their effect on the pressure. This information facilitates the selection of measures to be elaborated in the next phases of MSFD (see Section 3.12). The CBA indicated the expected direction and scale of changes to human welfare of MSFD targets. This information helps to target the MSFD to a more balanced benefit cost ratio (see Section 4.12).

The Dutch government has related the targets of MSFD as much as possible to other EU directives and policies (for example Water Framework Directive,

Common Fisheries Policy, IMO). Hence, the MSFD does not add much to the autonomous development of the marine environment of the North Sea except for litter. Therefore, the Dutch Government considers that the gaps between the Business as Usual scenario and the MSFD targets are small for most GES descriptors. Many EU policies still have to be implemented on the national level, which creates a complex process of which the results are difficult to predict. Particularly, more insight into the Common Fisheries Policy and its impact on the marine environment is necessary to better determine the gap between autonomous development and MSFD (see Chapter 3).

Figure S.1 Sources of litter entering the sea (Percentages are very rough estimates)



S.3 Methodology

The Ministry of Infrastructure and the Environment asked (i) to elaborate a suitable methodology for the required Cost-Effectiveness Analysis (CEA) and a preliminary Cost-Benefit Analysis (CBA) for the MSFD and (ii) to apply this methodology on MSFD objectives and measures using currently available data and data collected in the short time span of this project period (iii) to indicate the need for additional information to carry out the CBA analysis in line with MSFD requirements in 2012.

The elaborated CEA method is based on currently available information and input from experts. For the CEA quantitative descriptions are needed for both the Business as Usual scenario and for the MSFD targets. This information is currently not sufficiently available for a full CEA. Thus the amount of measures to be taken cannot be estimated. The physical effects of potential measures can be identified, but not quantified. The pressures that are being addressed by a measure can easily be identified, but how much these measures (per unit) contribute to achieving GES is not yet known (see Chapter 3).

Most of the possible measures assessed in this study are new. Therefore, information about their effect is not yet available. In these cases, expert opinion is the only available source of information. On the basis of this study potential cost-effective measures can be selected and elaborated before the phase of implementation of MSFD. The methodology applied is suitable in circumstances with limited data availability. Several caveats have been pointed out to improve on the CEA and CBA.

Samenvatting

S.1 Belangrijkste uitkomsten

De uitgewerkte methode is geschikt voor de KRM-kosteneffectiviteitsanalyse. Binnen de maatregelen die in dit rapport worden overwogen, zijn de grootste baten van de Kaderrichtlijn Mariene Strategie (KRM) gerelateerd aan zwerfafval op zee.

De grootste financiële voordelen zijn gerelateerd aan het reduceren van grotere stukken zwerfafval op zee. Het doel dat is gesteld om een goede milieustatus te bereiken voor biota, zal echter pas worden bereikt als de hoeveelheid kleine plastic deeltjes in de zee wordt verminderd, aangezien dit de grootste drukfactor is. Maatregelen om het aantal verloren netten en delen van netten tot een minimum te beperken, zijn potentieel kosteneffectief. Mensen bewust maken van hun eigen bijdrage aan het zwerfafval probleem op zee zal een belangrijke rol spelen bij het beperken van zwerfafval, zowel van toeristen op het strand als van zeevaarders en vissers op zee. De internationale harmonisering van haven-ontvangstfaciliteiten zal ertoe leiden dat er minder afval van schepen in de zee terechtkomt.

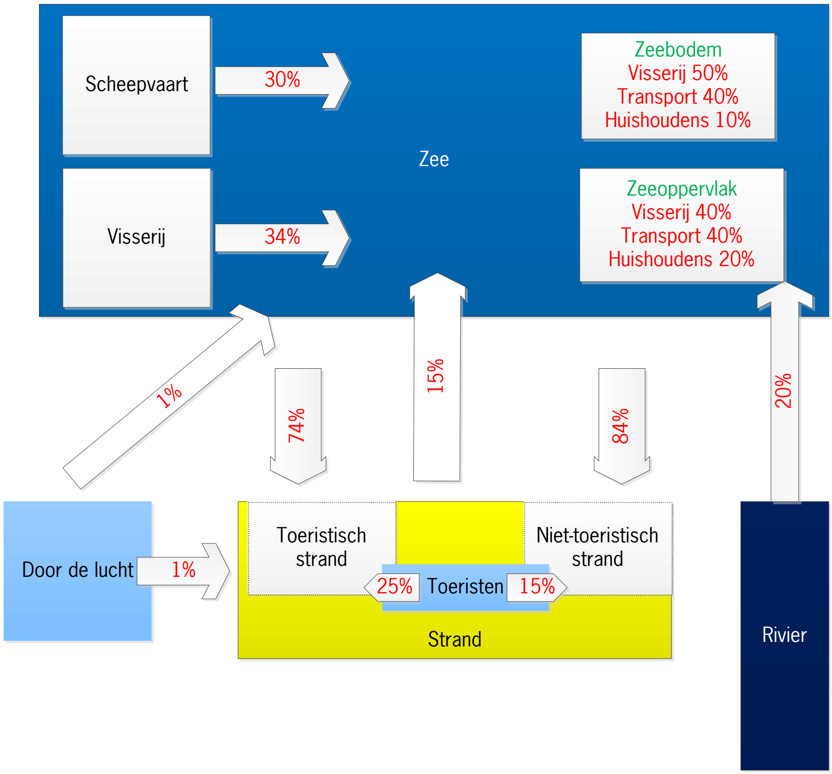
S.2 Overige uitkomsten

De baten van minder afval in de zee en op het strand staan in verband met het soort zwerfafval. Toeristen hebben bijvoorbeeld weinig last van nylondraden op het strand, maar worden eerder afgeschrikt door grotere stukken afval. Ook de impact van het afval op biota is afhankelijk van het soort zwerfafval. Zwerfafval kan daarom niet worden behandeld als één homogene factor voor een goede milieustatus.

De KEA (kosten-effectiviteitsanalyse) en KBA (kosten-batenanalyse) onthulden nuttige informatie voor beleidsvormers. De KEA bepaalde de rangschikking van mogelijke maatregelen op basis van de geschatte kosten en het effect op de drukfactoren. Deze informatie maakt het mogelijk vast te stellen welke maatregelen kunnen worden uitgewerkt in de volgende fase van de KRM. De KBA gaf de verwachte richting en omvang van veranderingen aan voor het welzijn van de mens in het kader van de KRM-doelstellingen. Dankzij informatie kan de KRM zich richten op een meer gebalanceerde kostenbatenverhouding.

De Nederlandse overheid heeft de doelstellingen van de KRM zo veel mogelijk aan andere EU-richtlijnen en -beleidslijnen gekoppeld (bijvoorbeeld de Kaderrichtlijn Water, het Gemeenschappelijk Visserijbeleid en de IMO). De KRM voegt hierdoor weinig toe aan de autonome ontwikkeling van het mariene milieu van de Noordzee, behalve op het gebied van zwerfafval. De Nederlandse overheid is van mening dat de kloof tussen het 'business as usual'-scenario en de doelstellingen van de KRM slechts beperkt is voor de meeste descriptoren voor een goede milieustatus. Veel EU-beleid moet nog op nationaal niveau worden geïmplementeerd: een complex proces waarvan de resultaten lastig te voorspellen zijn. Het is met name noodzakelijk meer inzicht te vergaren in het Gemeenschappelijk Visserijbeleid en de impact daarvan op het mariene milieu om de kloof tussen de autonome ontwikkeling en de KRM beter te kunnen vaststellen.

Figuur S.1 **Bronnen van afval in de zee (de percentages zijn grove schattingen)**



S.3 Methode

Het ministerie van Infrastructuur en Milieu heeft gevraagd (i) een geschikte methode te ontwikkelen voor de vereiste kosteneffectiviteitsanalyse (KEA) en een voorbereidende kostenbatenanalyse (KBA) voor de KRM en (ii) om deze methode toe te passen op de doelstellingen en maatregelen van de KRM op basis van de huidige beschikbare data en data die verzameld wordt in de korte tijdspanne van deze projectperiode en (iii) aan te geven of er meer informatie nodig is om de KBA uit te voeren in overeenstemming met de KRM-eisen in 2012.

De uitgewerkte KEA-methode is gebaseerd op de huidige beschikbare informatie en op input van deskundigen. Voor de KEA zijn kwantitatieve omschrijvingen nodig voor zwel het 'business as usual'-scenario als de doelstellingen van de KRM. Op dit moment is deze informatie onvoldoende beschikbaar voor een volledige KEA. Daardoor kan geen schatting worden gemaakt van het aantal te nemen maatregelen. De fysieke effecten van potentiële maatregelen kunnen wel worden geïdentificeerd, maar niet worden gekwantificeerd. De druk die door een maatregel wordt aangepakt, kan eenvoudig worden vastgesteld, maar in welke mate de maatregelen (per unit) bijdragen aan het bereiken van een goede milieustatus is nog onbekend.

De meeste mogelijke maatregelen die in deze studie worden beoordeeld, zijn nieuw. Daarom is er nog geen kwantitatieve informatie beschikbaar over hun effect. In die gevallen is de mening van deskundigen de enige beschikbare informatiebron. Op basis van deze studie kunnen potentiële kosteneffectieve maatregelen worden geselecteerd die voor de implementatiefase van de KRM kunnen worden uitgewerkt. De toegepaste methode is geschikt in situaties waarin er slechts beperkte data beschikbaar is. Er zijn enkele duidelijke verbeterpunten aangewezen voor de KEA en KBA.

1 Introduction

1.1 Background

In 2008 the EU established the European Marine Strategy Framework Directive (EU, 2008). The MSFD aims to achieve Good Environmental Status (GES) of the EU's marine waters by 2020. MSFD promotes the integration of environmental considerations into all relevant policy areas and delivers the environmental pillar for the future maritime policy for the European Union. The MSFD requires EU Member States to comply with this directive by developing strategies for their marine waters. According to the MSFD, article 13/1:

> 'Member States shall, in respect of each marine region or subregion concerned, identify the measures which need to be taken in order to achieve or maintain good environmental status ...'

And article 13/3 states that:

> 'Member States shall ensure that measures are cost-effective and technically feasible, and shall carry out impact assessments, including cost-benefit analyses, prior to the introduction of any new measure.'

The Marine Strategy Framework Directive (MSFD) requires EU Member States to put in place measures to achieve Good Environmental Status (GES) in their marine waters by 2020. By July 2012 Member States must determine the characteristics of GES for their marine waters and set appropriate targets and indicators to ensure these will be achieved (as specified in Articles 13/1 and 13/3). In preparation, the competent authority for the MSFD in the Netherlands, the Ministry of Infrastructure and the Environment, through its DG Water[1], wished to carry out a preliminary analysis, based on the presently available data and knowledge, already in 2011.

MSFD GES is defined 'as the environmental status of marine waters where these provide ecologically diverse and dynamic oceans and seas which are

[1] Operational responsibility for the implementation of the MSFD lies with the Directorate-General for Public Works and Water Management Centre for Water Management.

clean, healthy and productive within their intrinsic conditions'. The use of the marine environment must also be at a level that is sustainable, thus safeguarding the potential for uses and activities by current and future generations. GES is determined at the level of the marine region or sub-region on the basis of 11 qualitative descriptors.

This study builds on three recent studies carried out for the MSFD that are relevant for the Netherlands:

1. *MSFD targets and the indicators*, by DGSW (2011), written in the course of this study;
2. DHV/IMARES (2011), which presents possible measures with qualitative information on their costs and effects; and
3. Walker et al. (2011), which describes the current costs related to the actual condition of the North Sea.

To carry out a cost-effectiveness analysis for the technically feasible measures, a database of potential measures to arrive to the MSFD objectives (targets), is needed. For the cost-benefit analysis the associated benefits have to be analysed.

1.2 Objective

This study was commissioned by Directorate-General for Public Works and Water Management Centre for Water Management on behalf of the Ministry of Infrastructure and the Environment. Its aim was: (i) to elaborate a suitable methodology for the required Cost-Effectiveness Analysis (CEA) and a preliminary Cost-Benefit Analysis (CBA) for the MSFD and (ii) to apply this methodology using currently available data and data collected in the short project period on MSFD objectives and measures (iii) to indicate the need for additional information to carry out the CBA analysis in line with MSFD requirements in 2012.

Given the tight time schedule for this project, the focus in this study was on developing a comprehensive methodology in line with EU requirements. This methodology should be easy to communicate to relevant agencies and stakeholders, provide the basis for upscaling and expansion (in case new information becomes available). The required Cost-Effectiveness and preliminary Cost-Benefit Analyses are intended to shape the Dutch MSFD policy. As not all information could be based on scientific research, for some data we had to rely on best guess estimates to allow policy decisions based on the results. At the same time, the methodology should also be firmly grounded in generally accepted economic practice.

1.3 Methodology

The purpose of applying a cost-effectiveness analysis (CEA) is to determine how the presently formulated MSFD targets can be achieved against least costs. It should be noted that the present MSFD targets have not yet been formally set by the Ministry. The steps involved in conducting a CEA are:

1. Quantitative gap analysis;
2. Identification of pressures and impacts;
3. Classification of the additional MSFD measures;
4. Description of the effects of additional measures;
5. Quantitative assessment of the effect on the MSFD objectives per measure;
6. Determination of the costs of the additional measures;
7. Assessment of least costs to reach MSFD objectives, based on a ranking of measures on their cost-effectiveness.

These steps are comparable with the methodology presented by Turner et al. (2010) for the MSFD. In our methodology however, steps 1 and 2 of the aforementioned approach are combined into one discrete step.

Although the steps are taken in sequence, important iteration takes place between steps. If additional information becomes available, for example on the targets set for the GES descriptors, or on the source-effect pathway and possible solutions, the same step may be revisited, as not all information is available yet and the MSFD requires a programme of measures to be developed in 2015. Also, the targets can be adapted to information on the costs based on step 7. This method can be filled with extra information to make the outcomes of the CEA more precise. The methodology allows for the incorporation of data at different levels of detail and confidence. The outline of the various steps illustrates that carrying out a CEA is a multi-disciplinary exercise, requiring the input of and collaboration between different scientific disciplines. This methodology has been tested in previous studies (e.g. Kuhlman et al., 2010; Reinhard et al., 2006).

As mentioned before, GES is determined at the level of the marine region or sub-region on the basis of 11 qualitative descriptors. Member States need to consider each of the criteria and related indicators listed in the Annex of the commission decision on the MSFD in 2010 (EU, 2010) to identify those which are to be used to determine good environmental status. Under Article 10 of the

Directive (EU, 2008), there is a requirement to establish environmental targets and indicators designed to guide progress towards achieving GES, taking account of the continuing application of relevant existing environmental targets laid down at National, Community and International level in respect of the same waters.

The starting point for our analysis (step 1) was the MSFD text (EU, 2008) that identifies the 11 GES descriptors in Annex 1. Possible indicators associated with these GES descriptors are presented by the EU (EU 2010) and need to be elaborated by the Member States. Furthermore, we made use of the draft document of the Dutch Marine Strategy (DGSW, 2011) that specifies the MSFD objectives and subsequent targets by the Ministry of Infrastructure and the Environment. This information was contrasted with the autonomous development (Business as Usual, BaU). The BaU is the expected autonomous development, including (expected) policies. In fact, the BaU is a description of the situation in 2020, without MSFD. If a gap between the MSFD targets and the BaU scenario was identified, potential measures to close this gap, were defined. The definition of potential measures was carried out in a workshop with experts from the Directorate-General for Public Works and Water Management, and from the Ministry of Economic Affairs, Agriculture and Innovation.

Based on this workshop and additional information identified during the workshop, a long list of potential measures was drawn up and prioritised. This list was amended by the commissioner of this report (Directorate-General for Public Works and Water Management -Centre for Water Management), based on their consideration on the social economic concerns (see Textbox 2.1, Chapter 2) and new insights into the objectives of the MSFD. The amended list is a starting point for the CEA and CBA presented in this report.

CBA is an economic technique, useful as an aid to policy decision making. It involves identifying and measuring, in monetary terms, as many as possible of the costs and benefits that relate to the MSFD. This helps to determine whether the MSFD will produce a net gain or loss in economic welfare for society as a whole. In contrast to the CEA, the objectives of the MSFD are also valued in a CBA. To carry out a practical and simple CBA in addition to the aforementioned CEA, the benefits of the MSFD objectives are investigated, and compared with the costs from the CEA. In the CBA, the benefits of the gap between the MSFD objectives and the BaU are identified and monetised. The ecological values not directly related to money transfers, are not taken into account quantitatively. They will be elaborated separately in another project based on the Nature Points Methodology (Liefveld et al., 2011). The choice between CBA and CEA is determined by the nature of the policy problem under scrutiny. If the problem is one of meeting some environmental standard, complying with a law or achieving a target, then finding the least-cost way of achieving this by completing a CEA is the appropriate action. If the problem is one of choosing between a number of different possible policy or project options which do not involve compliance with standards or targets, then CBA is the most appropriate assessment tool (Turner et al., 2010). The CEA and CBA methodology are elaborated in Chapter 2.

1.4 Ministry of Infrastructure and Environment

The MSFD requires an economic and social analysis as input for the definite list of MSFD measures which has to be handed in to the European Commission in 2015. The economic and social analysis includes a cost-effectiveness analysis (CEA) of the list of potential additional MSFD measures and a cost-benefit analysis (CBA) of different MSFD implementation options. This study contributes to this requirement by setting up the framework for the CEA and the CBA. Within the Ministry of Infrastructure and the Environment two divisions will use the results of this study, the Directorate-General (DG) Space and Water (DGSW) and the DG for Public Works and Water Management (RWS). DGSWS is the competent authority for the MSFD.

DGSW is responsible for the list of additional measures needed to reach the good environmental status as described in the MSFD. To underpin this list, a cost-effectiveness analysis is obliged. RWS will contribute to the list of additional MSFD measures, based on their expertise. The Directorate-General for Public Works and Water Management is a management and executive organisation. RWS will contribute only to the list with potential additional measures they are responsible for. To underpin this list, RWS need a cost-effectiveness analysis of the measures concerning RWS. Another organisation with a responsibility for measures on the list is for example the Ministry of Economics, Agriculture and Innovation for fishery measures. The assumption in this research is that by attaining the objectives of the Common Fisheries Policies, the MSFD objectives for commercial fishery are achieved.

In addition to the obliged CEA, DG Space and Water is responsible for the required social cost-benefit analysis of the MSFD. This CBA will be carried out in 2013. As preparation for the CBA analysis in 2013, in 2012 a strategic Social Cost Benefit Analysis (CBA) will be carried out. In this report, a provisional CBA is done based on information of the cost-effective set of measures and the value of the MSFD targets.

1.5 Structure of the report

In Chapter 2 the methodology for the CEA and preliminary CBA is described in more detail. The relevant steps per GES descriptor are then elaborated on in Chapter 3. The gap analyses, potential measures and analysis of these measures are described for each GES descriptor in one section. The quantitative effects of these measures on affected activities (e.g. tourism) are converted into relevant costs and related to the effect on the GES target. A cost-effective package of measures is then elaborated on in Section 3.12. This includes comparing the cost-effectiveness of the measures. Thereafter, in Chapter 4, the CBA is presented, based on the MSFD target specified by the client. In the final chapter conclusions are drawn and recommendations are presented for implementation of MSFD in the Netherlands and further research.

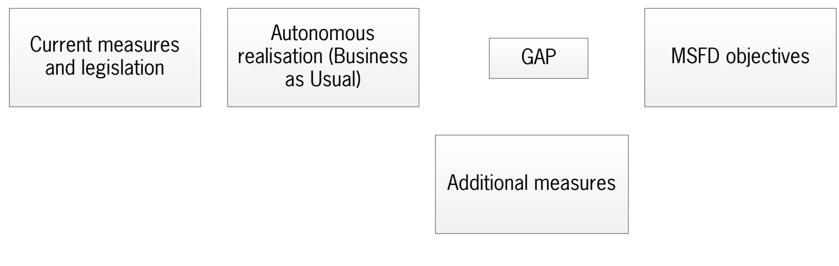
2 Research method

2.1 Step 1: Quantitative gap analysis

The MSFD contains 11 qualitative descriptors of good environmental status laid down in Annex I of the Directive (EU, 2008). A number of associated indicators and related targets are distinguished for assessing good environmental status, in relation to the 11 descriptors. In the MSFD, the difference between the MSFD targets of each indicator, and the value of the GES indicator in the BaU scenario in 2020 constitutes the gap that needs to be filled with additional measures (see Figure 2.1). Gap analysis should be carried out for each GES descriptor based on the quantitative indicators. In this study, the indicators and targets are based on a draft version of the Dutch Marine Strategy (DGSW, 2011). The GES descriptors are not independent. As an example, the biological diversity (GES 1) depends amongst others on the concentration of contaminants (GES 8). The relation between the GES descriptors can be explained by the common pressures (see step 2). The Ministry of Infrastructure and the Environment selected the relevant potential measures for this study based on the Dutch Marine Strategy, version 2.0 (DGSW, 2011).

This first step requires insight into measures included in the current or foreseen policy (business as usual). This is more difficult than it seems at first. First, part of the policy and measures until 2020 is not known yet. Second, in some cases, the policy is presented as an ambition rather than a solid set of measures. Based on discussions with policy makers, consideration of the Ministry of Infrastructure and the Environment on the social economic concerns in setting targets (see DGSW, 2011) and other relevant policies (e.g. Natura 2000) the distinction between BaU measures and additional measures was made.

Figure 2.1 **Gap analysis, comparing MSFD objectives (targets) with Business as Usual**



In this step, the gap was quantitatively specified per GES indicator, whenever possible. For most GES descriptors only a qualitative gap could be determined, since most targets are presently only defined qualitatively based on directions rather than clear end points. For those cases where the target was met in the BaU, additional measures are not necessary and no further analysis was carried out for this specific GES descriptor.

Figure 2.2 **Gap analysis, comparing MSFD objectives with Business as Usual**

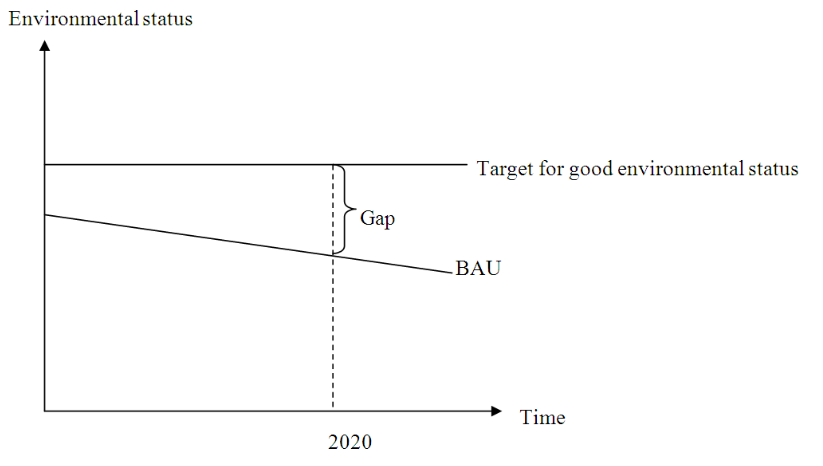


Figure 2.2 illustrates the difference in environmental status between GES and the BAU.

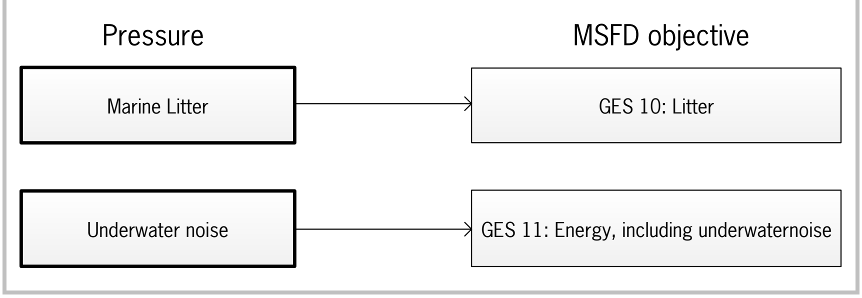
2.2 Step 2: Identify pressures and impacts

In line with the MSFD, the pressures and impacts related to the GES descriptors were identified in step 2:

> 'Member States shall also take into account the pressures or impacts of human activities …' (EU, 2008: art 9.1).

This step builds on the Boon et al. (2011) study. Examples of linking the objectives of the GES descriptors to pressures are given in Figure 2.3.

Figure 2.3 Linking the objectives of the GES descriptors to pressures



2.3 Step 3: Identification of additional measures

In this step a long-list of measures was identified with a potential to reduce the pressures with an impact on the MSFD objectives (targets). To develop this long-list, we started with the list of measures available in the DHV/Imares (2011) project. Based on the available knowledge of the gap between MSFD objective and BaU these measures were re-assessed and new additional measures were proposed. Experts were consulted within government agencies, research institutes and documentation from other EU Member States was used. A key part in this step was a workshop involving experts with a broad expertise relevant for the MSFD. Based upon the results of the workshop and additional information identified during the workshop, the long list of measures was prioritised according to the expected effects and costs. This long-list is presented in Appendix 1. This list was then amended by Directorate-General for Public Works and Water Management (the commissioner), based on their further elaboration of MSFD targets (see Textbox 3.1 and DGSW, 2011). This amended list was then taken as starting point for the CEA and CBA presented in this report. The amended list was then discussed with experts for each GES descriptor and based on these discussions the measures were further detailed. The final list of measures was used to describe whether and how they could contribute to achieving MSFD targets.

An important step is to distinguish between current and additional measures, since current measures will not be taken into account in the CEA. Current measures are already applied in the BaU scenario, or are measures based on expected policies (for example the Common Fisheries Policy). Based on current policy documents and the expert input of government representatives, it was decided whether to label a measure as additional or not. Additional measures were defined as completely new ones or further restricted versions of current measures. Only the additional measures were elaborated upon.

2.4 Step 4: Describing the effects of additional measures

As discussed above, 11 GES descriptors are distinguished. From the final list of additional measures, understanding the effects of the measures on the GES indicators is needed. For the cost-effectiveness analysis, the contribution of the measures to the GES indicators needs to be determined (see Table 2.1). In this study the effect of each measure was determined through either expert consultation or literature review (see Appendix 2 for a list of experts participating in the workshops).

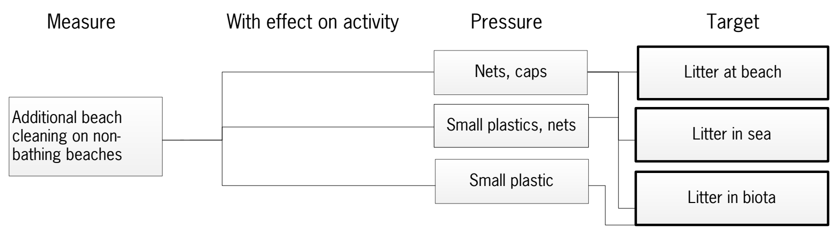
To describe the effects of the measure, the first stage was to create logical diagrams of impact (LDI's) to show the relationship between the measure and the target for each GES descriptor. If a measure was not expected to contribute positively to the GES descriptor and if a positive effect on other GES descriptors could not be expected, the analysis was discontinued at this step. The measure was then rephrased in such a way that some positive effect was expected by the experts.

Table 2.1 Example of classification of the effects

Specified measure	Main GES descriptor	Effect on GES descriptor
Additional beach cleaning on non-bathing beaches	10	Less litter on the beach

Figure 2.4 presents an example of an LDI describing the effect of an additional MSFD measure. It describes the effect of an additional MSFD measure with an effect on litter, additional beach cleaning on non-bathing beaches.

Figure 2.4 **The effect of additional beach cleaning on non-bathing beaches**



2.5 Step 5: Quantitative assessment of effect on MSFD objectives

After having determined the effect of each measure in step 4, the effects were quantified in step 5. The logical diagrams of impact (see Figure 2.4 for an example) showing the relation between the measure and the effect of the measure on the gap has to be filled with quantitative data. To do this, we made use of information provided by experts during workshops and interviews, and by document research.

To quantify the relevant effects, two ways of measuring the effect are relevant:

- The number of units of one measure needed to reach the MSFD target;
- The number of units of one measure needed to alter the MSFD target by 1 unit.

In an ideal situation, the quantitative measure-effect relationships can be derived acquired from scientific studies (e.g. bio-economic modelling). For the majority of measure-effect relationships however, these studies were not available. In those cases, we relied on expert opinion, gathered in interviews (via a protocol), or related information that allowed us to describe this relation quantitatively (for instance based on case studies).

Expert judgment is likely to involve a degree of uncertainty. This was recorded if possible to allow for potential sensitivity analysis and evaluation. We needed to make many assumptions in order to quantify these relationships. For example, we may know with reasonable certainty the effect of the first unit of measure, but we cannot assume that the 100th unit will be as effective. We may therefore need to assume that this, actually, is the case (i.e. a linear relationship).

In Table 2.2, an example of the quantitative assessment of the additional measures is given.

Table 2.2	**Classification of the effects**			
Specified measure	**Main GES descriptor**	**Effect**	**Unit**	**Q**
Additional beach cleaning on non-bathing beaches (once a year)	10	Less litter on the beach	Extra (kilo)metres	61

2.6 Step 6: determination of the costs of additional measures

In this step, an estimate was made of the level of effect per euro (see Table 2.3). We entered the costs of measures in the database (including the upper and lower bounds, if relevant and known). Experts and literature were then consulted to determine the costs per unit of measure. The experts were consulted either through bilateral interviews or expert workshops that enabled deliberation on the best estimate. In this step the database was filled.

In the database the following items are distinguished:

- *Measure*: the original measure as defined in the amended list of measures;
- *Specified measure*: the measure re-specified to attain the objectives of MSFD better than the original measure;
- *Main GES-descriptor:* the GES descriptor the measure will primarily affect;
- *Additional measure:* 1 measure is additional ; 0 measure is not additional;
- *Effect:* description of the primary effect of the measure;
- *Unit:* the unit of activity affected by the measure;
- *Q:* the quantity of (Q) the measure or the activity affected;
- *Investment costs:* Investments costs (costs made once);
- *Maintenance and monitoring costs:* variable costs that are incurred yearly;
- *Costs per year:* summation of investment costs transformed into yearly costs and maintenance and monitoring costs;
- *Cost per unit:* yearly costs per unit (yearly costs divided by Q;
- *Effect on the gap:* effect presented as quantitatively as possible

- *Cost-effectiveness:* evaluation of the cost-effectiveness, including assessment of how a smaller or larger quantity of the measure will influence the cost-effectiveness.

Table 2.3	**Costs of additional measures**			
Specified measure	**Investment costs**	**Maintenance and monitoring costs**	**Cost per unit**	**Annual costs**
Additional beach cleaning on non-bathing beaches (once a year)			24,000	€1.5m

2.7 Step 7: assess least costs to reach MSFD objectives

Given the knowledge on the costs of measures per unit of effect, the cost-effectiveness was be computed by dividing the costs and the effect, and arriving at the cost-effect ratio. This information was provided in steps 5 and 6.

The CEA was first carried out for each Good Ecological Status (GES) indicator. A measure intended for a particular indicator was then attributed only to that indicator (one effect per measure). Some of the measures are expected to have multiple effects and might need a more complicated assessment. In this study we only qualitatively describe the contributions of measures to other GES descriptors than the GES descriptor it is mainly contributing to. Sensitivity analysis is used to highlight the assumptions and uncertainties which have the most significant impact on the cost-effective set of measures. This is important because it will highlight where future research needs to be concentrated.

The CEA is carried out by considering the direct costs of implementing measures. A good example is the additional measure ban on plastic bags in supermarkets. A ban implies a greater reliance on other packaging materials, e.g. paper. For litter on the beach, paper bags seems to be attractive, but as a result of pulp, the paper production process and the weight of the material per bag, paper bags are not an attractive alternative. This report does not take all these indirect effects and costs into account. Furthermore, this is an issue which relates not only to marine policy but also to other national policies.

2.8 Cost-Benefit Analysis

In this study, the effects resulting from a change in environmental status of the North Sea will also be calculated through a provisional social cost-benefit analysis (CBA). The aim of this provisional CBA is to elaborate the CBA methodology for the MSFD and to get a grip on the data available to carry out such an analysis, and to acquire an insight into the level of missing information. For this analysis we made use of the CEA we carried out within this project. Furthermore, we made use of current literature.

The OEI guideline (Economic Effects of Infrastructure) was followed to carry out this provisional CBA. The OEI guideline can be considered the framework within which CBA should conform (Eijgenraam et al., 2000). CBA consists of six steps, shown in Figure 2.5. CBA is essentially a comparative ex ante analysis, where developments will be compared to a reference situation. Therefore, in the first step two or more scenarios will be defined. In this case, the first is the scenario in which all MSFD targets are met. This scenario is offset against a baseline or 'business as usual' scenario. A scenario consists of a set of measures by which all MSFD objectives are met.

The second step describes the physical effects between a scenario and the baseline. Physical effects will be recorded in their own units of measurement, e.g. fish catches in tonnes/year.

The third step in the CBA is investigation of the welfare changes. The relation between measures, physical effects and welfare changes can be described and summarised by LDIs, Logical Diagrams of Impact. For example, measures to reduce litter will lead to cleaner beaches, enhancing their recreational value. Note that physical effects may have various (and possibly conflicting) welfare effects. In this section we focus on changes in economic value of the various functions associated with the North Sea. These values represent the benefits derived from these functions. Costs associated with actually performing the measures to meet the objectives of the MSFD are computed in the CEA , presented in Chapter 3. The benefits are described in Chapter 4.

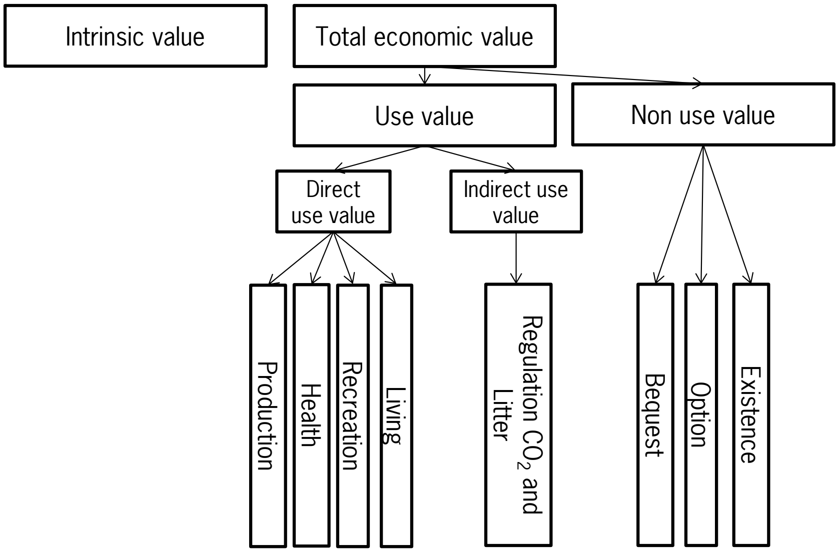
Figure 2.5	Summary of the CBA method in six steps

CBA step 1: Describe the planned MSFD scenarios and the current policy scenario
CBA step 2: Quantification of the physical differences between the scenario's
CBA step 3: Identification of the welfare effects
CBA step 4: quantification and monetarisation of the effects
CBA step 5: provisional SCBA
CBA step 6: sensitivity analysis

Economic values can be distinguished in use values, such as the production of seafood or recreation and non-use values; examples of the latter are the potential value for future generations, or the mere value assigned to the existence of the sea and sea life. Generally, quantification and expression in monetary terms (euros), which is the subject of step 4, is easier for use values than for non-use values, since the economic value can be approximated by market prices of the appropriate goods and services. See Figure 2.6 for a breakdown of economic values related to changes in the ecological status of the North Sea. Note that ecological or intrinsic values that are not associated with any present or future human awareness, have no place in this value system. Welfare or well-being of animals and plants as such are beyond economic valuation. However, as soon as anyone is prepared to pay for (i.e. to assign a value to), say, the mere existence of whales in the North Sea, this would immediately become an economic value, in this case a non-use value.

In the fifth step of a CBA, the positive effects (benefits) are compared to the negative effects (costs). In this step costs and benefits, both expressed in euros are compared. Since various costs and benefits are involved, generally referring to different time scales, investments or regular costs, all costs and benefits are discounted to one moment in time (present value). A sensitivity analysis (mainly on the quality of the information) completes the provisional CBA.

Figure 2.6 **Values related to changes in the ecological status of the North Sea**

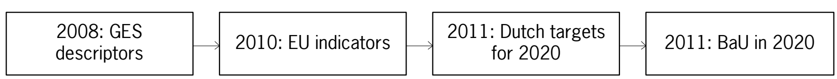


3 Cost-effectiveness analysis

In this chapter the short list of measures is evaluated according to the methodology described in Chapter 2. For a more coherent overview of measures, the measures were analysed for each GES descriptor. To assess whether a gap is foreseen the target and the autonomous development is presented for each GES descriptor.

The eleven GES descriptors are outlined in the Directive (EU, 2008). The Commission made a decision on criteria and methodological standards on good environmental status of marine waters in 2010 (EU, 2010). The Dutch MSFD includes only the part of North Sea. The Netherlands are responsible for setting the targets (within the European Directive) for the Dutch part of the North Sea. The Dutch indicators and targets will be set in 2012 in the Mariene Strategie (marine strategy). For this CEA study, a concept version of the Mariene Strategie is used. The Dutch interpretation of the marine strategy focus on the largest risks for the marine ecosystems and opportunities for sustainable use (DGSW, 2011).

Figure 3.1 GES descriptors, EU indicators and Dutch targets



The indicators used for this analysis are the indicators given by the commissioner. Based on these indicators and the corresponding targets, the gap analysis is carried out. For the GES descriptors which target was not met in the BaU, additional measures are necessary. If the target of a GES descriptor is met, no additional measures are necessary which implies that no further analysis has to be carried out for this specific GES descriptor. These are therefore only briefly dealt with. For the GES descriptors that do have a gap between the target and the business as usual scenario, additional measures were formulated. These measures were assessed for their effectiveness and costs. Based on this information the most cost-effective measures were selected per GES descriptor. In this chapter, for each measure, the effect on the target is presented, the uncertainty related with this effect and finally the costs are presented. Based on this information a cost-effectiveness analysis was carried out per

GES descriptor. The gap analyses are based on Textbox 3.1, complemented with consideration of DGSW (DGSW, 2011).

Textbox 3.1	Consideration of Ministry of Infrastructure and the Environment on the social economic concerns in setting targets

The most important present policies in the marine environment are Common Fisheries Policies, IMO, European Water Framework Directive, including 'basic measures' e.g. Nitrate Directive, Urban Waste Water Directive, IPPC, et cetera. The Ministry of Infrastructure and Environment assume that these policies will achieve their respective objectives, and by doing that, also achieve the objectives of the MSFD. E.g. the Common Fisheries Policies is expected to result in sustainable fisheries, IMO will prevent the introduction of non-native species, and the Water Framework Directive is expected to solve the eutrophication problems in the North Sea. If, unfortunately, these policies would fail to achieve their objectives, MSFD will address these other policy areas to achieve their objectives, because the marine environment is depending on that. In this way, MSFD will be agenda setting for the other policy arenas.

What has this got to do with social and economic considerations?
At present, a delicate process is under way for the Common Fisheries Policies, with all kinds of different stakeholders being involved. The inclusion of potential additional fisheries measures on top of the ones being proposed for the Common Fisheries Policies would destroy (the mutual trust in) this process, resulting in both social problems and economic costs. E.g. when partners do no longer trust the government and the negotiation process, they might turn to society and mobilise public opinion (or even vice versa; influence public opinion and mobilise society), which will cause partners to drift away from each other (social costs), and from the optimal solution, and slow down the process. Furthermore, within the negotiation process, win-win solutions are being looked for and often found. Destruction of the negotiation process would lead to second best solutions, which increase costs to society. In addition, the Common Fisheries Policies is Europe wide, thus assuring level playing field.

Above the situation is described for the Fisheries Policies, but the same applies for the other policies, e.g. Water Framework Directive and Nitrate Directive. With respect to noise, much is still unknown. For example, it is not clear whether ambient noise from shipping causes a serious problem for the environment. Since it is not known whether there is a problem in the first place, it is no use to already look for, let alone implement, additional policies.

Textbox 3.1	Consideration of Ministry of Infrastructure and the Environment on the social economic concerns in setting targets (continued)
The most important problem in the marine environment that is not handled or solved yet by present policies is waste (GES descriptor 10). The Dutch are performing a quick scan cost benefit analysis, the results of which will be helpful to determine the objective for this descriptor. Finally, as is the case in other policy areas, also for the MSFD the Dutch have stakeholder meetings and meetings with other departments to discuss the progress and decisions (to be) made for the MSFD, including discussions on the objectives and programmes of measures for the MSFD. The different economic and social analyses (including the quick scan CBA), but also other reports for the MSFD are input for these discussions (e.g. Targets and Indicators, GES, and the Initial Assessment). It is in these discussions and consequent decision making that the actual consideration of social and economic concerns takes place. The results of this will ultimately be included in the Dutch Marine Strategy.	

3.1 Descriptors GES 1 en GES 4: 'Biodiversity and Food web'

Biodiversity, abundances and reproduction potentials of many species are under pressure from a range of human impacts, particularly fisheries. Fisheries impact target species, other (bycatch) species and habitats (seafloor integrity) as well as inter-specific competitive and predator-prey relationships between species. There is little discussion that the North Sea biodiversity is well under that of a 'pristine' state. How this impacts ecosystem functioning, e.g. at the level of sustainability of exploitation, is less clear.

The EU specifies many different GES indicators (EU, 2010) for GES 1 and GES 4. For the Dutch situation, the indicators of GES 4 are set equal to that of GES 1. As the indicators for GES 1 and GES 4 are equal for the Dutch situation, these two descriptors are difficult to separate and taken together here. The GES descriptors are (EU, 2008):

1. Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.
4. All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.

The Dutch indicators (based on an earlier version of DGSW, 2011) used for this study are:

- Trend in population size and distribution of representatives of long-lived/vulnerable species of the benthic community, vulnerable bird species, and all regular occurring marine mammals (OSPAR EcoQOos);
- Size diversity index within the endangered and declining commercial and non-commercial fish species and vulnerable bird species;
- Distribution and pattern of habitats within the North Sea region (at EUNIS level 3).

Step 1: Gap analysis GES 1 and 4

As the target related to these indicators is not set yet, it is equally unclear how far we are currently removed from the targets of MSFD GES 1 and 4.

Nevertheless, as a wide range of fisheries-related measures is in place or under consideration, under the EU Common Fisheries Policy (CFP). Measures are directed at preserving the fisheries, the fish and other biota and certain habitat features such as Seafloor integrity (GES 6). The Commissioner of this study has stated that CFP is currently sufficient to bridge any gaps towards the targets of GES 1 and 4 and that additional measures under the MSFD are not needed (see Textbox 3.1).

Step 2: Pressures

Most human use of the seas affect biodiversity and ecosystem functioning to some extent. Relative impacts of the multiple-use of the seas are difficult to pinpoint, as these are rarely precisely measured and might interact with each other. Broadly speaking, extinctions might be seen as the ultimate state of species loss and reduced ecosystem functioning. Impacts leading to extinctions were ranked by Brander (2010):

- Exploitation 55%
- Habitat loss 37%
- Invasive species 2%
- Climate change/pollution/disease 6%

In the North Sea, fisheries cause most abundance and species loss, as well as habitat loss or habitat degradation (e.g. Lindeboom 2005). As fisheries are being dealt with under the CFP rather than under the MSFD, there is little scope for further treatment in this study.

Step 3: Additional measures
Of the measures on the shortlist, two measures can have a direct effect on GES 1 and GES 4.

Measure 51: Hard substrate items in bottom protection zones

According to the workshop participants, 'Silent construction methods' is not an additional measure. The Netherlands included this measure in the porpoise protection plan. This plan is carried out under N2000 and ASCOBANS (Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas). It is important to note that the porpoise protection plan is not area-specific, but generic to the whole NCP.

Step 4 and step 5: Description and quantification of the effect of the measures
Application of this measure with the aim to introduce an artificial reef, resulting in locally higher biodiversity could be an option. The substrate type and the exact location determine the effect on biodiversity. The effect of introducing hard substrate for maintaining soil disturbance as an enforcement measures is questionable. For example, introducing a ring around the Klaverbank requires a lot of rocks. The effect is that it is more difficult to fish. It is not desirable to have any stones in any habitat type, because the integrity of a specific habitat type is lost. The effect of the measure 'Hard substrate items in bottom protection zones' on GES 1 and GES 4 as enforcement measure is small, and in no relation to a measure as territorial protection.

The measure 'hard substrate items in bottom protection zones' can be made more specific by focusing on active recovering of shellfish banks (mussels oysters, spisula) The question is whether a measure as Marine Protected Areas will have the intended effect, in other words whether the natural dynamics of the system to return the animal shrill banks can be recovered in time. The answer to this question in unknown.

Uncertainty/certainty analysis
Should the CFP fall short in resolving all biodiversity and food web issues in the North Sea, additional measures, either under the CFP or under the MSFD might be considered. Before such additional measures can be considered, first a full gap analysis of all CFP is required. This falls outside the scope of the present study.

Step 6: Costs per measure
See Section 3.6.

Extra measures with an effect on GES 1 and IGES 4
A few new potentially attractive measures were put forward by the experts. These measures are not analysed in this study, but might be interesting enough to consider in next phases in the MSFD implementation process.

- Territorial protection as complement the birds and habitat directives. The determination of the size of this measure is a difficult choice.
- Protection of wrecks as point location for biodiversity (kind of artificial reefs)
- Species protection measures (plans)

3.2 GES descriptor 2: 'Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems'

In Olenin et al. (2010) the effect of invasive alien species (IAS) on the marine environment is described as follows:

> 'IAS cause adverse effects on environmental quality resulting from changes in biological, chemical and physical properties of aquatic ecosystems. These changes include, but are not limited to: elimination or extinction of sensitive and/or rare populations; alteration of native communities; algal blooms; modification of substrate conditions and the shore zones; alteration of oxygen and nutrient content, pH and transparency of water; accumulation of synthetic pollutants, et cetera. The magnitude of impacts may vary from low to massive and they can be sporadic, short-term or permanent. The degradation gradient in relation to non-indigenous species (NIS) is a function of their relative abundances and distribution ranges, which may vary from low abundances in one locality with no measurable adverse effects up to occurrence in high numbers in many localities, causing massive impact on native communities, habitats and ecosystem functioning.'

Step 1: Gap analysis GES 2
GES descriptor 2 of the Directive (EU, 2008) is as follows: Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystem. The EU criteria for GES 2 are (EU 2010):

2.1 Abundance and state characterisation of non-indigenous species, in particular invasive species;

2.1.1 Trends in abundance, temporal occurrence and spatial distribution in the wild of non-indigenous species, particularly invasive non-indigenous species, notably in risk areas, in relation to the main vectors and pathways of spreading of such species;

2.2 Environmental impact of invasive non-indigenous species;

2.2.1 Ratio between invasive non-indigenous species and native species in some well-studied taxonomic groups (e.g. fish, macroalgae, molluscs) that may provide a measure of change in species composition (e.g. further to the displacement of native species);

2.2.2 Impacts of non-indigenous invasive species at the level of species, habitats and ecosystem, where feasible.

The indicators used in this study are based on a concept version of the Dutch Marine Strategy 2.0 (DGSW, 2011): 1) Number of non-indigenous species; 2) Number of new non-indigenous species per year and 3) Ratio of non-indigenous species versus native species in a selection of groups (phytoplankton, benthos, fish) in Nature 2000 areas.

To get an idea of the autonomous regulation for non-indigenous species, the new IMO ballast water Convention is important. The IMO provides guidelines on how to deal with NIS. It is up to individual states to implement these guidelines in legislation/regulation. The legal status of the ballast water treaty depends on the number of countries that has ratified the Convention. If the required number is reached, there is a Treaty (above national laws). In that case, no separate implementation is required. Currently, the ballast water treaty has no legal status (IMO, 2011), but as ratifications are growing it is hoped that the Convention enters into force. The Netherlands had ratified the Ballast Water convention in 2010 as the fourth country in European Union.

According to Annex 26 of the Resolution MEPC.207(62) (IMO, 2011), the Marine Environment Protection Committee (MEPC) of the International Maritime Organisation (IMO) aims at minimising the risks associated with biofouling for all types of ships by providing a practical guidance to states, ship masters, operators and owners, shipbuilders, ship repair, dry-docking and recycling facilities, ship cleaning and maintenance operators, ship designers, classification societies, anti-fouling paint manufacturers and suppliers and any other interested parties. The recommendations of MEPC are voluntary mandatory since a state is free to determine the extent that the Guidelines are applied within that particular state. The biofouling guideline will be evaluated by the IMO to assess if it is effective, or that more mandatory measures are needed in the future.

In a separate Guidance document, based on these Guidelines, MEPC also provides advice relevant to owners and/or operators of recreational craft less than 24 metres in length, using terminology appropriate for that sector. The management measures outlined within these Guidelines are intended to complement current maintenance practices carried out within the industry. Effective biofouling management is directed to the prevention of biofouling accumulation in internal seawater cooling systems and sea chests. Other niche areas can also be particularly susceptible to biofouling growth. Therefore the MEPC drew up a catalogue of measures ranging from more effective anti-fouling systems to periodically undertaken in-water inspections and cleaning in combination with regular maintenance (i.e. polishing of uncoated propellers) with particular attention for niche areas such as sea chests, propeller thrusters, stabiliser fin apertures, et cetera. States are advised to take into account these Guidelines when developing other measures and/or restrictions for managing ships' biofouling.

Step 2: Pressures
Several vectors for NIS have been identified. Before considering these, it should be noted that there is a distinction between primary and secondary invasions. Primary invasions occur when a NIS reaches our country from outside their natural range. In practical terms this mostly means from outside Europe or from outside the NE Atlantic. Such NIS are species that did not occur in the Netherlands, or in the larger North Sea previously. After such a NIS has established itself anywhere in the North Sea, it might spread further, via secondary introductions. Most effort should go to preventing primary introductions, as secondary spreading may be impossible to prevent, after a species has become well-established, although further spreading might be slowed down.

Primary vectors:

1. Shipping (ballast water, hull fouling (including sea chest)): All international (trans-European or trans-Atlantic) commercial shipping, yachting, military shipping, 'technical shipping' and 'event shipping'.
2. Aquaculture: Deliberate introduction of commercial shellfish species for aquaculture from outside the NE Atlantic.

Secondary vectors:

1. Dispersal through artificial hard substrates put out at sea, such as buoys, offshore wind farms, artificial reefs, et cetera;
2. Dispersal with ships that have been stationary in an European port for an extended time period (providing opportunity for NIS to get attached to hull and

niche areas) that are then moved to another port. These include yachts put up for sale, ships kept chained up in port, to be released later;

3. Dispersal of commercial species, such as shellfish from outside the North Sea, from areas with aquaculture.

Step 3: additional measures

No additional measures are analysed in this study for GES 2.

Extra measures with an effect on GES 2

It was brought to our attention that military ports or parts of ports are off limits to inspectors. This, clearly, has no biological warrant. Military ports are not yet (officially) inspected, while navy ships can be a primary vector due to their prolonged presence in waters outside the North Sea.

Floating jetties, oil rig equipment, dredging machines are frequently used outside Europe and return to the Netherlands for maintenance and repair, they are not yet formally inspected because they are not treated in a harbour.

3.3 GES descriptor 3: 'Commercial fish and shellfish'

Step 1: Gap analysis GES 3

In Annex I of the MSFD, Descriptor 3 is formulated as (EU, 2008): 'Populations of commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of healthy stock.'

The efforts of the Dutch government in the reform of the CFP will be in accordance with the MSFD targets for GES 3 (DGSW, 2011). As measures with an effect on MSFD target 3 will be taken within the reform of the CFP, these measures are not additional for MSFD. Measures for Descriptor 3 are not taken in to account in this CEA.

3.4 GES descriptor 4: 'Foodwebs'

See Section 3.1

3.5 GES descriptor 5: 'Human induced eutrophication'

Step 1: Gap analysis GES 5

The 5th descriptor to achieve GES is as follows (EU, 2008): 'Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algal blooms and oxygen deficiency in bottom waters.'

This target is elaborated in indicators (EU, 2010). National targets and indicators have not been fully developed yet for GES 5. The indicator used in this study is: the percentage of dissolved inorganic nitrogen. This is one of the indicators in the concept version of the Mariene Strategie (DGSW, 2011).

Nitrogen is now the target nutrient, as levels of phosphorous inputs have greatly been reduced in recent decades. Concentrations have shifted away from the Redfield Ratio (the N/P ratio that is optimal for plankton growth) and measures that reduce N concentrations work towards restoring this ratio and towards reducing possibilities of excessive plankton growth. At the same time, reducing possibilities for plankton growth may propagate through the food web, resulting in poorer feeding conditions at higher trophic levels, i.e. fish and birds (Philippart et al., 2007); nutrient reduction measures should thus be closely monitored.

At the onset of this project the Ministry of Infrastructure and Environment considered GES 5 as a minor issue that should largely be tackled on land fully addressed by the Water Framework Directive, as the sources of nutrients that might cause eutrophication problems at sea are largely land-based (DGSW, 2011).

According to the experts present in the workshop desired nitrogen reductions will not be reached without additional measures. The indicators proposed by Deltares show that the current situation is quite different from GES. A point of concern among the workshop experts is that the GES 5 aims for N are unlikely to not be met by 2020.

Step 2: Pressures

- Riverine discharge, ultimately mainly stemming from agricultural applications.
- Maritime transporation (NOx): increase expected.
- Transboundery effects: very small. Not an issue.

Step 3: additional measures

No additional measures are analysed in this study for GES 5.

Proposed additional measures with an effect on descriptor 5

- Addressing NOx from shipping. This is being addressed under IMO.
- Signalling and monitoring the implementation of the water framework directive.
- Considering fertiliser use in agriculture.

3.6 GES descriptor 6: 'Seafloor integrity'

Seafloor habitats are physically and structurally diverse and productive. They provide ecological services (cycling carbon/nutrients) and ecological functions (food, refuge and reproduction). Substrate characteristics and benthic communities are vulnerable to physical damage. Therefore, an increase in the cumulative footprint of human activities on sensitive habitats has to be counteracted. Since it is recognised that the removal of an impact does not necessarily mean the state of the seafloor will return to its original condition, restoration measures are appropriate to achieve GES.

Step 1: Gap analysis GES 6

Descriptor 6 is formulated as (EU, 2008): 'Sea floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.' This target is elaborated in the following indicators (EU, 2010):

6.1 Physical damage, having regard to substrate characteristics (with many underlying indicators);

6.2 Condition of benthic community (with many underlying indicators).

The following indicators are used based on a preliminary version of the Dutch Marine Strategy (DGSW, 2011):

- Extent of the seabed significantly affected (EU) or not impacted by human activity in the previous year (Deltares);
- Presence of vulnerable benthos species;
- Multi-metric indices such as benthos species richness, evenness, Hill's index, BEQI;
- Length-frequency distributions of specific bivalves.

Specific parts of Natura 2000 sites (including the Frisian Front) are undisturbed; the remaining parts of the Dutch Continental Shelf (DCS) are fished in a sustainable way (to be achieved under the Common Fisheries Policy). The target will not be reached without additional measures. Large proportions of the DCS are fished with high intensity (more than one time per year); many benthic biota have regeneration times considerably longer than one year. Sand mining and coastal nourishment impact the seafloor near the shore. Autonomous development is an increase in these activities (Deltacommissie, 2008). This development may result in frequencies of coastal nourishment that surpass the physical and biological regeneration times of the seafloor; moreover, so-called mega-nourishments are considered that will effectively change the seafloor into sandbanks above the water (dry land) for decades.

DGSW (DGSW, 2011) considers that fisheries will be regulated under the CFP and coastal nourishments under a separate set of rules and guidelines, so that additional measures under the MSFD are not to be considered here. Zoning of activities, i.e. restricting fisheries to certain plots while closing other parts for fisheries on a larger scale (PBL, 2012), is not part of this study either.

Step 2: Pressure

The main pressures are fisheries, particularly beam trawling, sand mining, and coastal nourishments.

Step 3: Additional measure

The measure of introducing hard substrate items in bottom-protection zones is potentially useful as an additional measure in order to achieve GES on seafloor integrity. In the workshop the following aspects of the measure were discussed:

1. The measure is not meant to reduce adverse activities (bottom trawling and sand mining) with respect to sea-floor integrity. The Dutch Government has other tools to restrict fishing and sand mining from bottom protection zones. Sand mining, in fact, is already restricted to areas outside bottom protection zones. Fishing in Natura 2000 zones is to be regulated in the management plans for these areas (no boulders required); at present fishing continues in these areas.
2. Three (future) bottom protection zones could in theory be targeted: the Natura 2000 site Cleaver Bank, the Borkum Reef (still considered as a future Natura 2000 site) and the Texel Stones Area (no Natura 2000 site or consideration as such in the future). The Cleaver Bank still has stones and it is unclear if many have been removed there. The Texel Stones Area has no status as a Natura 2000 site, and dumping stones there seem politically unfeasible. The Borkum Reef might be the only area where this measure might be applied, but first the Natura 2000 status needs to be established
3. Stones are already applied to the DCS sea-floor in rather large quantities, to seal off pipelines and cables, and to protect objects put onto, or into the

seafloor such as offshore wind farm turbines and oil and gas installations. It was noted that some 3000 m^3 of stones were applied to such a platform at the Cleaver Bank in the 1980s.

4. A suitable location for introducing stones/boulders would be 'Texelse Stenen', an area of about 50,000 hectares northwest of the island of Texel nearby the 'Diepe Gat'. According to Lindeboom et al. (2008) Texelse Stenen assumedly had an enriched fauna. Due to intensive fishing almost all boulders and big stones have disappeared, either by fishing them or burying with sand. Today there is no longer a distinct habitat.
5. A reference area to determine the density of stones to be achieved, is Borkum Reef, an area of 1400 km^2 adjacent to the German Natura 2000 site 'Borkumer Riffgrund'. During a 5-day side-scan sonar survey in that area Bos et al. (2010; not yet published) found that there are parts which are still strewn with hundreds of rocks bigger than 30 cm. The proportion of the area that contains stones and boulders is estimated at 25%. The biggest boulders found had the size of megaliths. In order to use area-specific stones, it is advisable to investigate whether it is possible to reintroduce stones that come from the Texelse Stenen and have been dumped on land nearby.

Step 4 and step 5: describing and quantification of the effects of the measures
In general, adding stones to the seafloor may increase the potential of settlement and survival of some stone-associated benthic organism and thus help to increase/restore benthic biodiversity. An adverse effect may occur when non-indigenous species invade due to the dumping of stones. If, in addition, fisheries is banned from the target area, also benthos living between the stones will benefit. It should be noted that banning fisheries per se, without the extra stones, would have the same effect (leaving the stone-associated organisms aside). The effect of the measure on the target could not be quantified due to lack of detailed data. Most probable, the gap will be slightly reduced.

Uncertainty/certainty analysis
Largely uncertain due to lack of data on specific benthos still present in target areas and lack of specific monitoring data to estimate gap, and dose-effect relation of the measure.

Step 6: The costs per measure
Not addressed in full by experts. It was noted that Greenpeace has undertaken a stone-dump already, suggesting that costs are manageable. What would be needed is shiploads of stones from e.g. Norway. Such transports already occur regularly and if the measure could be combined with current work, costs would be reduced. If we assume that one big stone per hectare is needed in an area of 50,000 ha. The cost of 1 m^3 of stones is approximately €300.

3.7 GES descriptor 7: 'hydrographical conditions'

Step 1: Gap analysis GES 7
In Annex I of the MSFD Descriptor 7 is formulated as (EU, 2008): 'Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems.' It is not possible to formulate generic and quantitative targets for this GES descriptor. Effects of hydrographic operations depend heavily on local conditions and impact-effect relationships.

Within existing legislation (current licensing measures based on Natura 2000), no gap between autonomous realisation and MSFD target is expected. This implies that no additional measures are needed (DGSW, 2011).

3.8 GES descriptor 8: 'Contaminants'

Step 1: Gap analysis GES 8
In Annex I of the MSFD Descriptor 8 is formulated as (EU, 2008): 'Concentrations of contaminants are at levels not giving rise to pollution effects.' In legal terms, this may be formulated as: 'Concentrations are below standards set by -) national and international legislation.' These indicators are criteria for the concentration of contaminants and for the effect of contaminants (EU, 2010):
8.1 Concentration of contaminants (with many underlying indicators);
8.2 Effects of contaminants (with many underlying indicators).

Workshop experts recognised the suitability of the indicators as proposed by Boon et al. (2011), but stated that currently a regional discussion is conducted on the applicability of EAC (Environmental Assessment Criteria; OSPAR standards). Furthermore, the suggested indicator on concentrations of contaminants in sediments is under discussion due to political synchronisation with the Water Framework Directive.

The targets will not be reached without additional measures. Specifically concentrations of a selection of contaminants are above international and national standards, and EcoQOs on imposex targets and oiling rate targets will not be reached in 2020. Effect targets such as imposex will not be met in 2020, but might be met in 2027 due to stricter IMO regulations. However, there is a lack of frequent monitoring and as a result no detailed information exists.

Oiling rates in quillemots remain point of concern although long-term trend is clearly downward. The foreseen increase in shipping, however, might counteract the current trend. Furthermore, other components than oil, such as paraffin, palm oil, glue-like substances and other lipophilic compounds, have the same effects but are not always recognised as such (Camphuysen et al., 1999). The full reach of the problem is currently not recognised, and is not handled accordingly in current legislation.

The Ministry of Infrastructure and the Environment considered contaminants to be a minor issue, as contaminant levels are mostly below legal limits and sources are largely land-based, i.e. the problem should be approached on land (source) rather than at sea (sink). No additional measures on top of the one analysed within this study are needed above the WFD and above IMO according to the Ministry (DGSW, 2011).

Step 2: Pressures

Several activities and sources contribute to the introduction of contaminants and their related effects. However, once introduced, contaminants might persist in the marine environment for a longer period (e.g. TBT). Most important sources are: i) Maritime transport, ii) River discharge, iii) Atmospheric deposition and iv) Oil platforms.

The major contaminants are:

- Metals (Copper, Zinc, Cadmium, Mercury et cetera). Sources and problem areas are diffuse;
- Pesticides, dioxins, PCBs (Polychlorinated Biphenyls) and PAHs (Polycyclic Aromatic Hydrocarbons). Sources and problem areas are diffuse;
- TBT (Tributyltin): Measures are taken by IMO (global ban on TBT in antifouling paints). However, this compound is very persistent. Degradation is slower at lower temperatures than described for 'normal' conditions. It is expected that TBT will remain present in the marine environment for decades to come. TBT effects are more severe in marine ecosystems than in freshwater ecosystems, and imposex is not the only effect related to TBT. Effects on other ecosystem components are described, even at very low concentrations (nanograms). Experts note that the TBT issue is probably an

underestimated problem. The ban on TBT might not be enough to achieve GES in 2020 or in periods thereafter;
- Oil: floating oil slicks are found across the North Sea, due to accidents and 'chronic pollution', i.e. deliberate operational spills, as evidenced by a spatial correlation between slick occurrence and locations of shipping lanes (Camphuysen et al. 2009). Seafloor contamination mainly occurs after clean-up operations (using detergents) and around active and decommissioned oil and gas platforms, where oil-based drilling muds have been used in the past (no longer allowed at the DCS).

Step 3: Additional measure

Dredging of contaminated sediments is considered to be potentially useful as an additional measure in order to achieve GES on contaminant concentrations.

In the workshop the measure was judged as not applicable (quote 'absurd'), because most contaminants are widely distributed, and dredging cannot be directed to a specific problem area in order to tackle the general problem of contaminants in sediment. General statement by experts was that 'once contaminants are at sea, no cost-effective measure is applicable'. Applicable measures should not focus on 'end of pipe' situations (as the marine environment), but at the source instead. Furthermore, sediment related measures under MSFD are politically 'no go' discussions, due to synchronisation with WFD.

An adjustment to the measure was proposed instead: dredging on hotspot locations, e.g. harbours. The measure was adjusted to 'Dredging of hotspots' as it is believed among the experts that harbour sediments are a potential additional and localised source of TBT to the marine environment. Handling this potential source is in line with the general agreement that measures at the source are more meaningful than 'end of pipe' measures. In the open sea, the diffuse character of marine pollution would make dredging prohibitively expensive, or simply not effective. Close to the shore, both the WFD and the MSFD apply. In these areas the MSFD only applies for aspects of Good Environmental Status that are not already addressed by the WFD. As the proposed TBT measure is not addressed by the WFD, it may be considered an additional MSFD measure.

Even TBT, for which the source (shipping) is known and for which it is known that concentrations in the sediment decrease with decreasing shipping intensity (i.e. distance from major shipping lanes; Ten Hallers-Tjabbes et al., 2003), cannot simply be removed from the marine environment by dredging, due to the sheer size of areas covered by shipping lanes in the North Sea. This measure is evaluated in the next section.

Step 4 and step 5: describing and quantification of the effects of the measures
In general, a decrease of concentrations of contaminants can be observed based on present monitoring. However, the exact rate at which the gap is being closed is hard to establish, as detailed monitoring is lacking. Effectiveness of (additional) measures cannot be inferred from available data. The effect of less TBT leaching from harbour sediments into the North Sea is beneficial to the North Sea environment. Less TBT helps to reduce the incidences of intersex, imposex and delays in growth and development of susceptible biota in the long term. Reducing impacts on sensitive species helps conserving biodiversity. The adjusted measure could not be quantified due to lack of detailed data.

Other hotspots at which the measure could be adjusted to are:

1. Shipping lanes (TBT). Experts note that dredging at hotspot locations should be considered only in case of dredging needs from another perspective, e.g maintenance. Only in this manner the operations are considered cost-effective. Note that dredging for maintenance of shipping lanes is restricted to small parts only (like harbour approach channels) but also that these will have the most polluted sediments due to traffic concentration;
2. Harbours (several contaminants, but particularly TBT). Harbours are potential sources of TBT (via resuspension and re-allocation). MSFD should signal this aspect, and allocate this to Water Framework Directive as harbours are outside MSFD, but inside WFD jurisdiction. To quantify the effect of this measure (dredging harbour sediments), the experts did not have the information to fully address this issue during the workshop. Estimations can be made from harbour reports on TBT concentrations in sediments, and total volume of sediments dredged from Dutch harbours. Removing contaminated sediments from the system, rather than dumping them at sea affects all locally present contaminants, not just TBT. Currently, the environmental benefits cannot be properly assessed, due to lack of data available to the experts consulted;
3. Oil and gas platforms; historic contaminations from drilling with oil-based muds are still present around some platforms. Contaminations are restricted in range and should be removed, e.g. when platforms are ultimately dismantled after depletion of the hydrocarbon resource;
4. Historic sediment deposit locations such as Loswal. Although (harbour) sediments have been dumped here under criteria legally set for deposits at sea, the sea floor is still contaminated here;
5. North Sea coastal zone. Via beach nourishments additional sand is deposited in the coastal zone. Only when sediments are applied that were extracted from highly polluted areas, such as harbour approaches (Euro geul, IJ geul)

might this be a problem, Such sediments should be properly tested for contaminants before nourishment.

Uncertainty/certainty analysis
No monitoring data available to estimate gap, or effect relation with measures.

Step 6: The costs per measure
Expert opinion was that costs were probably prohibitively large in most cases, as affected areas are very large. Costs of dredging depend on the specific characteristics (soil, accessibility, sailing distances, et cetera) and will range from €2 and €40 per m^3 for maintenance dredging, beach nourishments and land reclamation (source: http://www.iadc-dredging.com). The price of dredging in harbours is probably similar. However, in addition, larger costs are involved for discarding or cleaning large volumes of contaminated sediments.

Potential for increasing cost-effectiveness:

- Combining efforts , e.g. combine with maintenance dredging;
- Mining of metals out of dredged (maintenance) material, production water, drilling muds.

3.9 GES descriptor 9: 'contaminants in seafood'

Step 1: Gap analysis GES 9
In Annex I of the MSFD Descriptor 9 is formulated as (EU, 2008): 'Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards.' The levels of contaminants in fish and fish products do not exceed the norms of national and international legislation. DGSW expects that this will remain without additional measures (DGSW, 2011).

3.10 GES descriptor 10: 'marine litter'

Step 1: Gap analysis GES 10
Marine litter results from human actions and behaviour, whether deliberate or accidental, and is the product of poor waste management, inadequate infrastructure and a lack of public knowledge about the potential consequences of inappropriate waste disposal (UNEP, 2009). In Annex I of the Marine Strategy Framework Directive Descriptor 10 is formulated as (EU, 2008): 'Properties and

quantities of marine litter do not cause harm to the coastal and marine environment.' This target is elaborated into the following indicators (EU, 2010):

10.1 Characteristics of litter;
- 10.1.1 Trends in the amount of litter washed ashore;
- 10.1.2 Trends in the amount of litter in the water column;
- 10.1.3 Trends in micro-particles;

10.2 Impacts of litter on marine life;
- 10.2.1 Trends in litter ingested by marine animals.

Targets have to be set for these indicators.

The GES 10 target used in this study is: litter shows a negative trend in the sea water, biota and on the beach compared to the level in 2008 (DGSW, 2011). The quantity of litter on the beach can be an indicator for the amount of litter at sea. This first indicator is a decrease in the amount of litter washed ashore. The quantity of plastic in the stomach of Northern Fulmars is the second indicator for the amount of plastic ingested by marine animals and for plastic floating at sea. In the OSPAR EcoQO approach for the North Sea, an undated target has been set that there should be less than 10% of Northern Fulmars having more than 0.1 g of plastic particles in the stomach (in samples of 50-100 fulmars washed ashore in all North Sea regions for a period of 5 years). This last target is not included in the Dutch Marine Strategy (DGSW, 2011).

Step 2: Identification of pressures and impacts

Marine litter has been monitored for the last 10 years on four reference beaches in the Netherlands (Stichting de Noordzee, 2011), but trends have not yet been assessed. At the greater scale of the OSPAR region, trends across 50 beaches are apparently largely stable or slightly increasing. Statistical analyses of beach data from the Monitoring of marine litter in the OSPAR region (OSPAR Commission, 2007) indicate neither a significant increase nor a significant decrease in the average numbers of marine litter items found in the surveys made on the 100-metre stretches of the regular reference beaches over the OSPAR region as a whole during the pilot project in the period 2001-2006. Monitoring of marine litter in stomachs of beached Northern Fulmars has been done since the early 1980s. Consistently well over 90% of beached Fulmars had plastic in the stomach. Substantial changes in quantity and composition of ingested plastics were observed, but for recent periods statistical analyses show no significant change (Van Franeker et al., 2011; Van Franeker and the SNS Fulmar Study Group, 2011). In addition, the cost of marine litter to marine users and coastal communities continues to rise (Ten Brink et al., 2009, p118). Costs due to marine litter are presented in Chapter 4.

Sea
Globally, ship-generated litter and cargo residues contribute approximately 20% of the discharges of litters and residues at sea (EMSA, 2011). According to Van Franeker and the SNS fulmar study group (2011) shipping (including fisheries) is a major source for marine litter in the North Sea. The large difference in pollution between the Channel and Scottish Islands is an indication that a large portion of North Sea marine litter is of local origin. In contrast with the global pressures, litter in the North Sea is for an important part linked to sea-based activities, in particular shipping and fishing. However, riverine outputs (land-based source) have not yet been researched explicitly.

Table 3.1 **Top 10 items on Dutch North Sea seabed (in the waterways where vessels from IJmuiden fish) in 2010**

	Item	**Litter items per 20 tonnes**
1	Paint cans	82
2	Gloves	73
3	Oil filters	57
4	Buoys	51
5	Rubber flaps	43
6	Paint rollers	38
7	Tyres	36
8	Ropes and cords	37
9	Clothing and shoes	31
10	Steel wire	30

Source: Fishing for Litter (2006-2010).

There is a range of initiatives at the global, regional and national level that have been implemented to help address the problem of marine litter. Three international conventions address various aspects of marine litter: Annex V of the International Convention for the Prevention of Marine Pollution from Ships (MARPOL 73/78), the Convention for the Prevention of Marine Pollution by Dumping of Wastes and other Matter (the London Convention) and the Convention on the Transboundary Movements of Hazardous Wastes and Their Disposal (the Basel Convention) (Ten Brink et al., 2009). Also EU legislation has been introduced such as the Directive on port reception facilities for ship-generated waste and cargo residues (EC2000/59), with the aim to reduce illegal discharges from ships using ports in the Community, by improving the availability and use of port reception facilities, thereby enhancing the protection of the marine environment.

'Fishing for litter' is a programme run by the Dutch, Belgian and UK Government to stimulate fishermen to bring litter caught in their nets ashore, rather than dumping it back into the sea. This programme is considered highly suitable for stimulating public awareness, but is regarded as unsuitable for statistically founded monitoring. Most of the fished litter are wastes from ships and boats (see Table 3.1)

Beach

The North Sea Directorate monitors quarterly four different beaches along the Dutch coast on litter. These beaches are located in Zeeland, South Holland, North Holland and on the islands. Over a distance of one hundred meters, all available items are counted using a standardised list. Also, all items larger than 50 cm are counted, over a distance of one kilometre. The beaches where the counts are made are more remote beaches. These counts are performed to get an idea of the amount of litter in the North Sea. In the period 2005-2010 the North Sea Directorate found an average of 387 litter items on one hundred meters beach. If that translates to the entire Dutch coast and is based on a coastline of 340 km, this amounts to over 1.3m items of litter. Over the last ten years, the trend is stable (the amount does not increase but decreases either). This is a sign that the amount of litter in the North Sea is stable.

Table 3.2	Top 10 items on Dutch beach (non-tourist beaches) in 2010		
	Item	**Item % of total litter**	**Number of items/100m**
1	Rope and cord (diameter <1 cm)	22.3	86.3
2	Plastic or polystyrene from 0 to 2.5 cm	13.3	51.4
3	Nets or 3 pieces just <50 cm	5.7	22.1
4	Caps	5.5	21.4
5	PUR foam	5.2	20.2
6	Plastic or polystyrene 2.5 <5.0	5.0	19.2
7	Balloons	3.5	13.6
8	Bags of crisps and candy, lollipop sticks	3.5	13.5
9	Entangled nets/rope/cord	3.4	13.1
10	Other plastic or polystyrene items	2.5	9.9

Source: Draft Monitoren zwerfvuil (2005-2010).

Table 3.2 presents the top 10 litter items found on Dutch, non-tourist beaches. On the reference beaches 87% of all litter in 2010 consisted of plastic (similar to percentages in previous years). In reality, the percentage of plastic in the number of litter items is even higher because plastic pellets and small frag ments are not included in these figures (see Textbox 3.2). Plastic bags constitute a significant part of litter on Dutch beaches (North Sea Foundation, 2011b). Nylon ribbons and balloon remains contribute to the amount of litter in the sea. The valves used on helium-filled balloons are often made of hard plastics and the ribbons from hard nylon-like materials that remain in the marine environment for a very long time.

The detected amount of crisps and candy bags and lolly sticks are considered to be an indicator of tourism. Their amount is striking (14 items/100 meters) because there are no beach pavilions in the vicinity of the reference beaches and these beaches do not attract many tourists. In other years, similar amounts of crisps, candy bags and lolly sticks were found.

The amount of lost and discarded nets by Dutch fisherman is unknown. Lost and discarded pieces of netting are an important component of the litter problem. Nets are recognised as a particularly hazardous form of marine litter for the marine environment (Ocean Studies Board, 2009). Netting is frequently found in beaches and is a known threat to e.g. seabirds, like the Northern Gannet, which rather often is found entangled (and dead) in such pieces of netting (Camphuysen, 2001). Ghost nets are a problem to biota that get entangled in these nets. This applies to large and small parts of netting floating around or settling on the seabed or beaches. Small parts of netting might be taken for food by fish and birds, and be ingested. Northern Gannets and other seabirds frequently use discarded netting as nesting material, with entangled birds (chicks and adults) at the nesting sites as a deadly result. Reducing the amount of netting entering the sea by implementation of a deposit return system would thus help to reduce the gap.

Textbox 3.2	**Small plastic pellets**

Plastic (resin) pellets *are the raw materials for plastic products. Plastic may be formed into pellets of various shapes, sizes and colours. The most commonly produced resins include polyethylene, polypropylene, and polystyrene. After being formed, the pellets are packaged and transported to processors for molding into plastic products (US EPA, 1993).*

Trends of marine pellet pollution worldwide are negative. New players, i.e. companies producing pellets from recycled plastics are apparently less regulated and constitute a growing part of the problem (Van Franeker, pers. comment). A level playing field, i.e. applying the same rules to newcomers, would further reduce the gap. All industrial plastics taken together are only a minority (20%) of current mass of plastics in stomachs of northern fulmars (showing a negative trend). The expert opinion is that the inflow of plastic pellets will decrease autonomously, reducing the pressure of plastic pellets in sea.

Pellet loss can occur at any stage of operations. Open valves, outlet caps and top hatches are frequent causes of material spills (Source Operation Clean Sweep, October 2010). In terms of transports of plastic pellets - for which a different packaging standard might yield in less pellet loss - large bags conveyed in ocean containers are currently mainly used. These containers are transported on containerships over the oceans.

The items larger than 50 cm are counted as a separate category. The top three items larger than 50 cm stem all from either fisheries or ships (see Table 3.3).

Table 3.3	Top three items on the Dutch reference beaches per 1 km (items larger than 50 cm)			
Position 2009	**Position 2010**	**TOP ITEMS 1 km (>50 cm)**	**Total Litter (>50 cm) (%)**	**Number of items/km**
1	1	Nets or pieces of net	23.8	16.5
3	2	Packaging materials and coatings	16.1	11.1
2	3	Ropes and cord (diameter <1 cm)	14.5	10.1
		Top 3 items	54.5	37.7
Source: Draft Monitoren zwerfvuil (2005-2010).				

Biota/Northern Fulmars

The incidence of plastic in stomachs of fulmars from the Netherlands averaged 91% in the 1980s, increased to about 98% around the year 2000. During 2003-2007, 95% of 1295 fulmars sampled in the North Sea had plastic in the stomach (on average 35 pieces weighing 0.31 g) and the critical level of 0.1 g of plastic was exceeded by 58% of birds, with regional variations ranging from 48 to 78% (Van Franeker et al 2011).

After the mid-1990s the percentage of birds exceeding the critical level of 0.1 g ingested plastic did show a 10% decrease but this has not continued in the most recent periods. Long-term data for the Netherlands since the 1980s show a decrease of industrial (resin pellets), but an increase of user plastics, with an approximately level overall trend, and shipping and fisheries as the main sources. Recent trends suggest a very slow decrease in marine litter, but at totally insignificant level (Van Franeker and the SNS Fulmar Study Group, 2011). At such rate this will certainly not achieve the OSPAR EcoQO target by 2020 and it is unlikely that the trend could be significantly negative by 2020. Measures to reduce streams of industrial plastics entering the marine environment have thus yielded significantly positive results, but this gain has been countered by increasing streams of user plastics. Vectors for these are direct dumping into the sea (shipping) and land and riverine runoffs. Any piece of plastic, manufactured anywhere in the world may find its way to the oceans, which are downstream from everything. Only reducing production of synthetic plastics, or recycling for reuse potential (without loss of quality of material = downcycling), may reduce the constant stream of plastics into the oceans. The percentage of plastics recycled is 'diddly point squad' (Moore, 2009).

Textbox 3.3	Sources of marine litter

The United Nations Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP) categorised litter into four major groups:

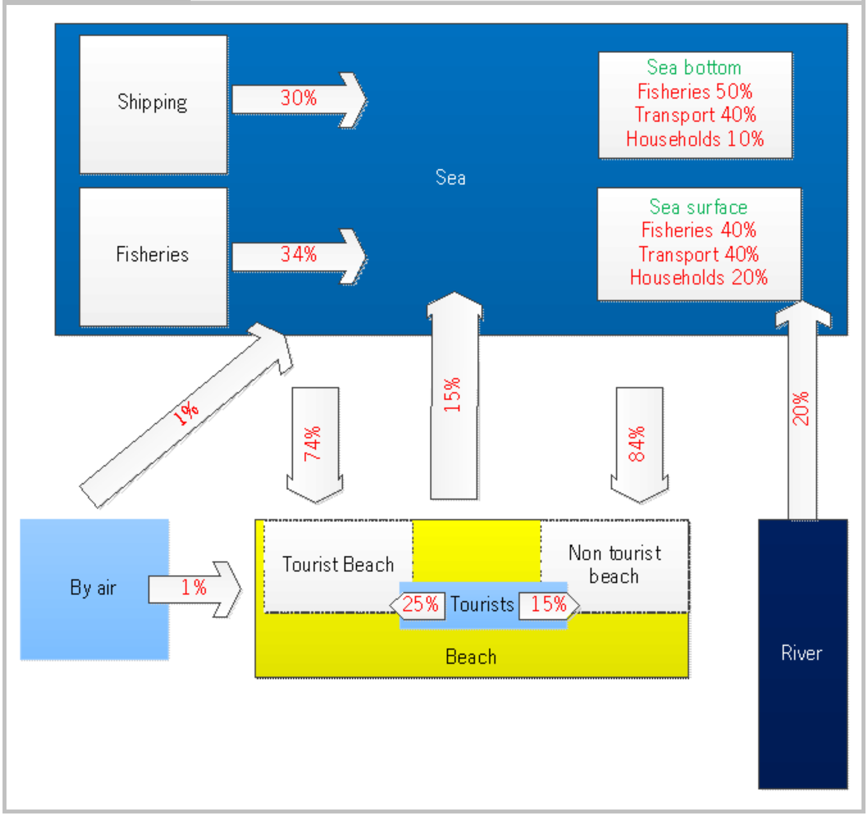
- Tourism related litter at the coast: this includes litter left by beach goers such as food and beverage packaging, cigarettes and plastic beach toys;
- Sewage-related debris: this includes water from storm drains and combined sewer overflows which discharge waste water directly into the sea or rivers during heavy rainfall. These waste waters carry with them garbage such as street litter, condoms and syringes;
- Fishing related debris: this includes fishing lines and nets, fishing pots and strapping bands from bait boxes that are lost accidentally by commercial fishing boats or are deliberately dumped into the ocean;
- Wastes from ships and boats: this includes garbage which is accidentally or deliberately dumped overboard.

Marine litter originates from numerous different sources (see Textbox 3.3) with approximately 80% of litter entering the marine environment from land-based sources (world-wide) and the remaining 20% originating from sea-based sources, although this varies between areas (GESAMP, 1991; Mouat et al., 2010). The experts in the workshops considered that the proportion of sea-based litter on Dutch beaches is relatively high. In the 2005-2010 period 44% of the litter found on beaches originates from shipping and fisheries (Draft Monitoren zwerfvuil, 2005-2010). This could be an indication that most litter in the North Sea originates from shipping and fisheries. Thirty percent of litter stems from land based sources. From 26% of litter the origin is unknown (Draft Monitoren zwerfvuil, 2005-2010). From a large scale study on the island of Texel in 2005, Van Franeker (2005) concluded that by far the majority of litter originated from sea based sources. Hence the division of litter over sources in the North Sea differs largely from the figures presented by GESAMP (1991).

From all plastics in sea around 15% is washed up ashore on beaches, 15% moves around in the sea due to the sea-currents and 70% is estimated to sink to the sea-floor and is covered with sediment (source: Plastic Soup Foundation, Ministry of Infrastructure, Environment and Waterworks).

The link between sources of litter, and litter found on beaches is not understood enough. Furthermore, there is a lack of evidence describing the effect of marine litter on the marine ecosystem. Figure 3.2 gives an impression of the sources responsible for litter entering the sea. Figure 3.2 presents a schematic overview of the sources of litter entering the sea. The anchors depict the vectors of litter. The percentages are very rough estimates.

Figure 3.2 **Sources of litter entering the sea (Percentages are very rough estimates)**



Step 3: Additional measures with an effect on GES 10

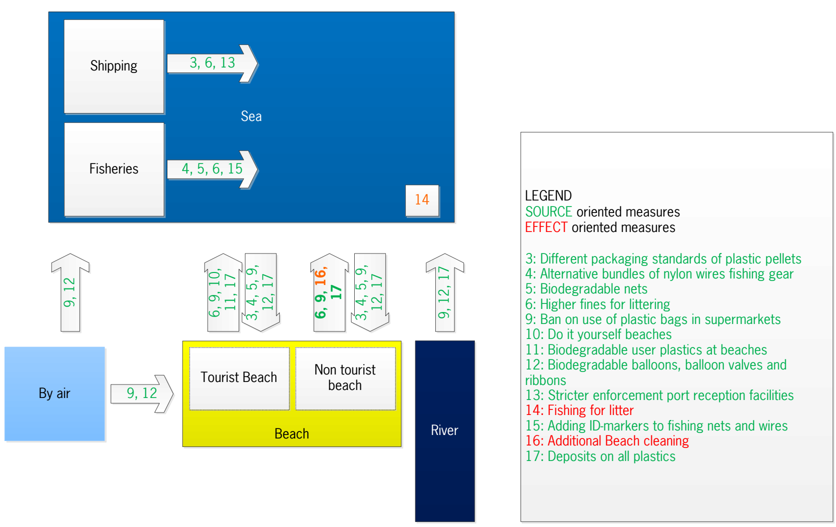
The Commissioner of this report considers the following list of measures to be beneficial in addressing the issues related to GES 10:

3: Different packaging standards of plastic pellets;
4: Alternative for bundles of nylon wires used to protect fishing gear;
5: Biodegradable nets;
6: Higher fines for littering;
9: Ban on use of plastic bags in supermarkets;
10: Do it yourself beaches (Bathing beaches);
11: Biodegradable user plastics at beaches;
12: Biodegradable balloons, balloon valves and ribbons;
13: Stricter enforcement on the use of port reception facilities to collect waste;

14: Fishing for litter;
15: Adding individually recognisable ID-markers to fishing nets and wires;
16: Additional Beach cleaning (non-bathing beaches);
17: Deposits on all plastics.

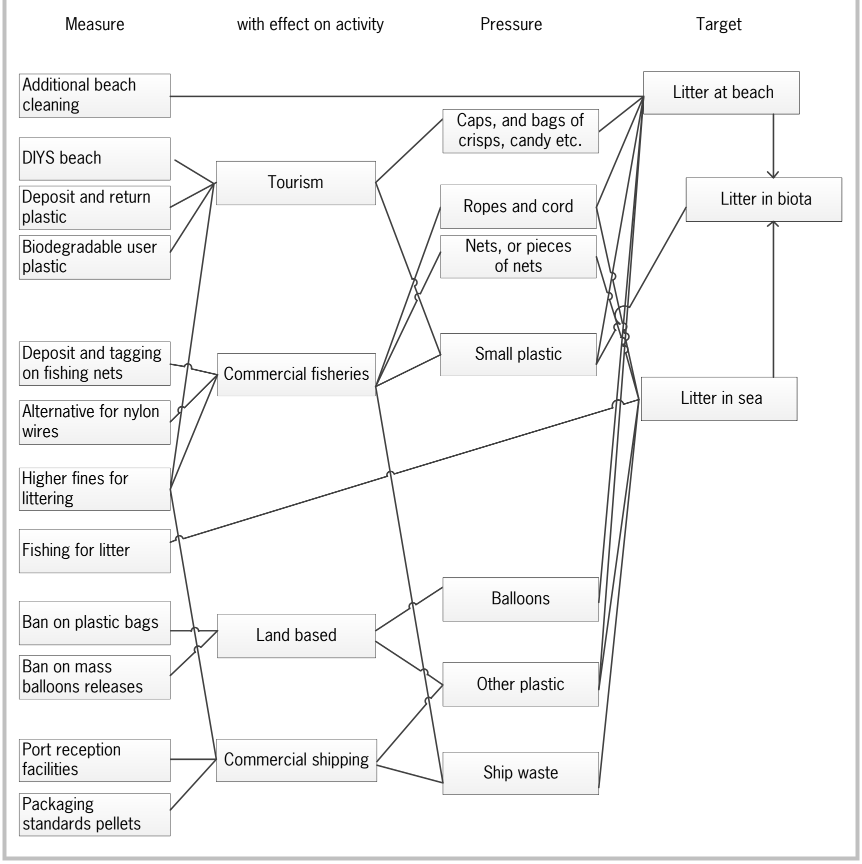
In Figure 3.3 these measures are classified according to the way they affect the litter quantity. Measures that effect the amount of litter disposed of in the (marine) environment are source oriented measures. They will reduce the pressure at the source. Another category of measures reduces the pressure (and its effect) reducing the amount of litter after it has entered the (marine) environment (the effect oriented measures).

Figure 3.3 **Measures divided into source or effect orientation, the driver (shipping, fishing, tourism) or the target (sea, beach biota)**



The logical diagram of impact (LDI) for GES 10 is showing the relation between the litter measures and the target. The number of measures and the intensity of the measures needed depend on the ambition of the Netherlands, reflected by the target values set.

Figure 3.4	Logical Diagram of Impact GES 10: Litter



In the rest of this chapter, the measures will be specified. Per measure, first the pressure and factors responsible for the pressure on which the measure intervened are described (step 3). Then, the effect will be described (step 4), quantified (step 5) and the costs of the measure will be determined (step 6).

Measure 3: Different packaging standards of plastic pellets

Step 4 and step 5: Describing and quantitative assessment of the effect of the measures on the gap

Compared with larger forms of litter, plastic production pellets are more difficult to clear from a beach but are aesthetically less obtrusive. The main ecological risk associated with pellets, however, appears to be their inadvertent (or sometimes selective) ingestion by animals, including birds, fish and invertebrates, resulting in diminished foraging ability and feeding stimulus, loss of nutrition and intestinal blockage (Ashton et al., 2010).

The effectiveness of the measure is unknown. Plastic resin pellets are produced in a very high production volume all over the world. Worldwide production of plastic grew by more than 500 per cent over the last 30 years till approximately 80m tonnes in 2010. Current annual global plastic resin pellet production is estimated at over 244bn kilogrammes and is expected to increase by 3 per cent a year (World Plastic Market Review and PlasticsEurope Market Research Group 2010). A tiny percentage of this production volume spilled in the marine environment already constitutes a large volume, with potentially negative effects on biota.

Experts indicate another production method for plastics, evading the use of plastic pellets in the production-process globally, might be more effective to decrease the introduction of plastic pellets in the marine environment. Another less drastic measure with some effectively to direct spillage of pellets in the sea according to Operation Clean Sweep is to: Place resin containers in ship holds and avoid or even prohibit stowing resin containers on deck. Both measures are not further elaborated here.

The source and age of resin pellets is hard to identify. Hence the relative contribution of separate industries and transporters is unknown, which makes it difficult to determine effective source based measures. More stringent rules would mainly affect new industries.

The costs of this measure are not elaborated.

Measure 4: Alternative for bundles of nylon wires used to protect fishing gears

This measure deals with an alternative for the bundles of nylon-wires that are used to protect bottom trawling gear. In the Dutch North Sea, these bundles are used to protect the nets of conventional beam trawling and the new Pulse/Sumwing technology.

Fishing gear protection, by definition, is wear-resistant. Alternatives that are 'softer' than current ones may not be supported by the fishing industry (because they are less effective). Degradable plastics are no alternative since these plastics will only break up in smaller pieces more easily, i.e. leading to micro plastics pollution. Metal (iron) would seem too heavy; teflar too expensive; wood/sisal too soft. Coconut matting is considered as a potential alternative.

A life cycle analysis (impact analysis) is needed on the effects of use of coconut matting.

Step 4 and step 5: describing and quantitative assessment of effects of the measures on the gap
The effect of an alternative for these wires on the gap is not quite clear because nylon wire fragments from net protection bundles form one (but an important one) of the many sources for the rope and fragment category in Table 3.3.

Uncertainty/certainty analysis
At this moment, no alternative is available on the market. However, the first steps are made to look for solutions. The sector considers potential alternatives as not feasible yet. However, the first steps are made to look for solutions.

Step 6: The costs per measure
Currently 220 beam trawlers fish on the DCS (Dutch Continental Shelf). It is estimated that each of these ships annually spends around €0-5,000 on nylon wires to protect their gear. The €0-5,000 are the costs of replacing these bundles. This, however, does not mean that this amount of money is equivalent to that of the alternative, it seems plausible that the alternative is more costly (or has to be replaced more often). Therefore we assume additional costs from €0-5,000 per beam trawler.

Measure 5: Biodegradable nets

A few decades ago natural materials like pure drawn hemp and flax have been used in the fisheries. As their failure, replacement, and repair rates were very high, these natural fibres have been replaced by artificial fibres, nylons. The life time of bottom-trawling nets is estimated to be 6-12 months (Taal, K., personal comment.). During this period many small repairs and adjustments are made on deck. Small wires or parts of these nets may get flushed into the sea instead of being collected in litter bags during the cleaning of the deck. This may be as much as 75% of the total amount during repairs at sea. The bigger parts of the nets will be handed over at the harbour and processed onshore. Repairs of set nets are mostly done onshore. Therefore, small pieces of set nets do usually not end up in the sea. However, larger pieces of set nets may be lost at sea during fishing operations. Based on current knowledge it is not possible to estimate the amount of set nets lost at sea.

To solve the problem of micro-plastics in the sea, the idea of compostable nets is worth considering, as an alternative for biodegradable nets. This idea of biodegradable nets goes against fishing standards: nets are expensive and should last. Biodegradable means: breaks easily up into smaller parts. This might solve the problem of ghost nets in the longer term, but will significantly increase the problem of micro plastics in the marine environment and will have adverse effects on fish, birds and marine mammals. Most compostables are compostable on industrial scale, between 65-70 degrees. That does not mean that this kind of compostable plastic will break apart in water from 10 to 30 degrees Celsius. And if it does, it also happens during normal operation, which makes this kind of compostable plastic no alternative material for fishing nets. The alternative is to look for compostable plastic with a longer lifetime. In this case, it will take much longer before the material is fully composted. Let us assume the life time of a normal net is one year. Most probably, it will take at least 5 to 10 years before the net is composted. (For more information on the difference between compostable plastics, see under measure 11).

As biodegradable nets will not have the expected effect on GES 10, we specified the measure in stimulating fishermen to handle their nets, and the litter as a result of repairs and adjustments made on deck (small wires or parts of the nets) more carefully. This could be implemented by a deposit return system on used nets. Buying new nets should require handing in old ones. The objective of the return system is to discourage illegal or improper spill of nets. According to NCEE (2001) deposit-return systems appear best suited for products whose disposal is difficult to monitor and potentially harmful to the environment. If old nets are lost (or discarded) at sea, a new net would be more expensive to buy. Fishermen will then pay for the ecological damage they cause by losing their nets. Nets are already an expensive asset for fishermen, hence they will not easily spill their nets. A side effect of this measure is that fishermen are stimulated to return whole nets or big parts of the net. However, a considerable part of the problem is that often only parts of nets are lost or discarded. Little can probably be done about accidental losses, but active discarding can be discouraged, by e.g. providing big bags in concert with the fishing for litter programme to all ships, and by education to fishermen: all rope and netting, large or small, should never be discarded as it is detrimental to the environment from which the fishermen themselves obtain their income. This elaboration of the measure is a kind of awareness raising. This alternative relates to measure 15 'adding individually recognisable ID-markers to fishing nets and wires'. The same deposit return system could apply to other items commonly used in fisheries, which are also commonly found discarded (washed up on beaches) such as fish boxes, gloves, et cetera.

Step 4 and step 5: Describing and quantitative assessment of the effect of the measures on the gap

Currently 220 beam trawlers fish on the DCS (Dutch Continental Shelf). The question is what will be the effect of the return system on the percentage/amount of nets lost. In the autonomous situation, fishermen do not lose their nets on purpose. The nets are necessary for them to earn their income. The expectation is that the effect of a return system of nets will be small. A positive effect can be expected as the number of (parts of the) nets collected in litter bags increase. Pieces of net and nets entangled with other litter are number 3 and 9 of litter found at Dutch beaches (Table 3.3). Nets and pieces of net are also ranked first of the large pieces of litter found (Table 3.4). This measure is effective because it directly affects these important litter items.

Uncertainty/certainty analysis

The amount of netting discarded and lost by fisherman is unknown, as are the impacts. The impact of this measure on fishermen behaviour is difficult to estimate.

Step 6: The costs per measure

The costs of the specified measure deposit return system on (parts of) used net are the additional costs manufacturers or vendors of nets that will become subject to such a return system incur for handling the returned (parts of) nets. Returned nets are considered as litter without a market value. Furthermore, the administrative costs of this return system have to be determined (handling the fee that buyers have to pay who did not hand in enough nets).

Measure 6: Higher fines for littering

This measure stems from the high fines for littering in for instance Singapore. To maintain this clean and green city, there are strict laws against littering of any kind. First-time offenders face a fine of up to USD1,000 (approximately €575). For repeat offenders it is a fine of up to USD2,000 and a Corrective Work Order (CWO). The CWO requires litterbugs to spend a few hours cleaning a public place, for example, picking up litter in a park. The litterbugs are made to wear bright jackets, and sometimes, the local media are invited to cover the public spectacle. Naturally, the authorities hope that public shame will make diehard litterbugs think twice about tossing their scrap paper or cigarette butt on the roadside (Singapore, 2011). The Singapore National Park Board issued 8300 fines for littering in their various parks (Singapore, 2010). Hence, although the high fines and strict enforcement, still a lot of offenders are caught.

Current legislation in the Netherlands

According to the Dutch legislation 'Besluit bestuurlijke boete overlast in de openbare ruimte' a fine of €90 is issued if a recreation area is used against the rules valid for that area, by disposing of litter, garbage, remains of foodstuff, paper, cans, bottles or packaging material (Staatsblad 2008 580). In the Netherlands 69% of respondents is in favour of higher fines as a solution for the litter problem (Agentschap NL, 2009). While many support the use of enforcement, studies show that few jurisdictions are able to enforce littering laws effectively for two reasons: (i) Lack of personnel available for such a low priority issue and (ii) the fact that it is difficult to 'catch' offenders in the act.

Littering at sea cannot be controlled directly: policing the seas is nearly impossible. Aerial surveillance is applied to enforce legislation on dumping garbage (primarily oil). The number of observed oil slicks has reduced, despite a fourfold increase in the number of flights (Carpenter, 2007). Enforcement of legislation for dumping oil in sea is more easily than that for litter. Where clear evidence of illegal disposal of litter is available, alleged offenders can be prosecuted under The Merchant Shipping Regulations 1998 (Prevention of Pollution by Garbage). The maximum fine in the UK was increased in 1997 from €5,500 to €27,500 in a Magistrate's Court and is unlimited on conviction before the Crown Court. But there have been very few successful prosecutions in the UK for illegal dumping of litter at sea, especially when compared with those for oil spills, due to the difficulty in obtaining enough evidence to undertake a successful prosecution. The main difficulty with enforcement, and hence prosecution of MARPOL offences, is acceptability of evidence - photographs or video footage are rarely available but are the best way of securing a conviction. Beachwatch report 2005 (Marine Conservation Society, 2006) reports 3 convictions in the UK during a period of almost 10 years. In a US case in 2003, the Captain of the Muskegon Clipper was sentenced to two years in prison as the 'person responsible' for dumping trash bags full of asbestos and renovation debris.

Littering at sea should be tackled in ports, by port waste reception facilities, education and increased fishing for litter programmes. Maximum fines can be applied to act as a sufficient deterrent to illegal discharges of litter. These fines should secure greater use of port reception facilities for oil and garbage by visiting ships, bringing the shipping industry in line with terrestrial industries. Additional evidence may now be available with the introduction of mandatory ships' waste management plans and garbage record books, required under the Merchant Shipping (Prevention of Pollution from Garbage) Regulations 1998. Inspection of garbage record books should reveal anomalies in the amount of waste present on ships, as compared with benchmark surveys of the predicted amounts of waste, which should be on board. Unfortunately, this will always be compounded by limited resources and pressing schedules.

Controlling littering on beaches (by the general public) is a matter of education, setting rules, and enforcing them. The levels of fines (or penalties, penalty charges and non-compliance fees) are set using different criteria - in some cases on the costs of damage, or on an 'affordability basis', or on other factors such as legal limits or precedents set elsewhere. Sometimes non-compliance fees are significantly higher than the costs associated with compliance if done correctly. Fines and penalties can focus specifically on beaches (e.g., for littering specific items, including cigarette butts), fishing-related gear (e.g., illegal disposal of unwanted fishing gear, bait boxes, line, sinkers and hooks) or illegal dumping. Penalties range very widely depending on the country and scope of the problems. Revenues can be used to help awareness campaigns or to provide additional waste receptacles and other infrastructure support.

In Washington State a litterbag in vehicle or watercraft was mandatory (RCW 70.93.100). The USD95 fine for failing to have this litterbag was repealed in July of 2003. One of the two important reasons was that patrol officers felt that persons who were not littering met the intent of the law whether or not they had a litterbag. Because of these concerns, the 2003 Legislature increased the fines for littering and repealed the litterbag law. In 2008 on state highways in Washington State (USA) 344 citations were issues for throwing litter; 202 warnings and 144 tickets (Washington State 2009). Hence, a lot of offenders are caught, but most of them get away with a warning.

Step 4 and step 5: Describing and quantitative assessment of the effect of the measures on the gap

An advantage of this measure is its source based orientation, directly reducing the amount of litter in sea and on beaches. The effectiveness of this measure depends on the level of enforcement and collection of fines. The measure can be elaborated for the sea and for beaches. The effect at sea will be limited. A larger direct effect is expected on public beaches. For tourist beaches that are cleaned daily in bathing season, the effect will be much smaller, because (most of) the litter would be removed that night.

Uncertainty/certainty analysis

The effectiveness of this measure is unknown. At sea the effect is small, on the beach is can be considerable if it is enforced and if enough possibilities to dump litter are available (e.g. garbage bins).

Step 6: The costs per measure

Tentative cost statement: 23 coastal communities, times 1 police officer for 6 months per year, times a yearly salary. Note that in the US life guards have the authority to hand out fines: this would enhance the stature of life guards in the Netherlands and would probably be more cost-effective. This results in an extra annual costs of €0.9m.

Measure 9: Reduce the use of plastic bags in supermarkets

Current legislation in the Netherlands

In 1990 the Dutch government and the relevant economic sectors concluded the first covenant on packages, which primary objective it is to reduce the amount of packages including plastics. The first action to be undertaken in this voluntary agreement - leading to visible results in only one year - should be to 'stop issuing free bags in supermarkets' (Ministerie VROM, 2008). This measure was not implemented in the Netherlands until 2011.

Due to EU-competition regulation, a ban on use of plastic bags provided by supermarkets in the Netherlands is not a feasible stand-alone measure. Plastic bags fall cannot be prohibited when they fulfil all norms (see European Parliament and Council, 1994), which is the case for free-issued plastic bags. The EU is investigating at this moment whether a sustainable packaging guideline is an option to supplement or replace the Council Directive 94/62/EC (source: European Commission DG ENV, 'Plastic Waste in the Environment', Specific contract 07.0307/2009/545281/ETU/G2 under Framework contract ENV.G.4/FRA/2008/0112, Revised final report, April 2011).

Specification of the measure

Plastic bags can be divided in free plastic bags weighing 3 to 6 grams (type 1) and plastic bags that are sold by supermarkets for €0.10 till 0.20, and weigh between 30 till 80 grams (type 2). This type of plastic bags is more frequently reused. The first type of plastic bags is light and vulnerable to be transported by the wind and water, and therefore end up as street litter and marine litter. Reducing the amounts released into the environment would thus help reducing amounts on beaches and presumably in the sea. Bans might be hard (total ban) or soft (environmental fee on plastic bags). The measure is specified in two directions, namely 9a 'Ban on issue of free plastic bags by retail', and 9b 'introduction of a fee on plastic bags'. The latter measure is based on the renowned example of the Irish PlasTax, see Textbox 3.4.

While European countries as Austria and Italy have a total ban on the issue of free plastic bags in the retail (Measure 9a), countries like Ireland, Switzerland, Germany, Sweden, Spain, Norway and the Netherlands have implemented a fee/ tax on issuing 'free' plastic bags to customers in the retail (Measure 9b). Portugal postponed the idea of plastic bag taxation, but some supermarkets starting taking initiatives themselves, by implementing a symbolic €0.02 fee for each bag (Perestrelo Luis and Spinola, 2010). In Denmark a tax is applied to producers and retailers. The taxes differ strongly between countries. Ireland installed a tax of €0.28 per bag. The Netherlands uses a general packaging tax affecting producers, which for a free plastic bag in a supermarket, would mean a tax of €0.003 per bag. The costumer is not charged directly.

Step 4 and step 5: Describing and quantitative assessment of the effect of the measures on the gap

To be able to quantify the effect of both measures, the number of plastic bags distributed per year and the number of plastic bags found on the beach are needed. The 5,600 Dutch supermarkets sell around 460m plastic bags (type 2) annually to clients. The share of supermarkets in the plastic bags that is paid for by clients is over 90%. Furthermore, 2bn free plastic bags (type 1) are issued per year by retail. (Personal communication with different experts.)

The share of plastic bags issued by the Dutch retailers (type 1) ending up as litter on Dutch beaches is unknown. What is known is that 87% of all litter found on beaches is plastic. Small pieces of plastic are ranked second and sixth (0 to 2.5 cm and 2.5 to 5 cm respectively (see Table 3.3). On basis of Table 3.3, approximately 700 pieces of plastic bags are found on a stretch of 1 km beach per year. Assume all these pieces are from different plastic bags (type 1), and only plastic bags that are issued in the Netherlands end up on the Dutch beaches, a quick calculation reveals that at most 1 in 8,000 issued plastic bags would end up scattered on 340 km of Dutch beaches.

Measure 9a: Ban on issue of free plastic bags by retail

Alternatives (paper bags, PP fibre bag, canvas bags, burlap bags, heavy duty bags) are available as are systems for reuse of plastic bags by consumers (tassenbol.nl). The question on the answer which bag has the least environmental impact depends on which environmental impact category is considered. For litter on the beach, paper seems to be more attractive, but as a result of pulp, the paper production process and the weight of the material per bag, paper is assessed the highest environmental impact (Lewis et al., 2010). The expected effectiveness of the measure 'ban on issue of free plastic bags by retail' for the indicator litter is low because this measure is not targeted at litter on the beach. The effect of this measure is limited to that portion of the plastic bags that end up in the sea and on the beach. This will be a small fraction of all plastic bags issued. For municipalities along the coast this fraction will be higher.

Step 6: The costs per measure
Preparation-costs for 'a ban on issue of free plastic bags by retail' in the Netherlands in terms of decision-making costs are not high, since implementing such measure does not need adaptation of laws. Prevention-costs, the costs foregone after implementing the measure - are considerable. This measure will reduce the costs for removal of both street and marine litter, and will reduce the costs for garbage-management. The annual costs of removing street litter (€250m per year) in the Netherlands.

Measure 9b: Fee on plastic bags in supermarkets

Introduction of a fee on plastic bags is an interpretation of the polluter pays principle, as it provides a financial incentive. It is an attempt to influence consumer behaviour (Ayalon et al., 2009). This measure is based on the renowned example of the Irish PlasTax, see Textbox 3.4.

Textbox 3.4	The Irish PlasTax

In March of 2002, Ireland implemented a PlasTax of €0.15 on one-time use plastic bags (with exceptions for bags used for packaging meat and produce). The bags were claimed to create a negative visual impact and were obstructing drains. Within months, plastic bag consumption dropped over 90% and litter visibly decreased across the nation. (In a nation highly dependent on tourism, the aesthetic detriment of plastic bags was a main catalyst for this legislation.) In the next year, plastic bag consumption dropped from 1.2bn bags (more than 300 bags per inhabitant) to 60m bags while €9.6m were generated for environmental protection. After initial opposition to the tax, retailers ended up strongly supporting the bill as the average supermarket increased reusable bag sales while saving €50m/year from lower grocery bag stocking costs. Finally, enforcement costs borne by the Irish government were minimal as the tax receipts were provided to the government along with revenues from the national Value Added Tax (VAT) (Convery et al., 2007).

Ayalon et al. (2009) analysed the effect of various levies on the use of plastic bags in Israel. The effects can be divided in volume-, substitution- and innovation-effects. Two billion plastic carrier bags are used annually in Israel. A levy of about €0.20 will decrease the consumption of plastic bags with 88%. Since 6% of the bags used outdoors have a potential of creating an environmental nuisance, the levy will be effective if this number will also be reduced with 88% (or a smaller percentage). Experience in Ireland shows an erosion in the public's cooperation with the levy mechanism (Creagh, 2007). The first sharp reaction of the market to the levy has been moderate, and 5 years later consumption rose. Comparison of the 2006 usage rate with the one before the tax rate shows a decline from 94 to 91%. In July 2007, the levy was increased in Ireland from €0.15 to €0.22.

A tax seems to be effective to reduce the amount of plastic used and therefore reduces the chance on plastic being introduced in the marine environment. The example of Ireland is the most striking. The example of Portugal shows that a rather symbolic charge to customers of €0.02 has a relatively large effect on the reduction of plastic bags consumption in supermarkets, namely 27% reduction in plastic bag consumption. Basically there are three effects of a fee/taxation on plastic bags:

- Increase in the abstention of plastic bags (because customer bring sustainable bags from home);
- The reutilisation rate of plastic bags increases;
- Filling optimisation of the used bags.

Step 4 and step 5: Describing and quantitative assessment of the effect of the measures on the gap

Based on the Irish example, the effects and the costs of a fee on issuing plastic bags in retail for the Dutch situation are estimated. We expect consumer-behaviour between consumers in the Netherlands and Ireland to be comparable. A fee of €0.15 will lead to 90% reduction of used plastic bags. Assuming that the same holds for the Dutch situation, and a linear relationship between free plastic bags and litter on the beach, this will result in 90% less plastic bags or parts of plastic bags on the beach.

Step 6: The costs per measure

In the Netherlands the estimated amount of free plastic bags issued is 2bn annually. The total costs of setting up and maintaining a fee system in the Netherlands will approximately be €6.6m per year. This measure results in an annual cost paid by the consumers of €23.4m. Whether this is indeed a cost depends on what happens with this money. If this amount adds to the general funds, only administrative costs are left.

Measure 10: Do it yourself beaches

This measure originates from a comparable initiative where coastal communities take care of domestic beaches in New Zealand. Such a concept has been promoted elsewhere, including in the Netherlands, where The North Sea Foundation and the Scheveningen municipality have taken on the idea. Basically a public awareness concept that educates beach-goers to leave the beach the same as they found it, by taking home all the refuse they brought in.

MyBeach is the winning concept developed in a contest. The question was: How can the involvement of tourists in cleaning up the beach be increased? The MyBeach concept implies that if a recreant chooses to make use of a MyBeach, he is he is obliged to clean the beach himself (this is similar to the concept of silence coupe in Dutch trains, an initiative of The Netherlands Railways). The MyBeach concept is intended for beaches with beach pavilions. At these pavilions brochures, signs, and recognisable bins are available, to make the tourists aware of the fact that they are making use of a MyBeach. The employees of the beach restaurants wear t-shirts with a MyBeach logo. In the Netherlands, two MyBeach sites exist since summer 2011. Both are in Noordwijk, one at 'Take 2' and one at 'Buitengewoon'. According to the foundation Nederland Schoon (an organisation paid by the packaging industry), the first is a success the second not. The additional measure proposed is to expand this concept to more beaches in the Netherlands. This measure is elaborated by Nederland Schoon by their proposal to create a toolkit consisting of brochures, signs, t-shirt and bins that the beach restaurant owner can acquire for €10,000.

In 2011 Blue Flags have been awarded to 50 Dutch beaches1. The blue flag is a voluntary eco-label to stimulate sustainable development of beaches and marinas. The label is awarded through strict criteria dealing with Water Quality, Environmental Education and Information, Environmental Management, and Safety and Other Services. Criteria awarded within this eco-label with an effect on litter are (http://www.blueflag.org/):

- The beach must be clean;
- Algae vegetation or natural debris should be left on the beach;
- waste disposal bins/containers must be available at the beach in adequate numbers and they must be regularly maintained;
- Facilities for the separation of recyclable waste materials should be available at the beach;
- An adequate number of toilet or restroom facilities must be provided;
- There should be no unauthorised camping, driving or dumping of litter on the beach.

A significant, but yet unknown proportion of litter on beaches is left on site by the visiting public. A better attitude towards (not) littering would thus help reduce the problem. Note that the high-profile public beaches where this concept might catch on best, are only a minor part of the total length of the Dutch coastline. On the other hand, beaches that receive most tourists might also receive most public-related litter.

The foundation Nederland Schoon organised the cleanest beach election. (this can be seen as an alternative measure for do it yourself beaches) The reward for participation in the election is wide publicity for the winner and also stars are awarding for clean beaches. For municipalities it is tempting to stand high on the list. A reliable, independent organisation (The ANWB) is responsible for inspection of the beaches. For the election, many different parties are involved for each municipality (local administrator, beach managers, pavilion owners and audience).

Since 2002, the cleanest beach election is organised on a yearly basis. The result of this campaign: within five years, the beaches are two times as clean (according to Nederland Schoon). The total cost of this election for Nederland

[1] Also beaches along rivers and lakes can qualify for a blue flag.

Schoon is €150,000 per year. Other costs made due to this campaign are changes in the design of the beach, extra beach cleaning, distribution of litter bags with a message meant for a behavioural change, et cetera (paid by the local government, beach managers, pavilion owners).

The cleanest beach election is attractive as it contributes to environmental sustainability, even as to tourist attractiveness. Assuming that the result of a 50% cleaner beach results in 5% extra tourists. The turnover on beach pavilions is about €400m. With 5% extra guests, this results in an extra revenue of €20m. Assuming a margin of 10% for the beach pavilions owners this gives €2m.

Step 4 and step 5: Describing and quantitative assessment of the effect of the measures on the gap

MyBeach is a source oriented measure, reducing the amount of litter left at the beach by tourists. Public awareness campaigns are effective to keep beaches clean in the first place.

Uncertainty/certainty analysis

In the Dutch situation, with large high-use public beaches, where the 'tourist population' is refreshed weekly, it is unclear to whom 'yourself' refers. There is little concept of responsibility for one's own beach if the site is only visited occasionally or for a short period of time. In the cleanest beach election 'Yourself' might thus mainly refer to the stake holders: the coastal municipalities, caterers and ngo's. They must create a sense of common interest with the general public to achieve the concept of do in yourself beaches.

Step 6: The costs per measure

The costs of a yearly Mybeach awareness-campaign are €10,000 per beach restaurant. For the 380 Dutch beach restaurants, the total costs are €3.8m.

Measure 11: Biodegradable user plastic at beaches

Specification of the measure

The annual turnover of all beach pavilions is on average €500.000,- per year (2008). This is generated by about 54,000 visitors per pavilion. (branchprofiel 2008). The total amount of plastic packaging sold annually by beach pavilions in the Netherlands is unknown. The trend is that more customers are eating at the beach-pavilion venues, instead of taking food (including the packaging) from the beach-pavilions to consume at the beach (personal communication).

As mentioned in the specification of the biodegradable nets measure (5), it is important to make the distinction between degradable, biodegradable and compostable. These terms are often used incorrectly and interchangeably. Biodegradable plastic is plastic which will degrade from the action of naturally occurring microorganism, such as bacteria, fungi, et cetera over a period of time. Note, that there is no requirement for leaving 'no toxic residue', no requirement towards the material in which the plastic degrades (e.g. toxic or poisonous environments) and no requirement for the time it needs to take to biodegrade. Biodegradable plastic is therefore plastic that will undergo a significant change in its chemical structure under specific environmental conditions resulting in a loss of some properties. Compostable plastics (shortly biocompostables) are a new generation of plastics which are both biodegradable and compostable. They are derived generally from renewable raw materials like starch (e.g. corn, potato, tapioca, et cetera), which is made into a resin, cellulose, soy protein, lactic acid, et cetera are not hazardous/toxic in production and decompose back into carbon dioxide, water and biomass when composted. Some compostable plastics may not be derived from renewable materials, but instead derived made from petroleum or made by bacteria through a process of microbial fermentation. In order for a plastic to be called compostable, three criteria need to be met under semi-industrial composting condition:

1. Biodegrade - break down into carbon dioxide, water, biomass for at least 90% over 6 months;
2. Disintegrate - after 3 months at least 90% of the original material should pass a filter of 2 mm;
3. Eco-toxicity - the biodegradation does not produce any toxic material and the compost can support plant growth.

A plastic therefore may be degradable but not biodegradable or it may be biodegradable but not compostable (that is, it breaks down too slowly to be called compostable or leaves toxic residue) Current standards (from the European Standardization Committee (CEN) EN13432) are that compostable plastics need to be broken down for 90% within 6 months whereas biodegradable plastics need to be broken down for 90% in 2 years.

It is required - due to the shorter breakdown time and the importance of a lack of toxic residue (see GES 8 pollutants) for the marine environment - to rephrase the measure 'Biodegradable user plastics on beaches' in a more ambitious measure 'Compostable user plastics on beaches'. Our analysis towards effects focuses on the latter.

Step 4 and step 5: Describing and quantitative assessment of the effect of the measures on the gap

Being green on the beach is mostly a matter of public awareness and education. As such, measures such as providing (truly) biodegradable packaging materials, specially geared to be used on beaches, will help both the public, the local retailers (green image) and coastal municipalities, if managed properly. Overall effects are small, as the material concerned are only a fraction of all litter on beaches, but only a changing attitude to the general problem will ultimately solve it.

Uncertainty/certainty analysis

The discussion on compostable plastics - in relation to effects on marine environment - continues on several themes.

A. Compostable standards indicate that residues could remain after 3 to 6 month industrial composting conditions; degradation and composting under natural conditions will be much slower.
B. Are there really no residues of all compostable plastics after biodegrading and disintegrating in the marine environment. Striking is that disintegration tests include an analysis of the effect of the remaining residues (biomass) for plant growth. So the re-use potential is investigated. However, the compounds and substances in biomass are not measured, and unknown (North Sea Foundation).
C. Compostable plastics don't digest like normal food when eaten by marine animals. The microbes that digest micro-plastics are available in stomach and digestive tract environments, but will need, depending on the size and type of compostable plastic, at least 6 months to digest compostable plastics. The gap for marine litter - via the indicator of ingestion of plastics by Northern Fulmar - is not reduced with this measure.
D. What are the marine ecosystem benefits when plastics disintegrate faster but microscopic parts - taken up by algae - remain in the water. The smaller the parts the more difficult to remove, and the smaller the parts the more susceptible to get into the food chain. Disintegration of plastics is not the solution, but the problem. Residues of compostable plastics might be non-toxic but can still be hazardous for marine life.
E. 'Paper' packaging might be a multi-layer composite of paper and thin plastic. This, in combination with fatty substances such as mayonnaise, meant to be kept within limits by the plastic lining, are a fast vector into a gull's stomach. As this example indicates, alternatives should be carefully checked by an independent agency before they are put onto the market.

Step 6: The costs per measure

The additional costs in the production of compostable plastics compared with synthetic is 30-60% depending on technology and the scale on which biodegradable products is used already (www.bdpplastics.com). Since packaging costs constitute only a fragment of the price of sold consumer goods, these extra costs to substitute plastic for biodegradables are feasible. In terms of expected effects on the target, via the indicator 'litter shows a negative trend on the beach compared to the level in 2008' the expectations are low. Adverse effects, due to changing consumer behaviour, need to be taken serious. Overall the cost-effectiveness for this measure is considered low by experts.

Measure 12: Biodegradable balloons, balloon valves and ribbons

Current legislation

Since January 1st, 1995 in the Netherlands the 'Regulation cable kites and small balloons' is statuary. These regulations were drafted by the then Minister of Transport. The scheme is based on the Air Traffic regulation (Section 3 of Article 1a) and focuses on the launches of cable kites, small captive balloons, small free balloons and mood balloons. The scheme defines a mood balloon as a small free balloon, or a combination of small free balloons, the height or width not exceeding 75 cm and without metal objects.

The regulation states that 'permission is required from the local air traffic control service if 1,000 or more balloons are simultaneously launched within a distance of 8 km from the border of a controlled airport.' Air traffic control service 'may refuse permission if the speed of the balloons - given the prevailing wind direction - will take over the landing area or areas in the vicinity, which aircraft approaching or departing, and so the order and regularity of air transport is disturbed' (Section 3 of Article 3 of the Regulations). The same applies for launches within a distance of 3 km from the border of uncontrolled civil airport (source: Aviation News, 2011).

Specification of the measure

Of all the helium balloons that are yearly launched in The Netherlands, a part end up on the beach and in the North Sea. Balloons are the number 7 item on the list of beach litter (see Table 3.3). Commonly, remains of about 14 balloons are found per 100 meter of beach during monitoring (see Table 3.3). The balloons themselves are probably not the major problem as these (79%, excluding the 21% foil balloons) eventually break down. The attached nylon ropes and hard plastic balloon valves do degrade. Public aversion against the image of derelict balloons on beaches (or in sand dunes, forests, et cetera) is growing.

In 2010, Air Traffic Control Netherlands 21 times permitted the simultaneous launch of 1000 or more balloons. The total was about 45,675 balloons. The total for 2011 (until Nov. 1st) is estimated as 15 consents with about 45,900 balloons. These launches are mainly from May to September. It often starts with the Queen's 'birthday' on April 30 and the Liberation Festival on May 5. Massive 'invasions' of such balloons have been observed at distances over 800 km away from the Netherlands (Van Franeker and Le Guillou 2006; Van Franeker 2008). Air Traffic believes that their figures cover approximately 75% of the real mass balloon launches. That would mean that every year approximately 61,000 helium balloons are launched that need permission from the Air Traffic Control must give. So these are just the launches from towns within a radius of 8 km from Schiphol Amsterdam, Eindhoven Airport, Rotterdam Airport and Maastricht Aachen Airport. We estimate that this area (and population) is approximately 10% of the potential area (and population) of all massive (more than 1,000) balloon launches . This gives an estimation of about 600,000 balloons released annually in the Netherlands (in massive launches). To assess the total number of balloons launched in the Netherlands (including the smaller launches) a few assumptions have to be made. We take into consideration balloon launches related to Queen's day activities, weddings, school events and other events (see Table 3.4).

Table 3.4 **Summary of computation of total helium balloon launches in the Netherlands**

	Population	% that launches balloons	Estimated quantity per launch	Total balloons
Big launches	200 (15*1.33*10)		3,000	600,000
Queen's day	1100	25%	100	27,500
Weddings	83.000	20% (during 5 months)	50	86,000
Schools	7500	5%	100	37,500
Other events	20 per day		100	730,000
Total				1481,000

This means that a total of approximately 1.5m helium filled balloons are yearly launched in the Netherlands. According to the KNMI Climate Desk on average about 10-15% will drift towards the North Sea. So between 150,000 and

225,000 balloon will annually fly towards the North Sea. Most of them will end up in the North Sea and a small percentage will reach England.

In 2010 on average per 100 meters of beach 13 pieces of balloons or balloon remnants (Draft monitoren zwerfvuil, 2005-2010). If these figures are convert into balloons along the entire 340 kilometres Dutch coast, 44,200 pieces from the North Sea washed to shore. Note, however, that the DCS also receives balloons from neighbouring countries. The number of balloons from the UK must be considerably larger. Suppose that in England also 1.5m balloons are launched annually, then the prevailing westerly winds will blow perhaps 85-90% of those balloons towards the North Sea. That means that about 1.3m balloons may end up in the North Sea.

This measures will be divided into 2 (sub) measures:

12a A ban on all massive balloon launches (more than 50 balloons simultaneously);

12b Substitute Plastic Balloon Strings for natural materials.

Measure 12a A ban on all massive balloon launches (more than 50 balloons simultaneously)

Step 4 and step 5: Describing and quantitative assessment of the effect of the measures on the gap

A ban on all launches with 50 or more balloons simultaneously would first apply to most of the 1.5m balloons launched yearly. The launches during wedding parties, school festivities and other activities are not affected if they launch less than 50 balloons. Suppose that half of these events is prohibited, then the ban will reduce the annual balloon launches to about 300,000. This is a reduction of 80%.

Step 6: The costs per measure

Assuming the cost of an average helium balloon is €0.60, meaning that revenues for this sector reduce approximately €720,000 (these do not equal the costs). However, it is expected that balloon launches will be substituted for other activities related to this sector. A ban on mass releases of more than 50 balloons is a quite effective measure because it reduces the airborne balloons (with nylon strings) with 80%. However, only a small part of these balloons would end up in the sea. This measure could be more effective if it is targeted to a strip of the Netherlands within 25 km from sea (or when eastern wind prevails). The costs will be reduced if alternative festivities substitute balloon launches.

Measure 12b Substitute Plastic Balloon Strings for natural materials

Strings of coloured hard nylon, polypropylene or polyester ribbon are customary tied to helium balloons. These strings entangle birds and mammals. During mass releases of balloons no plastic ribbon or string should be attached to the balloons. Sisal is an alternative for plastic strings. Sisal rope is resistant to moisture and is therefore adequate in humid environments (source: http://nl.wikipedia.org/wiki/touw). Other alternatives are strings made of hemp or flax. Natural balloon strings are three times as expensive as plastic ones.

Currently companies that deliver balloons for mass releases (an estimated 500 to 700 companies) use strings made of nylon, polypropylene or polyester. The desirable situation is that all these strings are replaced by biodegradable sisal, hemp or flax ropes . Furthermore, the companies and organisations (schools, associations, et cetera) that buy balloons for massive launch must consciously choose biodegradable strings. A change in behaviour is required by both event organisers, businesses, schools, et cetera. Another option is that in a mass release of balloons no longer a plastic ribbon or string should be attached to the balloons. The balloons without a ribbon should be held together in a large net. But without a string no name cart can be attached to each balloon to enable a contest. During festivities other contest possibilities exist. A campaign is necessary to achieve this (personal communication with Renate De Backer, Wadden Sea Society, October 2011).

Step 4 and step 5: Describing and quantitative assessment of the effect of the measures on the gap

It is not easy to estimate the effectiveness of such a campaign. It is assumed that less than half of all businesses, schools, clubs, et cetera. will choose and pay for the relatively more expensive biodegradable. However many may choose alternatives to releasing balloons once they are aware of the consequences.

Step 6: The costs per measure

The total estimated cost for the entire campaign will be approximately €150,000 (personal communication with Renate de Backere, Waddenvereniging, October 2011). The extra costs for the ribbons €0.0165 per balloon rope. Total annual costs are €175,000.

Measure 13: Stricter enforcement on the use of port reception facilities to collect waste

Specification of the measure

The MARPOL 73/78 Convention, and especially through its Annex V on garbage, is the primary international instrument to control marine litter pollution from ships, including fishing vessels and leisure crafts. According to these, ships should deliver all their wastes ashore, and…'the Government of each Party to the Convention undertakes to ensure the provision of facilities at ports and terminals for the reception of garbage, without causing undue delay to ships, and according to the needs of the ships using them.'

In the Netherlands, in 1995 under the Pollution Prevention Act by Shipping, 35 seaports are designated that shall provide adequate reception facilities for wastes from shipping. Different types of port reception facilities (PRF's) for waste receiving are available, for example mobile collection (rubbish boats, e.g. the port of Rotterdam have a big rubbish ship on its disposal), and there are specialised companies for waste collection and processing (such as Tank Cleaning Rotterdam). To keep the price as low as possible, the network of PRFs is designed to avoid monopoly positions as much as possible. In 2005, the European Directive on port reception facilities was implemented. Currently, enough port reception facilities are available in all Dutch harbours. It is not mandatory for ships to present their waste; they may keep this on board to be discarded in the next port. Amounts of garbage on board are logged and are checked at random. In Table 3.6, the amounts of Annex V garbage is given. From 2004 till 2010, the percentage of ships that deliver increased from 25% till 60%. Since the implementation of the Directive on port reception facilities in 2005, the delivery of the waste in the Netherlands increased by 50% (Atsma, 2011). In the near future the Directive will be revised. Atsma (2011) indicates that the Netherlands are dedicated to further strengthen the waste delivery requirement for ships departing form a Dutch port to a port outside the EU.

From 2013 onwards, dumping of all solid household waste is banned under Marpol Annex V. The average amount of waste delivered has reduced to a bit less than 1 m^3, while the delivery right without paying extra waste delivery costs is, depending of the size of the ship, 3 till 6 m^3.

Despite all the current regulation and facilities, in the autonomous situation, still significant quantities of garbage, including materials classifying as litter are discarded by ships (merchant and/or fishing), as evidenced by the piles of litter on our beaches (see Textbox 3.5).

Textbox 3.5	**Litter on Dutch beaches**

Significant amounts of litter arrive from the North Sea on Dutch beaches, indication that large quantities are dumped at sea, rather than taken ashore to port reception facilities. Van Franeker (2005) studied possible sources by examining labels and barcodes on pieces of litter removed from a beach at Texel, NW Netherlands. Items produced in 15 different countries were found, but most were produced in the Netherlands themselves and neighbouring countries (Belgium, France, UK). This suggests a large local, or at most, regional origin of litter dumped at sea that later washes up on our beaches. Subsequent surveys (unpublished data), both by Van Franeker and by RWS Noordzee yielded largely similar results: most items had been produced in the Netherlands, Germany and Belgium.

Table 3.5 The delivery of waste in the Port of Rotterdam

	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Average amount of Annex V ship waste (m^3)	5	2	1	1	1	3	2
Number of ships discharging ship-generated waste (Annex V)	4,398	15,462	22,026	29,646	34,346	14,161	14,711

Source: Port of Rotterdam (2009).

In an evaluation done by Franeker and the SNS fulmar study group (2011) a decline in foamed plastic is found, which might be an indication that at sea waste disposal from ships is somewhat decreasing. Unfortunately, the intended environmental improvement is not realised. This implies that additional action is needed.

The port must have a good waste plan. Each ship pays (as supplement to the harbour), a contribution to the collection system, even if the ship does no hand in any garbage. The additional measure 'stricter enforcement on the use of port reception facilities to collect waste' can be elaborated into two measure stimulating a better litter management:

- Standard fee instead of paying per unit waste in port reception facilities, combined with mandatory waste disposal in each port: Make garbage disposal mandatory in each port, with equal costs (preferably included in harbour fees) across Europe. (100% indirect financing for all Annex V waste);
- Less waiting time before waste can be delivered to the port facility. Rules could be tightened, but also service could be increased, to the same effect. It should be made a harbour standard to send a garbage collector along every ship entering port (fees to be included into the general harbour fees)

so to stimulate the 'free' disposal of garbage. Any ship not handing in garbage under such a regime would be suspect (disposal at sea?) and should receive extra inspection. Clearly, such measures should be taken across Europe to create a level playing field. Preferably, such measures should be taken across Europe to create a level playing field, but the service level offered by a port could also act as a good marketing instrument.

Step 4 and step 5: Describing and quantitative assessment of the effect of the measures on the gap

The effect is unknown, but potentially large as a large proportion of litter on beaches and litter on the sea bed stems from passing ships. This measure does not have an effect on the amount of garbage produced on the ship. In the last ten years, the amount of litter found on Dutch beaches and in the stomachs of fulmars did not increase significantly, while simultaneous the number of shipping movements and the quantity of goods and packaging has increased. If this is the result of the extra measures taken in the last 10 years, a significant effect of the proposed measures may be expected. Franeker et al. (2009) concluded that the current mode of implementation of the EU Directive on port reception facilities since 2004, has not led to a measurable ecological improvement of the southern North Sea (Algemene Rekenkamer, 2010).

Several years ago, Sweden started with free port reception facilities for all. This attracted so much litter, probably also from free-loaders, that the measure had to be withdrawn. The lesson here is that the measure of a fixed fee is potentially highly successful, but should be implemented at every North Sea Harbour (pan-European at the minimum). 'Stricter enforcement' might be perceived as top-down management. Rephrasing this as 'Facilitating better …' would help to gain support from those impacted by this measure.

Whether an effect can be expected from introducing a fixed fee depend on the reason why ships do not hand in their garbage at the port reception facilities are. Possible reasons are: a) the vessels have the required space for waste storage on board, and do not want to spent time to hand in their waste, b) the port reception facilities are not convenient for the vessels, handing in garbage takes too much time, c) handing in garbage is too costly and d) enforcement of existing regulation is not strict.

Reason a, if the vessels have the required space for waste storage on board, handing in can be postponed till a next port. If this is indeed the case, no effect is expected.

According to experts, the port reception facilities are not convenient for the vessels. The procedure for waste up is unnecessarily complicated because forms must be filled. Due to this, it remains for the shipping cheaper and easier to handle the waste overboard. According to the MARPOL 73/78.

Fishing vessels do not use common port reception facilities, but they have their own means. For fishing vessels waste reporting obligations do not exist. This dichotomy makes it harder to estimate which parts of litter on beaches stem from merchant vessels and which parts from fishing vessels (unless one source is clear, i.e. fishing equipment). Also for marinas, a waste plan is obliged. The larger marinas typically have a container system for separate collection of waste. The waste disposal rules are obliged for the larger vessels.

In the EU directive on port reception facilities, it is required that the cost of waste collection to a substantial part (at least 30%) should be covered by indirect financing. The Netherlands take the most lenient way: 30% ('Wet Voorkoming Verontreiniging door Schepen', WVVS), to protect commercial trade interests. This implies that ships have to pay an amount for waste delivering, independent of whether waste is actual given off. In Table 3.5 waste delivery in the port of Rotterdam is given. In Table 3.6 the prices of waste delivery in the Port of Rotterdam is given. The price of waste delivery is a fixed fee per ship, within the waste delivery right. Big ships (more than 4.000 KW have a waste delivery right of 6 m^3). A waste delivering ships receives a discount on the fee.

Table 3.6 **Fee and discount for household waste, plastic and small chemical waste in the Port of Rotterdam**

Category	Main engine	Fee (in euros)	Delivery right ship generated waste (Annex V) in m^3	Discount per waste delivery (in euros)
A	1 - 1.999 kW	195	3	80
B	2.000 - 3.999 kW	195	3	80
C-G	4.000 - ≥30.000 kW	275	6	150

Source: Port of Rotterdam (2009).

If ships do not hand in their garbage because it is too expensive, introduction of a fixed fee, this reason will disappear. In that case the costs for garbage disposal are made indirect, ships entering the port pay *the full price* for garbage disposal anyway, whether they have garbage to deliver or not. This would ultimately reduce costs of garbage disposal and increase effectiveness. Currently, Member States are to some extent free to manage harbour fees, resulting in differences between European countries and even between ports within the same country. Such differences are detrimental (Nijdam and De Langen, 2005). This measure should be taken at a European scale, but an effect of this measure may be expected.

The EMSA audit concluded that many ships only hand in the waste paid for within the indirect financing will limit (EMSA, 2008). Non harmonised regulations in different European harbours may be an explanation for the decline in the average amount of waste delivery. Two examples of non-harmonised regulation: 1) in harbours abroad the delivery right is different, for example in Hamburg the delivery right is about 1 m^3 and 2) according to harmonised regulation, a ship with enough space for waste storage is not obliged to deliver waste in the harbour. It is remarkable that harmonised regulation on the required space for waste storage is missing.

Due to the MARPOL convention any skipper or captain must for entry into a port report how much and what waste he has on board. Better control on these reporting obligations could be an alternative measure as well, to stimulate the vessels to hand in their waste.

Uncertainty/certainty analysis

The European guideline on port reception facilities is currently being revised. Consultation rounds started in June 2011. It might be wise to use this momentum to make headway with respect to this measure.

Dutch shipping merchants have flagged up the problem that including garbage fees for 100% into the general harbour fees will mean that merchants get less insight in the actual costs of garbage disposal and of all other harbour costs. If this measure is only taken into account in the Netherlands, the effect may be that the harbour costs are relatively high. Taking in mind the competitiveness of the Dutch ports, the minister of Transport and Water Management decided in 2004 not to go for implementation of an 100% indirect harbour fee (Algemene Rekenkamer, 2010).

Measure 14: Fishing for litter

Directorate-General for Public Works and Water Management and the fisheries sector agreed in 1999 that fishermen will bring in the litter they catch during fishing activities. Before this project, the fishermen did not take this kind of litter to the port, because they had to pay for the disposal of litter. Since 2000, in the fishing for litter programme, fishermen have special big bags on board to store the litter they accidently catch. At their returning in the port, they deliver this litter to waste collector that takes care of the waste processing, paid by Directorate-General for Public Works and Water Management. KIMO since, has expanded this project to all Dutch harbours.

Fishing for litter is viewed by the experts as an educational and public relations measure, not as a general solution to the problem. The environmental gain has not been evaluated yet. In defence of the measure, however, it might be said that fishing for litter greatly increases awareness of fishermen to the problem of litter. In this sense, it is not only an end of pipe measure (removal of litter) but it also helps to prevent the dumping of litter in the first place: it is easier to dump litter in the fishing-for-litter big bag on deck, than dumping it overboard, fishing it up later, and then dumping it into the same bag.

Initiatives (in southern Europe) to licence -obsolete- fishermen to fish for litter, i.e. target litter rather than fish, should be avoided. One cannot catch litter alone, biota will always be by-caught. Moreover, such measures are in fact subsidies to the fishing industry.

Step 4 and step 5: Describing and quantitative assessment of the effect of the measures on the gap

In 2009, 69 different vessels from harbours across the country (Breskens, Colijnsplaat, Delfzijl, Den Helder/Texel, Den Oever, Eemshaven, Harlingen, IJmuiden, Lauwersoog, Scheveningen, Stellendam and Vlissingen) participated in the fishing for litter project. Together, they brought in 228,000 kg of litter. The project is to be broadened to include several Belgian ports (Rijkswaterstaat, online). These figures have apparently increased to 80 vessels and 300,000 kg of litter in 2010 (Rijkswaterstaat, online).

Uncertainty/certainty analysis

There is no information on the amounts of litter present at sea. Most litter brought in by fishermen was caught by beamtrawling, i.e. originates from the seafloor. Floating litter (surface and mid-water) is largely left untouched. Some incidents at sea generate large quantities of (floating, visible) litter. Suggestions are sometimes heard to have fishing for litter fishermen deal with this problem (and pay them to do so). This might seem cost-effective, but one has to realise that the netting used by these fishermen (beam trawls) might not be the most suitable removal tools. On the other hand, the authorities do not have better means at its disposal.

Step 6: The costs per measure
The price of a big bag is €10, waste treatment costs are €200 per 20 tonnes, and monitoring €4,000 per 20 tonnes. Addtional costs: the time of civil servants to manage the project, litter disposal

Measure 15: Adding individually recognisable ID-markers to fishing nets and wires

Nets and wires are the capital equipment used by fisherman to earn their income. By using the nets, there is a risk of damaging or losing their gear. The risk of damaging the nets depends on environmental conditions (e.g., weather, currents, tides, sea state, presence of sea ice, the makeup of the seafloor); the condition of the gear, equipment, and vessel; as well as a suite of economic pressures and regulatory factors. So, the fisherman is able to influence the risk (Ocean Studies Board, 2009). 'Fishing' encompasses a broad range of activities pursued with a variety of equipment; therefore, solutions to prevent and reduce nets and wires must be tailored to the different types of gear, their impacts, and the primary causes of loss. In this analysis we take into account: Beamtrawling, Bottom-setnets.

According to current MARPOL regulation it is now allowed to throw nets over board. The measure of ID markers, in cooperation with legislation, is a measure to reduce the discharge of unwanted fishing gear and the careless loss of waste gear. By a requirement to mark nets, these can be identified and traced to its source. Assuming that the measure of ID markers is technical possible, this does not immediately mean that this measure will have an effect. An effect can be expected in conjunction with accountability and/or liability law. MARPOL Annex V (Regulation 6c) states that 'Accidental' loss of synthetic fishing nets is allowed, provided that all reasonable precautions have been taken to prevent such loss' (International Maritime Organization, 2006c). At this moment MARPOL is being revised. This revision will be effective 1/1/2013. By then it is not allowed to dispose nets at sea. This revision of MARPOL will reduce the amount of nets in sea. So this revision (when being effective) will reduce the gap and contribute to the litter objective of MSFD.

For the time being and in addition to MARPOL we recommend to examine the scope of current laws Although the regulations under public law are currently insufficient, the chances to hold a fisherman liable for the loss of (parts of) his fishing gear on the ground of 'wrongful act' increase significantly when this event is attributable to the fisherman (which might be the case when using ID-markers) and damage has occurred as a result of it. The scope of wrongful acts is not limited to illegal acts, but includes acts that are immoral or anti-social (like environmental pollution). Not only private parties but in certain cases, also governments have the possibility to recover damages by invoking civil law.

Fishing gear in beamtrawling mostly is marked (by welding beads) as this gear is expensive, large and heavy. Retrieving lost gear is thus important and if another fisher retrieves the gear owner's disputes are easily settled by these markings. ID-markers on nets are probably only feasible on very large, pelagic gear, i.e. gear used outside the North Sea. Bottom-setnets could in theory be marked, but often lengths of several km are set in one string (of 50 individual nets). This would mean that very large numbers of tags would be required; it also means that complete sets must be lost to be certain that the marker is lost with the net. In reality, many fragments of net are discarded at sea (such parts are the number 3 litter item on Dutch beaches, see Table 3.2); it would be easy to remove tags from pieces of torn netting before dumping these.

Step 4 and step 5: Describing and quantitative assessment of the effect of the measures on the gap

To create an effective measure, the nets found have to be analysed to determine the owner. Herefore, net litter found on the beach have to be sorted and identified.

Step 6: The costs per measure

An option for making fishing nets and wires recognisable is the use of recognisable molecules. It is possible to put very specific kinds of molecule structures in nets. Two important technical problems arise. First, to avoid any effect on the properties of the nets, the amounts must be pretty small. Problem two is the number of licenses. To make the nets per licensed fisherman recognisable, many different, unique molecules have to be made. Therefore, quite complex structures of molecules are needed. The larger a molecule, the more options you can vary. And large, complex molecules that must be made in small quantities are per definition expensive. Think of an order of at least €1,000 per gram (source: plastic expert).

A cheaper alternative for making fishing nets and wires recognisable is to build in an RFID chip. We assume that the properties of the net are not affected by RFID chips. Such chips are already in use for different purposes, for example in food packaging, tickets, et cetera. At an RFID chip it is relatively easy to store a lot of information, and they are very small. This makes it possible to add many of these chips (assume 250) in one net. Furthermore, they're cheap to make (selling price around €0.15 (http://blog.odintechnologies.com/bid/52341/What-do-RFID-Tags-Cost). An RFID scanner (selling price from €30) is needed to read information from those chips.

We assume that for 340 km beach, four litter inspectors are needed. The total annual costs are €328.500 for the 220 beam trawling nets. This measure could also be effective for other kind of nets.

Measure 16: Additional beach cleaning

Beach cleaning during the bathing season is regularly carried out on high-profile, tourist beaches. Other beaches, receiving equal amounts of litter from the sea are not or less frequently cleaned and cleaning effort is low in winter. On-going monitoring of litter on North Sea beaches shows that about 30-40% is derived from marine-related activities such as shipping and fisheries (Atsma, 2011). Most beaches are cleaned mechanically. However, when mechanically removing the litter from the beach a large part of small litter items like cigarette butts, caps, candy wrappers, et cetera stays behind on the beach. Campaigns in the past reduced the amount of litter left on the bathing beaches . However small plastic elements are still left on the beach. To solve this problem, the focus should be on small litter prevention (cigarette butts, caps, candy wrappers, et cetera).

Additional (non-tourist) beach cleaning has been done at Ameland by beach wardens, under the Fishing for litter project, coupled to monitoring of litter (Coastwatch). Beachcombers in Ameland get a license if they remove litter from the beach (interview with Nederland Schoon). This could be an alternative for non-bathing beaches and other beaches that are only cleaned during the bathing season . Additional beach cleaning has been conducted at IJmuiden, Scheveningen and at various locations in the port of Rotterdam. Large quantities have been removed, to garbage processing plants.

The project 'Zwervend langs zee' (www.zwervendlangszee.nl) is meant to reduce the amount of litter on the beach within two years. Awareness is raised in nine beach location in the Netherlands. The type and amount of litter left on the beaches was initially monitored from an awareness point of view.

Municipalities along the Dutch and Belgium coast spend yearly about €10.4m to remove litter from the beach. The Hague has the largest costs; €1.25m in 2008 (Mouat et al., 2010), and also the most costs per km, about €100,000. Mouat et al. (2010) also advices to regularly emptying garbage bins and poster campaigns as the most effective measures to reduce litter. Even in case of abundant facilities to dispose of garbage, still tourist do not throw a large portion of their garbage in these bins.

Step 4 and step 5: Describing and quantitative assessment of the effect of the measures on the gap

A study on the island of Texel over summer 2005 indicated that that about 4.5 to 7.5 kg of litter may wash up per km per day on Dutch beaches (Van Franeker 2005). In this study 30 tonnes of litter was removed that had mostly accumulated over a single winter, indicating the high accumulation rates of debris if not periodically removed. Or will 'disappear' into the North Sea. Beach cleaning may thus change the appearance of a beach from heavily littered to 'clean'.

Monitoring of beach litter uses OSPAR protocols and results are forwarded to the Dutch Ministry of I&M and to OSPAR (KIMO, online). The effect of additional beach cleaning is clearly positive for the indicator litter on beach and for the indicator litter in sea.

Uncertainty/certainty analysis

Beach cleaning is clearly effective (litter might be removed in large quantities). A note of caution here is that mechanical beach cleaning is very detrimental to the beach natural environment (bird nests, shelter, primary dunes, microhabitats). From this point of view, cleaning by hand is much more environmental friendly and more effective as it also removes small litter that otherwise will be left on the beach.

Step 6: The costs per measure

Costs can be as low as 10 cents per meter of beach, if beach cleaning is embedded in schooling programmes, with help of locals (mainly for heavy transports of collected litter: Van Franeker, 2005). If managed commercially, costs are higher. Doomen et al. (2009) computed the cost of cleansing 1 ha of beach manually as €36. They assume that the beach is cleaned manually 120 times a year. Yearly cost per hectare amount €4,320 per year. Using a beach cleaner (tractor with beach cleaner), will cost around €45 per ha (a worker can clean 1.2 ha in 1 hour). They assume that 50 meters width of the beach is cleaned. So 0.2 km coastline is equal to 1 ha.

Bangura, 2011 interviewed 6 coast line municipalities. These municipalities cover 88 km of coastline. Of this coastline, 16 km is never cleaned-up. These municipalities pay €1.75m per year for beach cleaning. If we assume an equal spread of the clean-up costs over the other km, the cost per km is €24.000. For these 6 municipalities, 18% of the beaches is never cleaned.

Measure 17: Deposits on all plastics

'A deposit-refund system is the surcharge on the price of potentially polluting products. When pollution is avoided by returning the products or their residuals, a refund of the surcharge is granted.' (OECD, 2011) Deposit Return Systems (DRS) are reported, in the literature, to have a range of possible environmental benefits. The key ones mentioned in the literature are:

1. Increasing the recycling of containers covered by deposits (for refill or recycling);
2. Reducing the extent of littering;

A review of Hogg et al. (2010) based on available theoretical literature, suggests that deposit return schemes (DRS) are an efficient means of increasing recycling rates and reducing litter, though a key issue in moving from theory to practice is determining the costs of administering and implementing the system (see Table 3.7).

Table 3.7 **Overall Costs and Benefits of a Deposit Return System on all bottles in the UK, € millions**

	Cost or Benefit (negative is a cost), in € millions
Financial Effects	
Deposit Refund System (to Producers)	-233
Collection and Treatment/Disposal (to Local Authorities)	175
Change in Cost of PRNs (conservative estimate)	33
Collection and Treatment/Disposal (to Commerce)	19
Consumers (unclaimed deposits)	-540
Net Financial Costs	-547
Environmental Effects	
Without disamenity	76
With disamenity	1,448
Total Benefit to Society	
Without disamenity	-471
With disamenity	+902

Source: Hogg et al. (2010).

Hogg et al. (2010) investigated the costs and benefits of a DRS for bottles in the UK-wide, through bottom-up modelling (Hogg et al., 2010). Their results show that based on the financial effects only, the costs exceed the benefits. If the amenity value of the litter reduction is valued the benefits are larger than the costs. This scheme proposed by CPRE (NGO in UK) includes both glass and plastic bottles -€92m setup cost, €770m annual running cost net of revenues (these figures differ from Table 3.7, in this table only the sum of costs and benefits is presented). The Deposit Return System has low cost to producers because of unclaimed deposits. Savings of €175m for local authorities due to reduced waste management needs were found in the UK. Significant net air pollution benefits and amenity benefits.

To focus this measure, it is specified into two measures, namely measure 17a; 'Deposit on fish crates' and measure 17b; 'Deposit on small plastic bottles'.

Step 4 and step 5: Describing and quantitative assessment of the effect of the measures on the gap

Measure 17a. Deposit on fish crates

The North Sea Foundation that monitors the litter on Dutch Beaches (e.g. see Table 3.2) estimates that annually 1,000 fish crates are found at the Dutch beaches. These can be either Dutch or foreign (Belgian, French or British due to southern current). The fish auction in Urk loses yearly 500 fish crates. These can be lost at sea, and wash at the Dutch coast (or northern beaches), but they can also be disposed of as garbage.

The Urk fishermen take empty crates when they sail off for fishing and return the crates with fish at the auction. They receive €0.10 per crate they return (free from VAT). The deposit differs among the Dutch auctions. If we assume that 100 beam trawlers bring in 300 crates per trawler weekly, the total deposit is €3,000 per week. It is not sure whether the amount of crates that end up in sea will be reduced if the deposit on crates increases. The current €0.10 per crate can be too small for a real incentive. A higher deposit per crate can quite easily be implemented, because the deposit system on crates is already functioning.

Measure 17b. Deposit on small plastic bottles

The problem with respect to the pressure resulting in litter on the beach are small plastic parts. However, monitoring touristy beaches for the 'Zwervend langs Zee' project shows that drinking units in any form: glass or plastic bottles, tetrapacks and cans are in the top of litter left behind on beaches by tourists. Not all beaches are cleaned all year round or even every day during the bathing season so especially plastic bottles have a high potential of ending up in sea. Also during busy days, beaches are cleaned after visitors have left and due to wind or the tide coming in, again, a part of this litter will be swept into the sea. Also, when at sea, a deposit system on all drinking units will help prevent them to be thrown overboard.; the caps are the problem, not the bottles. In the Netherlands, 650m big bottles (0.7, 1 and 1.5 litre) are sold per year. On top of this, at least 650m small bottles are sold. Based on Table 3.2, it is calculated that around 75,000 caps are found on Dutch beaches per year. If the origin of all these caps are Dutch small bottles, 0.01% of all the caps sold per year are found as litter on the beach.

A deposit return system does not solve the problem. In the existing deposit return system on bottles, bottles can be handed in without the caps of the bottles. To solve the problem of caps on the beach with a deposit system, the system should not only be extended to small bottles. The system should be adjusted in such a way that only bottles with a cap can be handed in via the deposit system.

The costs of a deposit system on bottles is estimated on 5.5 Eurocent per bottle, for big bottles. The value of the returned bottle is estimated on 2 cent. The net value of the material of small plastic bottles is lower than the net value of bigger plastic bottles (Lavee, 2010). As 95% of the bottles are returned (a €0.25 per bottle), the returns of this system for the retailer are 1.55 cent per bottle (Bureau B&G, online) Assuming that the cost of a deposit system on small bottles with cap is comparable with the current system for big bottles, and if the value of a small bottle is negligible, the costs of a return system for small bottles will be around €0.04 per bottle.

Due to the refund system, benefits can be realised by savings in alternative treatment costs, clean public spaces, external effects of energy savings and smaller landfill volumes (Lavee, 2010).

An alternative to a deposit system is to ensure that the caps are fixed to the bottle. The price difference between a fixed cap, and a screw-cap is about 2 cent. The main reason is that the weight of a fixed cap is about double a screw cap. So the cost of producing the fixed cap costs more material and more energy, and in the end more waste. In order to process only fixed caps, production lines must be converted, an operation that cost tens of thousands of euros. Filling bottles with fixed caps is more complicated, this will increase the costs as well (Personal communication, 2011).

Other alternative measures are a ban on plastic candy wrappers, and other measures that reduce small plastic litter found on the beach.

Uncertainty/certainty analysis

Means to this end have been tried before in the Netherlands, and failed. Discussions sprang up on intake points, heights of taxes, logistics, public safety, et cetera. However, decreasing the amounts of plastics used overall is the only means to effectively reduce the problem at its source. There seems little sense in the fact that 1 litre and 0.7 litre bottles are under a return regime, while smaller bottles and other packaging items are not. The same applies to tetrapacks, tins, bags, and other items. It should be possible to recycle these items, as is proven in countries abroad.

Step 6: The costs per measure

Based on the assumptions made above, the cost for 75,000 caps less in marine environment is €26m. This is almost €350 per cap. This is not a cost-effective measure for less litter on the beach. This measure has import positive side effects, is also reduces litter in urban and rural environment.

Extra measures with an effect on GES 10

Several alternative, additional measures to reduce litter at sea and on beaches were brought up:

1. Stop the usage of microplastics in cosmetics and use biodegradable alternatives in e.g. peelings (see also: http://www.noordzee.nl/blog/consumenten-spoelen-massaal-plastic-milieu-in/);
2. Clean up sewage overflow points, by installing filters;
3. Set regulations on plastics usage (return systems!) in marine aquaculture, where currently large numbers of items, such as floaters, are lost;
4. Start studies on the drainage of microfibers from clothing, via our washing machines (http://pubs.acs.org/cen/news/89/i39/8939scene1.html);
5. Development of improved information systems and fisheries management measures that reduce conflicts between fishing gear and other user groups (Ocean Studies Board, 2009);

6. Documentation of position and reasons for gear loss (Ocean Studies Board, 2009);
7. Inclusion of degradable elements in synthetic gear to reduce the potential of entanglement and ghost fishing. (Ocean Studies Board, 2009).

Awareness of the issues is another area where there are significant gaps both in terms of the general public and specific source industries. For example two of the main sources of marine litter are the shipping and fishing industries but there are no compulsory courses on marine environmental awareness in either of these sectors, although the Dutch Government has been working with the ProSea Foundation to incorporate amendments into the STCW Convention at the IMO. If crew members are more aware of the impacts of marine litter, they are more likely to adhere to existing regulations.

3.11 GES descriptor 11: 'underwater noise'

GES descriptor 11 stipulates that the 'introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment' (EU, 2008). This target is elaborated in the following indicators (EU, 2010):

11.1 Distribution in time and place of loud, low and mid frequency impulsive sounds;

- 11.1.1 Proportion of days and their distribution within a calendar year over areas of a determined surface, as well as their spatial distribution, in which anthropogenic sound sources exceed levels that are likely to entail significant impact on marine animals measured as Sound Exposure Level or as peak sound pressure level at one metre, measured over the frequency band 10 Hz to 10 kHz;

11.2 Continuous low frequency sound;

- 11.2.1 Trends in the ambient noise level within the 1/3 octave bands 63 and 125 Hz (centre frequency) (re 1μPa RMS; average noise level in these octave bands over a year) measured by observation stations and/or with the use of models if appropriate.

The DGSW indicators are (DGSW, 2011):

- Impulse noise; the relative number of days that such noise occurs in the southern North Sea based on the image of spread, duration and accumulation and available habitat;
- Ambient noise; monitoring of trends in the level of ambient noise;

- Exploration of knowledge gaps for indicator development, monitoring and effectiveness of policies.

For Dutch waters, specific targets have not yet been set. There is a general understanding that noise levels should not significantly harm wildlife and that more knowledge is needed on both actual noise levels and on effects of these on various animals. Particularly activities that are new, very noisy and restricted in time and (if one can say this for noise that tends to travel far under water) in place, such as pile driving are under scrutiny.

A few new potentially attractive measures were put forward. These measures are not analysed in this study, but might be interesting enough to consider in next phases in the MSFD implementation process.

3.12 Costs of the additional measures identified to fill the gap

Based on currently available information and input from experts presented in the previous sections, a CEA (Cost-Effectiveness Analysis) is carried out. This CEA enables the ranking of possible measures according to their estimated cost-effectiveness. Based on this information potential cost-effective measures can be selected to be elaborated in the next phase of MSFD.

For a cost-effectiveness analysis it is necessary to have quantitative information available about the gap between the autonomous development and the MSFD objectives. This quantitative information was missing for the autonomous development as well as for the MSFD objectives. For this study, we used the targets specified in the concept version of the Dutch Marine Strategy (DGSW, 2011). The Dutch government prefers to set the objectives of MSFD in line with other EU directives and policies (Water Framework Directive, Waste Directive, Common Fisheries Policy, IMO). Hence, based on these targets a gap was not identified for the majority of the GES-descriptors. For GES6 and GES 10 a gap is identified and additional measures are assessed (Sections 3.1 till 3.11). For these measures proposed to fill the gap, the effectiveness and the costs of the measure is analysed. For most (mainly innovative) measures, quantitative information about the dose-effect relations is not available yet. Expert opinion (from relevant research organisations, lobbying groups and from the sector) is used (based on workshops and interviews) to get estimations for the costs and effectiveness of measures.

Step 7: Results of the cost-effectiveness analysis

In this section the measures are ranked based on their cost-effectiveness per GES descriptor. According to experts, introducing hard substrate items in bottom-protection zones is a not a cost-effective measure see Section 3.6, summarised in Table 3.8.

Table 3.8	**GES 6: Seafloor integrity**
Measure	**Introducing hard substrate items in bottom-protection zones**
Specified measure	Restoration of the ancient sea bed structure by adding hard structure to locations where hard structure was removed
RWS related	
Investment Costs	About €16m
Effect on the gap	The GES 6 gap will be reduced slightly, as will be the GES 1 gap
Cost-effectiveness	According to experts, not very cost-effective

According to experts Dredging of contaminated sediments on hot spot locations is not a cost-effective measure, see Section 3.8, summarised in Table 3.9.

Table 3.9.	**GES 8: Concentrations of contaminants are at levels not giving rise to pollution effects**
Measure	**Dredging of contaminated sediments**
Specified measure	Dredging of contaminated sediments on hot spot locations
RWS related	
Costs per unit	€2 and €40 per m^3
Effect on the gap	The GES 8 gap will be reduced slightly
Cost-effectiveness	According to experts, costs are too high to be cost-effective

Attribution of costs of GES 10 measures to the different pressures

The effect of any litter measure on the pressure cannot be determined at a reasonable degree of uncertainty for the source based measures. Lack of quantitative information on the marine litter cycle prohibits a quantitative cost-effectiveness analysis. Insight into the contribution of the sources to litter in sea is essential information. The best information available is on the quantity of items at the beach. This gives any information about sources of litter on the beach. A best guess on the effect of a measure on the source is possible. The best we can conclude is that measures affect a source for marine litter, or effect the quantity of litter in sea or at the beach. For each source related to litter, the most effective measure can be defined. In Table 3.10, the additional measures for GES 10 are summarised. The top 10 of litter items found on the Dutch beach is taken as indicator for the pressures of marine litter (see Table 3.2). The cost-effectiveness of all litter measures analysed is given in Table 3.12. An exact cost-effectiveness analysis is not possible, because the dose-effect relations of these measures are not known yet. This applies also to the magnitude of the contribution of each source to marine litter. Another problem is the lack of a common numerator (unit) of litter, to enable the summation of different types of litter items. In literature both the number of items and the weight of items is used as numerator. Both have their drawbacks, because they (over)-emphasise a specific part of the litter problem. The number of items will for instance stress the problem of small plastic items. The omission of a common numerator makes it impossible to compare measures that reduce different litter items. In the following text we present the cost-effectiveness analysis per source of litter (fisheries, industrial and user plastics, commercial shipping).

The most important source for litter on the beach are (parts) of nets (see Tables 3.2 and 3.3). To solve this problem, three measures were proposed (measures 4, 5 and 15). Measure 4 is a technical measure. If an alternative for bundles of nylon wires will be available, this will probably be a cost-effective measure because it is directly targeted to the most numerous litter items found on the beach; thin rope and cord (see Table 3.2). Measures 5 and 15 will be only cost-effective if these (parts of) nets are mainly due to illegal or improper spills by fishermen. In that case, these measures together with relevant legislation, will be cost-effective.

The second most important pressure of litter found on the beach is user and industrial plastic. These are for instance caps, plastic bags, plastic pellets. The main conclusion of this CEA is that awareness raising measures will be the most effective for reducing the amount of plastic entering the marine environment.

Otherwise, relatively large measures, not targeted to the marine environment have to be taken (e.g. deposit return system on small bottles in the Netherlands or a fee on plastic bags).

The pressure of shipping as driver for litter in the sea can be decreased with better port facilities. The main improvement is to come to uniform regulation of port facilities within the EU and controlling the amount of garbage handed in, to reduce any incentives for ships to throw garbage overboard. Also awareness raising can be an effective measure in the shipping sector.

Additional beach cleaning (measure 16) can be cost-effective, depending on the timing and location of the beach cleansing activities. This measure directly affects one of the indicators for marine litter, so the dose-effect relation is quite clear. It is an effect oriented measure and can be considered as filling a bucket (that's) full of holes. So in the long run it will be less effective compared to measures that are source oriented.

Table 3.10	**GES 10 Marine litter**			
	Specified measure	**Effect on the gap**	**Annual costs (in euros)**	**Cost-effectiveness**
3	Packaging resin pellets	Autonomous development shows a reduction of pellets spilled by ships	Not known	
4	Impose the use of alternative material to protect beam trawler nets	Reduces the biggest source of litter washed on the beach. Impact of coconut is expected to be smaller than plastic (but not scientifically analysed)	0 to 1.1m	Very cost-effective
5	Deposit system on (parts of) used nets	Reduce illegal or improper spill of nets, the biggest source of litter on the beach	Not known	Only cost-effective if (parts of) nets are caused by illegal or improper spills
6	Higher fines and more control on the beach and on sea.	Reduce illegal discharges of litter. It depends on the level of enforcement and collection of fines. Increasing control on sea will hardly increase the risk of being caught	0.9m	Not cost-effective at sea. At the beach, not cost-effective

Table 3.10	GES 10 Marine litter (continued)			
	Specified measure	**Effect on the gap**	**Annual costs (in euros)**	**Cost-effectiveness**
9	Fee on plastic bags in supermarkets	Reduce the second source of litter on the beach	23.4m	Polluter pays, not targeted.
10	Part of touristic beaches designed for tourists who take away their litter	Less litter on the beach	3.8m	By making the right stakeholders responsible for awareness, this will be cost-effective
11	Compostable user plastic at bathing beaches	Overall effect are small, as the material concerned are only a fraction of all litter on beaches	1.9m	No
12	Ban on mass releases of balloons	Relatively small part of launched balloons end up in sea. More effective in combination with weather forecast (rise awareness)	150 thousand	Awareness campaigns could be cost-effective
13	Better port facilities	The effect is unknown, but probably large as large proportion of litter stems from passing ships		Cost-effective measure if adopted internationally
14	Extra fishing for litter (primary goal is litter, not fish)	Negative effect: decreased seafloor integrity		No
15	Adding individually recognisable IF-markers to fishing nets and wires	Reduce illegal or improper spill of nets, the first source of litter on the beach	330 thousand	Only cost-effective if (parts of) nets are caused by illegal or improper spills
16	Additional beach cleaning on non-bathing beaches (once a year)	Less litter on the beach	1.5m	Depending on the timing and location very cost-effective
17	Deposit system on small plastic bottles	Less caps on the beach	26m	Polluter pays, not targeted

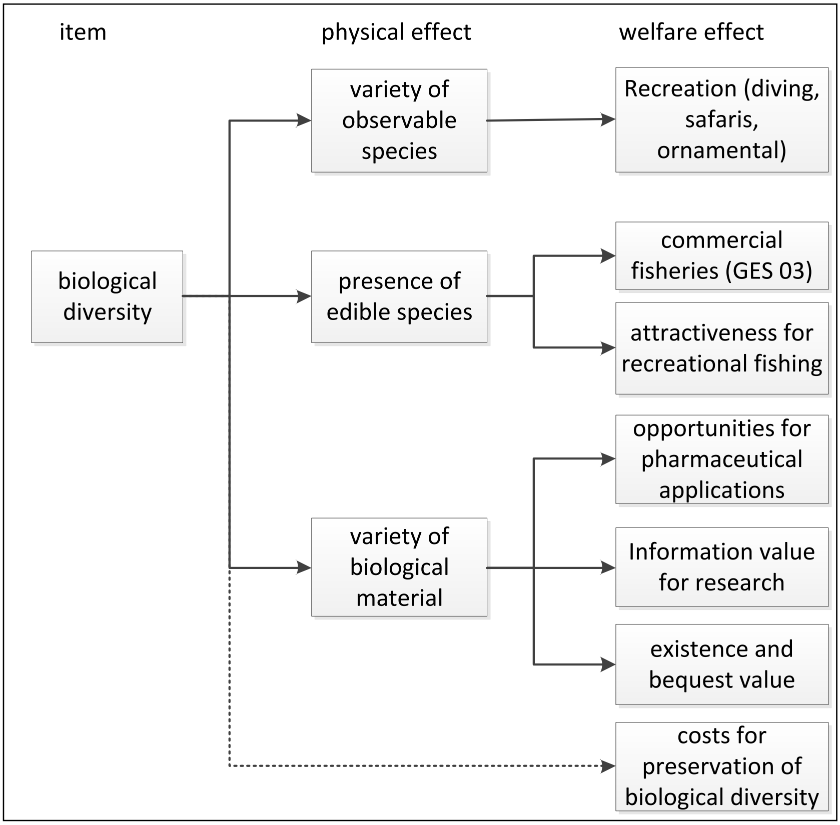
4 Cost-benefit analysis

The cost benefit analysis (CBA) is carried out according to the methodology described in Section 2.8. First the potential benefits related to the 11 GES descriptors are presented. For GES descriptors for which the autonomous development equals the MSFD situation, the benefits of marginally higher targets are qualitatively presented. Two scenarios are compared in this CBA: the autonomous development is compared to the situation in which all MSFD targets are met (CBA step 1). In the following sections, CBA steps 2, 3 and 4 are presented per GES descriptor.

4.1 CBA of GES Descriptor 1: Biodiversity

The main aim of the MSFD is to attain a good environmental status in the North Sea. Biodiversity is one descriptor to describe the good environmental status. Many benefits of GES 1 biological diversity refer to non-use values or intrinsic values. Figure 4.1 shows the Logical Diagram of Impact (LDI) for this GES descriptor. Direct welfare effects are related to observable diversity (variety of species), either as a passive recreational value or as a leisure activity with or without yield for personal use. Apart from information value (research) and existence and bequest value (see Figure 2.5), derived from the mere existence of species, use or potential use for pharmaceutical applications can be regarded as a welfare effect.

Figure 4.1 **LDI for GES descriptor 1: Biodiversity**



To monetarise the welfare effect of an improvement in biodiversity, a first step is to quantify the difference in environmental status. Without a difference in biodiversity, no welfare effect will be present. Only a significantly large difference in biodiversity will result in a significant change in welfare effects. In the MSFD many indicators are proposed for GES 1. To quantify the physical effect on biodiversity within one indicator, Liefveld et al. (2011) investigates the options of an eco-points methodology for quantification the difference in biodiversity resulting from MSFD.

Some of the welfare effects attached to biodiversity can be monetarised based on market prices (recreational fishing, presence of edible species). To monetarise the non-use value of biodiversity, the physical difference can be quantified in eco-points. To estimate the non-use value of biodiversity, stated preference methods are needed. According to economic theory, the estimated non-use value will have a relation with the environmental status quality difference. Based on existing literature only, the monetary value of an eco-point is unknown. This makes it is impossible to include this value in this preliminary CBA. To attach a monetray value to an eco-point, a stated preference study has to be carried out. In addition to this it is necessary to remark that there is still discussion about the usefulness of monetarisation of the non-use value. If DGWS and RWS decide not to monetarise the eco-points, the result of the CBA in 2012 will be a combination of a CBA balance presented in combination with the eco-point balance.

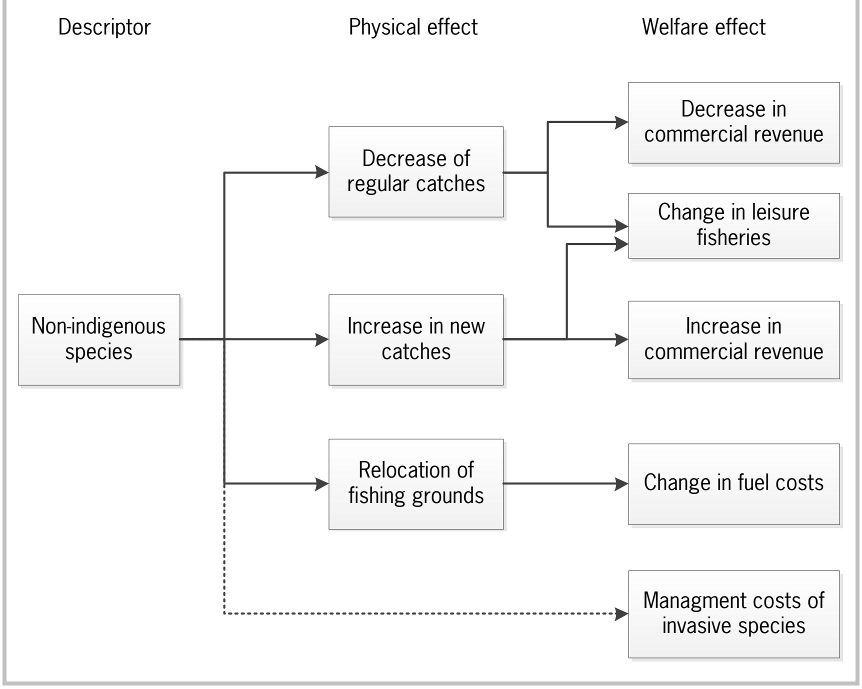
For recreational fishing, it is known that anglers assign high values to the presence of mackerel, cod, bass and sole, for private consumption purposes. The total economic value assigned to the activity of fishing from the Dutch coast at sea (from pitches and from ships) is almost €130m/year (Smit et al., 2004). There appears to be some effect of the abundance of species and interest in recreational fishing. On the other hand, preferences may shift towards other species; an example is the growing popularity of bass. Quantitative evidence of the effect of a decline or growth of the total amount of catchable fish on recreational fishing and diving for the North Sea could provide a basis for estimating the effect of the MSFD measures.

Potentially high benefits may arise from pharmaceutical applications (either direct of by avoiding R&D costs) by using gene bases. They are, however, very hard to calculate.

4.2 CBA of GES Descriptor 2: Non-indigenous species

Non-indigenous species may on the one hand, affect the current catch of fishes negatively, but can on the other hand be an attractive catch itself. Potential MSFD measures might reduce these effects, representing benefits. On the other hand, future or actual benefits from catching new commercially interesting species would be reduced. Longer or shorter travel time to changing fishing grounds could result in costs or benefits. Figure 4.2 shows the LDI for GES descriptor 2.

Figure 4.2	LDI for GES descriptor 2: non-indigenous species (only use value related effects shown)



In UK studies, measures against non-indigenous species (NIS) have the purpose of avoiding the risk of new introductions, instead of eradicating existing species, as mentioned by Adams and Eldridge (2011). They also remark, that data on the actual mechanisms and volumes of the introduction of new species are rare. In any case, measures can only be successful if they are coordinated in all relevant Member States. Furthermore, data on the current status of non-indigenous species is insufficient.

Benefits by avoiding costs presently due to NIS could be substantial. Williams et al. (2010) as cited by Adams and Eldridge (2011) report an economic loss due to all NIS (marine, aquatic and terrestrial) of €2bn/year, due to management and damage. It is unclear which part is due to marine NIS. Benefits of the MSFD measures are reduced costs to control NIS. The overall conclusion is, that costs and benefits related to NIS are potentially significant, although even an indication of the economic consequences is hard to get through lack of data. On recreational fishing, a change in the variety of species is not likely to have large effects, as the main attraction is catching as such. Therefore, no net costs or benefits will be attributed to this effect. In any case, the amount is negligible.

4.3 CBA of GES Descriptor 3: Commercial fish and shellfish

Commercial fishery as such represents economic benefits. An estimation of the benefits generated by implementation of the MSFD through the Common Fisheries Policy, however is less evident. For the Dutch commercial fleet, the data for 2008, given by Anderson and Guillen (2010, Table 3.14.1) show a total value of landings of €405m, resulting in a net added value of €113m or 28%. This represents the total fleet, fishing only partially in the North Sea. A method to estimate the benefits attributable to MSFD measures is discussed by Adams and Eldridge (2011), referring to the study of Tinch et al. (2008), based on the influence of illegal, unreported and unregulated (IUU) fishing. The modelling used, allows the results to interpret as an analysis of conditions where current fisheries exploitations prevent stocks recovering versus a condition where some management measures enable stocks to recover towards maximum sustainable yield (MSY). Such measures could be similar to those of the MSFD. The data of Tinch et al. (2008) calculate the annual value of landings attributed to IUU for the Netherlands of €85m/year for the period until 2020. Application of the above mentioned ratio between net added value and landings, this would amount to approximately €24m/year. Mussel industry, which is a non-negligible part of commercial fisheries activity is not included in the above data; it generates an annual net result of €25m (Taal et al., 2010).

4.4 CBA of GES Descriptor 4: Food webs

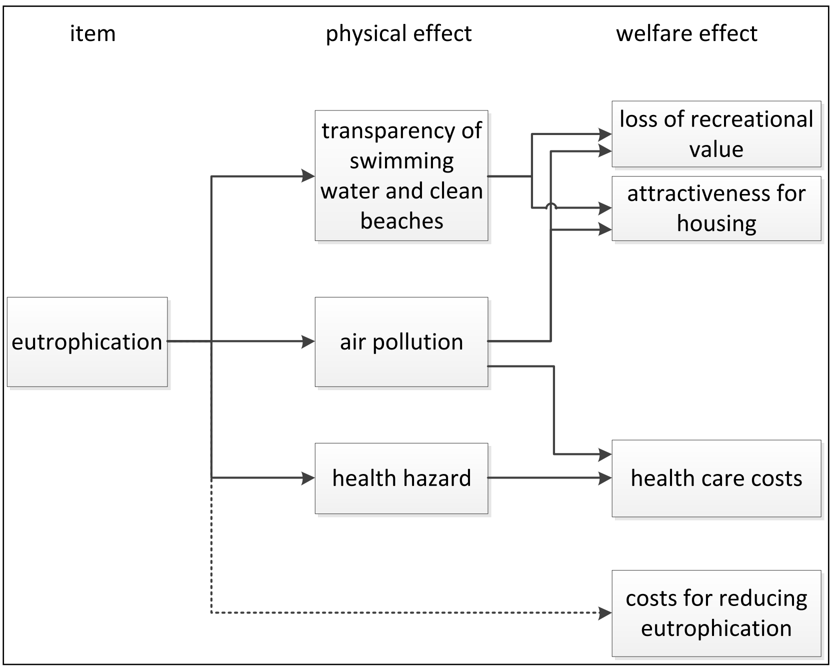
No direct or indirect use values are associated with this GES descriptor, other than those already mentioned under descriptors 1 and 3 (Sections 4.1 and 4.3).

4.5 CBA of GES Descriptor 5: Eutrophication

First of all, it should be noted that eutrophication at sea is mostly generated by nutrients supplied by rivers or discharged otherwise from the landside to the marine environment (minor sources are shipping, fishery and offshore industry). It is generally assumed that nutrient enrichment is being effectively dealt with through the Water Framework Directive (WFD) (Adams and Eldridge, 2011). Costs and benefits are therefore mainly related to the WFD. In the medium and long term, which is the scope of the MSFD analysis, there are no appreciable costs and benefits attributable to the MSFD, once the WFD has been implemented. Only short-term effects could arise.

Figure 4.3 shows the LDI for the physical and welfare effects related to eutrophication. Two of the welfare effects coincide with those of litter.

Figure 4.3 LDI for GES descriptor 5: eutrophication (only use value related effects shown)



- *recreational value and attractiveness for housing*

The benefits of clean swimming water and algal free beaches run along the same line as those for litter (4.10). The distinction between loss of recreational value (and residential attractiveness) caused by litter and by algae, however, is not clear. In fact, data used for 'clean' beaches, as presented by Mourato et al. (2003), might reflect the value of several improvements in beach amenity, as has been remarked by Adams and Aldridge (2011). In view of the above mentioned short time horizon and the poorly defined measures for reducing eutrophication through the MSFD, this benefit will be negligible.

- *health care costs*

The quality of swimming water depends on a variety of pollutants, among which bacterial pollution is the most prominent. Algae and chlorophyll play a secondary role, although at specific hot spots and temporarily, problems may occur. Benefits are not expected, once the WFD targets are met.

4.6 CBA of GES Descriptor 6: Sea Floor integrity

Benefits from Sea floor integrity are highly indirect. Potentially, the sea floor condition influences nautical possibilities and restrictions, and hence navigation safety; furthermore, coastal safety could be influenced by sea floor conditions. Both aspects of safety, however, are covered intensively by other policies and MSFD measures in this field will contribute only marginally, if at all. The same holds, but with more uncertainty, to CO2 sequestration that might be positively influenced by sea floor integrity measures. Therefore, benefits for this GES will be neglected.

4.7 CBA of GES Descriptor 7: Hydrographical conditions

Hydrographical conditions, probably even more than sea floor integrity, have only indirect effects. Benefits will be neglected. This is not uncommon (see, e.g. DEFRA, 2009).

4.8 CBA of GES Descriptor 8: Contaminants

Contaminants undoubtedly have effects on marine life, but this relation effects benefits through other descriptors, mainly 1 and 3. A direct effect, generating benefits is by its influence on health hazards. The magnitude of the effect, however, is uncertain. A possible non-use values is the bequest value of clean water for next generations.

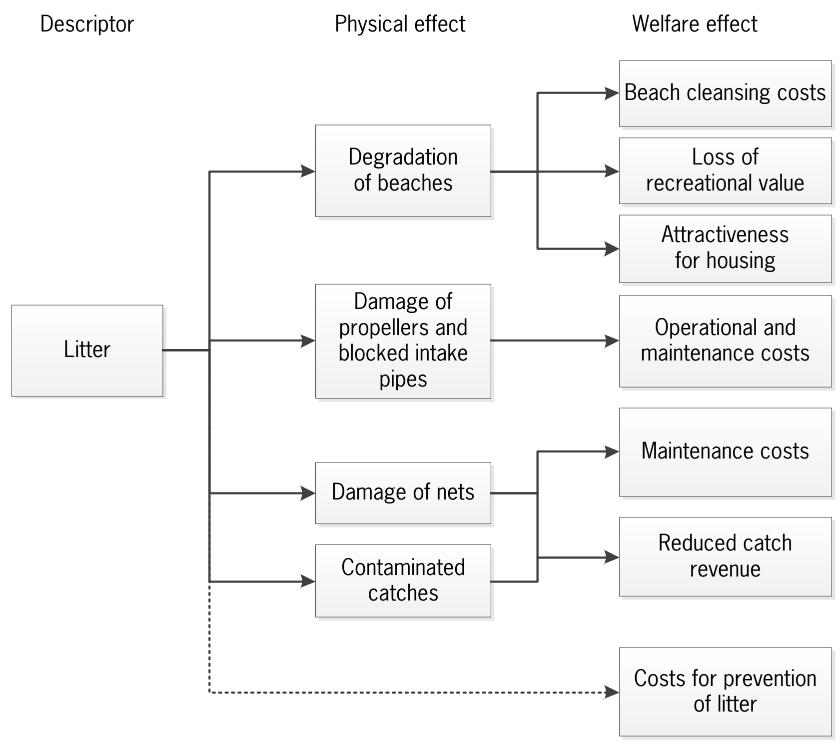
4.9 CBA of GES Descriptor 9: Contaminants in seafood

In the autonomous development the targets for the GES descriptor contaminants in seafood will be met. Expectedly, these targets are set at a level, where the consumption of seafood will be perfectly safe. Higher targets will not lead to any benefits.

4.10 CBA of GES Descriptor 10: Litter

Figure 4.4 shows the LDI for the physical and welfare effects related to marine litter. Only effects related to direct and indirect use values are shown. In particular health damage to marine species and individual organisms as well as damage to ecosystems and habitats are not taken into account. On the other hand potential benefits are shown.

Figure 4.4 **LDI for GES descriptor 10: litter (only use value related effects shown)**



Sources: Mouat et al. (2010), McIlgorm et al. (2011).

The physical effects are related to litter on the beach and litter at sea. Contaminated catches are related to both litter at sea and litter in biota.

- *beach cleansing*

The benefits of the MSFD measures aiming at a reduction of litter at beaches are twofold. A direct use effect is a reduction in beach cleansing costs, indirect use effects are the attractiveness of the beach for recreation and increased attractiveness of the seaside for residential purposes.

Removing litter from beaches serves two main purposes. In the first place, visitors prefer clean beaches for recreation for aesthetical reasons and in the second place litter is a potential health hazard (Mouat et al., 2010, Ten Brink et al., 2009). The costs of removing litter consist of fixed costs of equipment and organisation and variable costs for direct labour force and disposal of collected litter (e.g. incineration). From a UK study, it appears that 63% of the costs can be attributed to labour, 12% to disposal and 10% to collection (Mouat et al., 2010).

Benefits resulting from a reduction in litter on beaches depend on the actual intensity of the removal of litter and the decrease brought about by the measures. Removing litter is often restricted to the tourist season and the frequency varies from daily to once a week. In the case relatively high investments have been made in machinery, regular staff and organisation, a moderate reduction in litter is unlikely to result in proportional benefits. Furthermore, even moderate contamination levels could distract tourists, who could move to neighbouring beaches. Therefore, it can be expected that only a substantial reduction of litter would generate larger benefits. In particular in situations with an intense programme of litter removal, for example in the case of Den Haag (Scheveningen/Kijkduin), with annual costs of over €1.25m (Mouat et al., 2010), the relation between the amount of litter and the total costs for beach cleansing will presumably be highly non-linear.

An indication of the benefits can be obtained as follows. From Mouat et al. (2010), the average costs of beach cleansing in the Netherlands (and Belgium) is €34,400/km/year. There are however large deviations, with a peak of €97,300/km/year. These data are derived from a sample of 10 municipalities in Belgium and the Netherlands, and based on activities on the entire length of the coastline of their territory. These values are comparable to the ones given by McIlgorm et al. (2011) for mechanical shoreline clean-up for France of €32 €600/km/year.[1]

Assuming a beach length of 340 km, the total costs associated with beach cleansing would be of the order of €11.0m/year. This is of the order of magnitude given by Ecorys (2007), giving a value of €10m/year. The total actual costs, however are not the benefits for implementing the measures. As has been remarked (and this has to be verified quantitatively by detailed studies about the operational activities and the intensity of the programmes), a substantial reduction of litter to meet the MSFD requirements has to be realised in order to attain appreciable benefits. The beach cleansing *benefits* will therefore be

[1] The data for France are based on a litter density of 4 tonnes/km/year, whereas the Dutch/Belgian date are based on a litter removal intensity of approx. 10.5 tonnes/km/year (724 tonnes/year on 68.8 km).

considerably less than the mentioned average €34,400/km/year. The objective of MSFD measures is a declining trend in the amount of litter. The welfare effects of a relatively large physical reduction of litter by, approximately 50% are computed to show the magnitude of the possible benefits related to a reduction of the amount of litter. This reduction by half of litter might result in a gain of 10% of the maximum benefits, , corresponding to approximately €1m/year. This might even be optimistic, since local authorities could feel the necessity of maintain a certain level of tidiness of the beaches, regardless the actual supply of litter.

- *recreational value*

Evidently, litter free beaches are more attractive than litter spoilt beaches. Aesthetical reasons may be very personal and they are also highly sensitive. Data about the relation between the level of litter pollution and deterrence of tourists, however, is scarce (Mouat et al., 2010). One study (Ballance et al., 2000) reported that 85% of South African beach visitors would not visit a beach with a litter density of more than 2 items/m.

Apart from the uncertainties about the physical relations in the LDI, there is also a wide range in estimations of the willingness to pay values for clean, c.q. litter free beaches. Most of the studies are devoted to water quality in general, giving WTP values of roughly €3.80[1] up to €137 per person per year, see Table 4.1. The values clearly depend on the research methodology, in particular the specification of the situation.

[1] Assuming an average 2.25 person household.

Table 4.1	Willingness to pay values for improved water quality		
WTP value or range	**Unit (converted to 2007 values)**	**Study**	**Country**
38.90	€/household/year	Le Goffe (1995)	France
4.42-137.36	€/person/year	Markowska and Zilicz (1996, 1999)	Poland
72.00	€/person/year	Söderqvist (2000)	Sweden
11.40	€/person/year	Hanley et al.(2001)	Scotland
11.84-19.44	€/person/year	Hanley and Kristrom (2002)	
8.64-17.28	€/household/year	Mourato (2003)	England/Wales
24.90	€/person/year	Kosenius (2004)	Finland

Sources: Turner et al. (2010); Ruigrok (2008) for Mourato (2003) values, converted to 2006.

Since, the Mourato (2003) values refer explicitly to litter at sea and on beaches, they can be used as a basis for a benefit transfer estimation for MSFD measures. The Dutch population counts approximately 7.1m households. Therefore, the actual WTP for improved water quality would range from €61-€122 m/year. The relation between the reduction of the present amount of litter and the situation with say, half of the litter present is unknown, but there is no a priori argument why it should be linear. Assuming that in this case also 10% of the maximum benefits could be reached by a reduction of litter by half, the benefits would amount to €6-12m/year. Evidently, the level of this benefit requires more insight into the underlying mechanisms and the empirical basis of the key numbers.

This represents the effect of improving the quality of beaches for current visitors. Larger attractiveness of the beaches will also lead to new visitors. Based on the deterrence of swimmers due to low water quality, Ruigrok (2008) estimates this effect, with a large degree of uncertainty, at €3m/year for the Dutch North Sea shore. By the same assumptions as above, the annual benefits could be estimated at €0.3m. Including both the increased recreational value and the reduction of cleansing costs as benefits due to a reduction of litter, may cause double counting. Currently the beaches are already attractive, because most litter is removed at touristic beaches. If the amount of litter washed on the beach decreases by half, and the beaches are cleaned less frequently, the tourists will not notice as big an improvement. To correct for this effect, the beach cleansing cost will not be included in the summation of all benefits related to litter.

- *attractiveness for housing*

People assign a high value to a good neighbourhood, which is reflected by prices of houses and apartments. Houses in the vicinity of beaches derive a part or their value from sea sight, provided that the quality of the beaches is conserved attractively. Although this logic is evident, estimations of the exact relation between the presence of a clean beach and the price of houses are largely depending on circumstantial evidence. Ruigrok (2008) assumes an increase in value of 0.5% of house prices (taken as a proxy of the value of the attractiveness of a beach with less litter) and a volume of 56,300 houses affected by improvement of beach quality. This leads to a maximum annual benefit of €2.2m. This estimation is presented as a rough indication. More evidence, for example from real estate firms could largely improve this value.

It should be noted that attractiveness for housing is a rather intangible concept. Competing alternative locations could become popular if a certain level of contamination by litter is reached. On the other hand, the amount of litter on the beaches is evidently correlated to other variables determining the value of houses such as noise and traffic jams when crowds are on the beaches. Therefore, reduction of litter per se need not to the same amount cut down the value of real estate. Even if we assume a 20% benefit resulting from a 50% reduction of litter, the benefits are well below €1m/year.

The rise in housing prices is due to the improved attractiveness of the sea and beach. This is also captured in the recreational value (estimated above). Including the housing prices also in the computation of the benefits tend can lead to double counting (depending on the way the enhanced recreational attractiveness of beach and sea is measured). In this CBA we will not include the housing prices in the summation of total benefits.

- *litter at sea: damage to ships, fishery equipment and catches*

Litter at sea causes a number of damages, more or less related, and in available data not always separable.

- *Extra operational costs for ships*

Damage of vessels and parts of vessels is known to be a serious effect of litter, but the magnitude is uncertain as most incidents go unreported. Fouled propellers, anchors, rudders and blocked intake pipes and valves are among the reported damages, the first being the most common incident. Damage can range from a short delay and reparation costs to exceptional incidents with the loss of life of hundreds of passengers (Mouat et al., 2010).

Data on the actual costs are not abundant (McIllgorm et al., 2011). For ferry traffic in Asia, an amount of about €14,000/year/vessel has been reported in a harbour with an effective cleaning system (McIllgorm et al., 2009). Hall (2000) points out that harbour authorities throughout the UK reported over 180 incidences of propeller fouling during 1998. A survey of 42 harbour authorities reported that up to €33,000 is spent per year in some ports, often to clear fouled propellers. In 1998, the Royal National Lifeboat Institution (RNLI) attended over 200 incidents to vessels with fouled propellers. The rescues were divided equally between fishing vessels and pleasure craft. As noticed by the marina managers, the RNLI data confirmed that there are more incidences of recreational boats becoming fouled in the summer months. It is estimated that the cost to the RNLI to undertake these rescues is on average about €1.1m each year.

For fishery vessels, the costs of fouling incidents are relatively small as compared to other damage (see below). Mouat et al. (2010) estimate the damage due to litter at €180/year/vessel, based on data of Scottish fishing vessels.[1] Actual damage, however, depends on the type of vessel. According to reports from fishermen in both Shetland and Esbjerg, small inshore boats appear to be more susceptible to marine debris than large pelagic boats. This is because the larger offshore boats are fishing mid-water and are therefore less likely to collect debris on or near the seabed. Smaller boats may also notice the presence of marine debris more than larger boats as they have less crew and a lower profit margin, so any time or money lost would affect them more (Hall, 2000).

For the total fishery float on the Dutch Continental Shelf (220 vessels), this amounts to an annual economic effect of €40.000/year. This effect can be assumed to be proportional to the density of litter encountered by the vessels (in contrast to the effects on recreation and housing mentioned above). Hence, the *benefits* of measures to reduce litter are linearly related to the intensity of the measures taken. From these figures, the annual operational and maintenance benefits, even with a reduction of 50% of litter, are relatively low, <€25,000/year. It should be noted that this kind of benefits are mainly related to larger pieces of litter or ropes that actually damage ships; smaller plastic objects fall into other categories (catch revenue), if any.

[1] 1% of the average reported annual damage of €17,291 to €19,165.

- *maintenance costs for fishing ships*

The fishing industry has long been considered a major contributor to marine pollution but until recently, little work has been done on the reverse effect: damage caused by marine debris and other pollution on the industry. Shetland fishermen were questioned about the effects of marine debris on their fishing activities. They responded that 92% of them had recurring problems with accumulated debris in nets, 69% had had their catch contaminated by debris and that 92% had snagged their nets on debris on the seabed. The catch itself, as well as nets and other equipment, could be contaminated by oil containers, paint tins, oil filters and other chemical wastes (see below) (Hall, 2000).

The main issue is *clearing* of nets, consuming much fishing time. This is considered as an important economic damage, since the clearing has to be done in the restricted fishing days at sea. Mouat el al. (2010) report an average loss of 41 working hours/year/vessel for cleaning of nets. This corresponds, for Scottish vessels, with an annual loss of €12,000/year/vessel. If these data are also representative for (220) Dutch vessels, this amounts to €2.6m/year as the loss due to litter. Net *repairs* form the second source of economic losses encountered by the fishing industry due to litter. They amount to one third of the costs related to clearing, or about €3,800/year/vessel (Mouat et al., 2010), for Scottish fishers.

Again, these costs refer to the actual losses. Benefits arise from reducing these costs. As in the case of operational costs due to litter, it may be assumed that maintenance costs related to net repair and clearing are roughly proportional to the amount of litter. A reduction of litter by 50% would therefore result in a benefit of €1.3m/year.

- *Reduced catch revenue*

The third effect of litter is the degradation of catches. Selection of fish in catches takes more time; furthermore, contamination of catches, for example by paint, forces the fishers to discard part of their catch. Losses are reported to amount €2,200/year/vessel (based on Mouat et al., 2010). For 220 vessels, therefore, the actual costs are €0.5m. Based on these data, a 50% reduction of litter would result in an annual benefit of €0.25.

It should be noted, that the economic loss related to catch damage not only depends on the amount of litter, but also on the fishing itself at the moment that an indecent occurs (Mouat et al., 2010). In days when the fishing is poor, the effect of litter is low, whereas in times of good fishing, it may result in 'a hell of a lot of money'. Therefore, it is probable, that the relation between the density of litter at sea and the economic costs (and hence the benefits drawn from measures) is not straightforward. A more quantitative insight into the relation between catch, litter and economic losses will therefore contribute to a better estimation of economic benefits of MSFD measures.

In Table 4.2 all potential benefits of a reduction of litter are summed, and corrected for double counting. We did this exercise for an imaginary reduction of the amount of litter of 50% and estimate the aggregate benefits to range between €7m and €14m per year for the Netherlands. A reduction of litter in sea and at the beach of 10% will result in benefits smaller than one fifth of that figure (€1-2.5m per year).

Table 4.2 **Summary: indicative benefits generated by a 50% reduction of litter (this is a bigger reduction than will be attained by the MSFD targets)**

Benefits of 50% litter reduction	**order of magnitude €1m/year**
Reduced beach cleaning costs	1 a)
Enhanced recreational value	6-12
Attractiveness for housing	<1 a)
Reduced operational and maintenance costs	<1
Less damage to fisheries (nets)	1.3
Higher catch revenue	<1
Total benefits of 50% litter reduction	7-14

a) Reduced beach cleaning costs and attractiveness of housing are not included in the summation, to prevent double counting (see text above).

4.11 CBA of GES Descriptor 11: Underwater noise

Noise has the potential to affect bottom flora and fauna, fish and marine mammals (Adams and Eldrigde, 2011). Therefore, the chain of measures to reduce underwater noise to benefits passes largely, if not completely, through the effects on marine life. The benefits of marine life, however, are the same as those already encountered in GES descriptors 1, 3, 4 and possibly 7. Beneficiaries are the same: non-users in relation to protection of marine biodiversity and fisheries. As the effects of noise on marine life have not been fully quantified

(Adams and Eldridge, 2011), it will be very difficult to distinguish between noise-generated effects and other effects on marine life and henceforth on benefits.

4.12 CBA conclusions

To carry out a full CBA at this moment is impossible due to a lack of information. Although we simplified the CBA, by not taking into account the value of eco-system services that are not traded on a market, it is not possible yet to do a reliable CBA. We assessed the benefits of achieving GES by considering the reduction of current costs (for example reduction of litter removal from the beach) and the levels of eco system goods and services provided in the case the targets are met. To describe the missing information more precisely, we link it to the distinguished CBA steps (see Figure 2.4).

CBA step 1, describe the planned MSFD scenarios and the current policy scenario
There is limited understanding of the difference between the autonomous development (BaU scenario) and MSFD targets. This stems from the targets being defined only qualitatively, and the fact that the MSFD measures, that have to be taken to attain the targets, are not known yet.

CBA step 2, quantification of the physical differences between the scenarios
For this step either information about the amount of the measures taken, or a quantitative description of the BaU and MSFD targets, is necessary. This information is not sufficiently available for a full CBA. The physical effects of potential measures can be identified, but not quantified (e.g. the effect of alternatives for bundles of wires on the quantity of rope and cord in sea and on the beach cannot be established reliably). Also the autonomous development cannot be quantified properly because the impact of new or future policies is not known (for example, how much less marine litter will there be if the revision of the Port Waste Directive is implemented?). The pressures that are being addressed by a measure can easily be identified, but how much these measures contribute to achieving GES is not yet known (Adams and Eldridge, 2011).

CBA step 3, identification of welfare effects.
Based on the physical effects (see CBA step 2) the welfare effects can be identified.

CBA step 4, quantification and monetarisation of the effects.
Due to missing quantitative information on the physical effects, the welfare effects cannot be quantified. Prices can be attached to these welfare effects, their reliability is greater than the information on the magnitude of the physical effects.

CBA step 5, provisional CBA
As already indicated under the aforementioned CBA-steps, essential information is missing. If this information would be available a CBA could be carried out properly.

CBA step 6, sensitivity analysis
The current status of the CBA does not warrant a reliability analysis on top of the statements above.

Despite these challenges, analysis of benefits of potential targets (and potential measures) has revealed useful information to decision-makers. It has indicated the expected direction and scale of changes to human welfare. The most important benefits, based on the current information, are related to reduction of non-indigenous species (NIS) and the decreasing amount of litter. The benefits related to NIS depend heavily to the species which introduction is prevented by the MSFD. The costs associated with a specific NIS can be enormous (€2 milliard per year in the UK; Adams and Eldridge, 2011; based on Williams et al., 2010) and can only be compute with very large confidence intervals. The benefits of a reduction of litter in sea and on the beach are related to specific litter items. Tourists are not interested in nylon wires on the beach, but are deterred by larger items on the beach. Hence, in a CBA litter cannot be treated as one homogenous GES-descriptor. Measures targeting different sources of litter are linked to different benefits. Obviously the costs also differ between these sources.

The current provisional CBA can only be used for a selection of specific issues and measures arising in the implementation of the Directive. Additionally, several caveats have been pointed out to improve on the CBA.

5 Conclusions and recommendations

5.1 Conclusions

In this section answers will be given to the following three main questions of this study, namely:

1. To what extent is the methodology developed and used in this study suitable for the required CEA and preliminary CBA?
2. Which potential measures are most cost-effective in order to achieve the targets of the MFSD in 2020?
3. What additional information is needed to carry out the CBA analysis in 2012?

Methodology

- The methodology applied is suitable for the MSFD cost-effectiveness analysis.
- The Dutch government has related the targets of MSFD as much as possible to other EU directives and policies (for example Water Framework Directive, Common Fisheries Policy, IMO). Hence, in the eyes of DG Space and Water, the MSFD does not add much to the autonomous development of the marine environment of the North Sea except for litter. The gaps between the BaU scenario and the MSFD targets are considered to be small for most GES descriptors. Many EU policies still have to be implemented on the national level, which creates a complex process of which results are difficult to predict. In particular, more insight in the Common Fisheries Policy and its impact on the marine environment is needed to better determine the gap between autonomous development and MSFD. Because of the complexity of predicting the outcomes and impact of all these decisions, it is not striking that the experts consulted are not agreeing on the expected autonomous development of the state of the North Sea.
- The Ministry of Infrastructure and Environment and experts agree on the observation that a gap is to be expected between the autonomous development and the MSFD for GES 6 and GES 10. For these descriptors, additional measures are proposed.
- Based on currently available information and input from experts, a CEA was carried out. This CEA focused on marine litter measures and enabled the ranking of possible additional measures according to their estimated cost-effectiveness. Based on this information potential cost-effective measures can be selected to be elaborated in a next phase of MSFD. The current pro-

visional CBA can only be used for a selection of specific issues and measures arising in the implementation of the Directive. Additionally, several caveats have been pointed out to improve on the CBA.

- Most of the possible measures assessed in this study are new. Therefore information about their effect is not yet available. In these cases expert opinion is the only available source of information. The methodology applied is suitable in circumstances with limited data availability and reveals the knowledge gaps that have to be filled to enable a more reliable CEA and CBA.
- For a CEA, a quantitative description of the scenario 'Business as Usual' as well as of the scenario 'MSFD targets met' is necessary. As not all targets are set, and dose-effect relations are missing, the information currently available is not sufficient available for a full CEA. The physical effects of potential measures can be identified, but not quantified. This implies that the amount of measures to be taken cannot be estimated. The pressures that are being addressed by a measure can easily be identified, but how much these measures contribute to achieving GES is not yet known.

Cost-effective measures

- In Table 5.1, conclusions about the cost-effectiveness analysis are summarised per GES descriptor.
- For GES 6, the only additional measure analysed (re-introducing stones to the seafloor) is assessed to be not cost-effective.
- Pieces of nets are the most frequently found litter items at Dutch beaches. Measures preventing that these pieces of nets enter the sea are potentially effective. Examples of such measures are: alterna tives for bundles of wires (to protect nets)big bags on deck of fishing vessels to collect redundant pieces of nets are potentially cost-effective measures to reduce litter from fisheries.
- The amount of litter at the beach from tourists can be reduced cost-effectively by awareness raising activities and campaigns. Although deposit return systems for plastic bottles seem to be attractive, they are not targeted sufficiently to marine litter. This lack of targeting also applies for restrictions for balloon launches. In general, however, awareness raising is cost-effective. Increasing the awareness of one's own contribution to the marine litter problem will be an important trigger to reduce marine litter. International harmonisation of the fees of port reception facilities and controlling the amount of garbage handed in, is a potentially cost-effective measure to reduce litter from ships. The contribution of a reduction of litter to other GES-descriptors depends on the type of litter. It is not certain whether the number 1 item on

Dutch beaches ((thin plastic wires for instance to protect fishing gear nets) is also the most detrimental for the marine environment (GES 1 and GES4).

- The largest benefits of the targets formulated by the Ministry of Infrastructure and the Environment in order to attain the Good Environmental State (GES) of the Marine Strategy Framework Directive (MSFD) are related to marine litter. The biggest financial benefits are related to a reduction of larger litter items. The target for biota, however, will be attained if the quantity of small plastic items in sea is reduced as these are most frequently ingested.
- Despite the aforementioned challenges, analysis of benefits of potential targets (and potential measures) has revealed useful information to decision-makers. It has indicated the expected direction and scale of changes to human welfare.
- The most important benefits, related to the GES-descriptors are related to reduction of non-indigenous species (NIS) and the decreasing amount of litter. The benefits related to NIS depend heavily to the species which introduction is prevented by the MSFD. The costs associated with a specific NIS can be enormous (€2 milliard per year in the UK) and can only be compute with very large confidence intervals. The benefits of a reduction of litter in sea and on the beach are related to specific litter items. Tourists are not interested in minute nylon wires on the beach, but are deterred by larger items on the beach. Hence, in a CBA litter cannot be treated as one homogenous GES-descriptor. Measures targeting different sources of litter are linked to different benefits. Obviously the costs also differ between these sources.
- Key information gaps about the effect of noise on the marine environment impede a proper analysis of GES 11.

Table 5.1 **Conclusion cost-effectiveness analysis per GES descriptor. The Dutch MSFD strategy indicators and targets are given by the Ministry of Infrastructure and the Environment**

	GES-Descriptor	Target (EU)	Gap analysis (Ministry of Infrastructure and the Environment)	Most attractive additional MSFD measures
1	Biodiversity	Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.	The revised Common Fisheries Policies will enhance sustainable fisheries. The Birds and Habitats Directives and Natura 2000 will protect vulnerable areas and species.	None, measures taken for other GES descriptors also contribute to preserving biodiversity.
2	Non-indigenous species	Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystem.	The prevailing policy will reduce the risk of new introductions between 2020 and 2030 significantly.	None (on top of IMO)
3	Commercial fish and shellfish	Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock.	The revised Common Fisheries Policy will reduce the gap. Ecosystem response time will determine whether target is reached in 2020.	None (on top of CFP)

Source: DGSW (2011).

Table 5.1 (continued) **Conclusion cost-effectiveness analysis per GES descriptor. The Dutch MSFD strategy indicators and targets are given by the Ministry of Infrastructure and the Environment**

	GES-Descriptor	Target (EU)	Gap analysis (Ministry of Infra-structure and the Environment)	Most attractive additional MSFD measures
4	Food-web	All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.		None, measures taken for other GES descriptors also contribute to preserving the food web.
5	Human induced eutrophication	Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters.	Significant effect of eutrophication on the ecosystem will be small in 2020-2030 due to prevailing policy (WFD, Nitrate directive)	None (on top of WFD)

Source: DGSW (2011).

Table 5.1 (continued) **Conclusion cost-effectiveness analysis per GES descriptor. The Dutch MSFD strategy indicators and targets are given by the Ministry of Infrastructure and the Environment**

	GES-Descriptor	Target (EU)	Gap analysis (Ministry of Infra-structure and the Environment)	Most attractive additional MSFD measures
6	Sea floor integrity	Sea floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.	The target will not be reached without additional measures	The only measure 'Re-introducing stones and/or boulders' is assessed as not effective
7	Hydrographical conditions	Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems.	Prevailing Natura 2000 regulation with respect to projects is sufficient.	None (on top of Natura 2000)
8	Contaminants	Concentrations of contaminants are at levels not giving rise to pollution effects.	Due to prevailing policies the risk of known contaminants on the ecosystem is very small.	None (on top of WFD, IMO and Marpol). The only measure Dredging of contaminated sediments on hot spot locations is assessed as not cost-effective.
9	Contaminants in seafood	Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards.	Levels of contaminants are currently not exceeded, and is not expected to do so in future	None

Source: DGSW (2011).

Table 5.1 (continued) **Conclusion cost-effectiveness analysis per GES descriptor. The Dutch MSFD strategy indicators and targets are given by the Ministry of Infrastructure and the Environment**

	GES-Descriptor	Target (EU)	Gap analysis (Ministry of Infrastructure and the Environment)	Most attractive additional MSFD measures
10	Marine litter	Properties and quantities of marine litter do not cause harm to the coastal and marine environment.	The autonomous development of litter in sea does not show a reduction of litter (in the sea, at beach, in biota).	*Affecting fisheries* Coco matting as an alternative for bundles of nylon wires used to protect fishing gear
				Affecting shipping Uniform regulation of port reception facilities. And stricter control on the garbage handed in.
				Affecting households (inclusive tourism) Raising awareness
11	Underwater noise	Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.	Exact scale of the problem is not fully known.	No additional measures with an effect, the first step is to explore knowledge gaps and monitoring.

Source: DGSW (2011).

5.2 Recommendations

Recommendations for research

- Although the amount of litter at the Dutch beaches is currently monitored, no quantitative information is available on the quantity of litter in the sea, nor about the quantity emitted yearly by the distinguished sources, nor on the effects on wildlife. Therefore, a litter flow-model should be developed based on the currently available information on marine litter, in order to get more grip on the sources entering litter in the sea. This model should describe the litter circle and reveal missing information links that might be solved by extra monitoring or research.
- The amount of litter in the North Sea stemming from rivers is unknown. Although the share of riverine litter in North Sea is probably smaller than the average global amount of 80%, it still can be a significant source of litter. Therefore a more solid assessment is needed of the amount of litter in rivers so measures to reduce this source of marine litter can be developed.
- Scientists/researchers in cooperation with the shipping sector should acquire better understanding of vessel waste streams (and the current choice among disposal options) in order to improve the targeting of measures.
- International co-operation of monitoring and modelling will be more cost-effective and will provide more support for the relations found. Researchers should aim to quantify the sources, fates, and impacts of marine litter.
- More information on the dose-effect relation is necessary for most of the potentially cost-effective measures, to compute the cost-effectiveness more exactly. The valuation of welfare effects also needs improvement to translate them to the Dutch circumstances.

Recommendations for policy

- The Dutch government should initiate the establishment of scalable and statistically rigorous protocols that allow monitoring of litter at a variety of temporal and spatial scales.
- Marine litter is an international problem and should be addressed in co-operation with other North Sea countries. At international level the Dutch government should initiate the development of an international plan for marine litter management which includes: standards and priorities, metrics for assessing progress.

- A level playing field with respect to port reception facilities prevents better illegal dumping of garbage while reducing competiveness differences due to litter reception. So the national government in cooperation with the shipping and harbour sector should establish minimum qualitative and quantitative standards for port adequacy. Also the government should encourage ports to provide incentives to vessel operators for discharging their waste ashore, for example via a waste tracking system for sea ships. Furthermore the government and the private sector should develop and promote voluntary zero-discharge standards.
- Balloons ending up in the Dutch sector of the North Sea originate for a large part from the UK. Therefore the Dutch government should coordinate measures regarding balloon launches with UK's government in order to increase the effectiveness of the measures.
- Current regulations do not include accountability measures for gear loss and fishermen and fisheries management organisations have few incentives to take responsibility for their impacts and for clean-up. Because of that government in co-operation with the fishery sector should take steps towards rules on managing waste fishing gear and preventing accidental loss. This makes it also necessary to explicitly define' accidental losses' and ' reasonable precautions' with respect to fishing gear.

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Appendix 1

Long lists of additional measures

Table A.1	Long lists of additional measures		
	Analysed Y/N	**Reported + GES**	**Measure**
1	Y	N	Active elimination of newly introduced species in marinas
2	Y	N	Mandatory regular cleaning of sea chests, hull and propeller
3	N		Additional N-reduction
4	N		Implementation of more selective fishing methods
5	N		Replacing conventional beam trawl with the Pulswing technology
6	N		Closed areas for fishing in offshore wind parks
7	N		Closed areas for bottom trawling in offshore wind parks
8	N		Zoning of bottom trawling outside of Natura 2000 areas
9	N		Fisheries zoning inside Natura 2000 areas based on the impact of fishing techniques and the type of habitat
10	N		Combination of zoning and access to those fishing areas for specific fishing methods
11	N		Fisheries zoning outside of Natura 2000 areas based on the impact of fishing techniques and the type of habitat
12	N		Discard ban on all commercial quota- and non-quota species
13	N		Discard ban on all species caught
14	N		Cleaning production mud
15	N		Stricter enforcement, higher penalties pollutors
16	N		extending dumping bans lipophyllic substances
17	Y	GES 10	Different packaging standards of plastic pellets
18	Y	GES 10	Alternative for bundles of nylon wires used to protect fishing gear
19	Y	GES 10	Biodegradable nets
20	Y	GES 10	Higher fines for littering
21	N		Real-time management of noise pollution in time and space
22	N		Enforcing JNCC marine mammal protocol seismics
23	Y	N	Silent construction methods

Table A.1	Long lists of additional measures (continued)		
	Analysed Y/N	**Reported + GES**	**Measure**
24	N		Use of acoustical scaring devices and ramp-up
25	N		Stimulating the usage of (diesel-)electric marine propulsion
26	N		Using green lights on offshore platforms
27	N		Observers and/or camerasystems on set-net vessels
28	N		Supplementary feeding of gull chicks
29	N		Zoning tourism
30	N		Ban on imports of ALL exotics for aquaria
31	N		Ballast water treatment on all large ships
32	N		Prevention of non-indigenous species entering Dutch waters through shell imports from outside of the North Sea
33	N		Pole and cover stones inspections and cleaning
34	N		Certification of the fisheries chain
35	N		Reduction of fishing effort
36	N		Land base communal Water Treatment Plants: extra P to sea
37	N		Different river water management (directing river outputs in case of calamity)
38	N		Stricter restrictions on sea based dumping of dredged material
39	N		Additional P-reduction Water Treatment Plants
40	N		Additional reduction contaminants Water Treatment Plants
41	N		Deeper sand burrows
42	N		Ecological landscaping burrow pits
43	N		Limiting silt plumes by limiting silt overflow
44	N		Reduction of quota
45	N		Reduction of shell mining in Natura 2000 sites in the coastal zone
46	N		Zoning of dumping areas/reuse
47	N		Natura 2000 coastal zones: sea-bottom protection zones
48	N		(temporary) Zones with reduced frequency of certain fishing techniques outside of Natura 2000
49	N		Meganourishments in the coastal zone
50	N		Sand-efficient coastal strategies
51	Y	GES6	Introducing hard substrate items in bottom-protection zones

Table A.1	Long lists of additional measures (continued)		
	Analysed Y/N	**Reported + GES**	**Measure**
52	N		More calamity control
53	N		Zoning of oil and chemical spills clean-ups (uitsplitsen naar scheepvaart en boorplatforms)
54	N		Zoning of oil and chemical spills clean-ups (related to shipping)
55	N		Zoning of oil and chemical spills clean-ups (related to oil drill platforms)
56	N		stricter enforcement, higher penalties deep water shipping lanes
57	N		Additional public campains on litter
58	Y	GES 10	Ban on use of plastic bags in supermarkets
59	Y	GES 10	Do it yourself beaches
60	Y	GES 10	Biodegradable user plastics at beaches
61	Y	GES 10	Biodegradable balloons, balloon valves and ribbons
62	Y	GES 10	Stricter enforcement on the use of port reception facilities to collect waste
63	Y	GES 10	Fishing for litter
64	Y	GES 10	Adding indiviually recognisable ID-markers to fishing nets and wires
65	Y	GES 10	Additional Beach cleaning
66	Y	GES 10	Deposits on all plastics
67	Y	N	Noise reduction in shipping
68	N		Management of active sonar use
69	N		Implementation of silent gear boxes in turbines
70	Y		Reduction of noise emissions by seismic survey (level of duration) + detonation of munition
71	N		Natura 2000 coastal zones: recreational zoning
72	Y	GES 8	Dredging of contaminated sediments

Appendix 2

Consulted experts

Workshop participants

Participants MSFD general expert meeting, august 11	
Tom van der Have	Ministerie van EL&I
Robin Hamerlinck	RWS
Martine Graafland	RWS
Mariska Harte	RWS

Participants MSFD GES 1 and GES 4 meeting, September 20	
Peter Heslenfeld	RWS
Hans Nieuwenhuis	Ministerie van EL&I
Sietse Bouma	Bureau Waardenburg

Participants MSFD GES 2 meeting, September 7	
Arjen Gittenberger	GIMARIS
Andrea Sneekes	Imares

Participants MSFD GES 5 and GES 8 meeting, September 13	
Lisette Enserink	Ministerie van I&M, RWS
Wanda Zevenboom	Ministerie van I&M, RWS
Marcel Bommelé	Ministerie van I&M, RWS
Cato ten Hallers	Imares + Cato Marine ecosystems

Participants MSFD GES 6 meeting, September 23	
Ad Stolk	RWS
Lisette Enserink	RWS
Wanda Zevenboom	RWS
Jan van Dalfsen	Deltares
Mark van Koningsveld	Van Oord
Martin Baptist	Imares
Chris Dijkshoorn (RWS)	RWS, I&M

Participants MSFD GES 10 meeting, September 20	
Sandra van der Graaf	RWS
Lex Oosterbaan	Ministerie van I&M, RWS
Barbara Wenneker	RWS
Laura Graafland	Ministerie van I&M, DG Water
Quinty Duivestein	RWS
Paul Altena	KVNR

Participants MSFD GES 11 meeting, September 21	
René Dekeling	Ministerie van I&M
Paul Altena	KVNR, milieuzaken
Ronald de Rooij	Ministerie van Defensie
Klaus Lucke	Imares, Wageningen UR
Aart Tacoma	NOGEPA

Other experts who contributed to the CEA		
Expert	**Affiliatie**	**GES descriptor**
Brus, Dick	Ministry of Infrastructure and Environment	GES 2
Wijsen, Ditmar	BPM, Poetsch Limburg B.V. in Elsloo (over herkomst en prijzen van grote zwerfkeien)	GES 6
Afdeling inkoop	Boland, party items, Alphen aan den Rijn	GES 10
Afdeling verkoop	De Ballonerie, balloons wholesale, Amsterdam	GES 10
Backere, Renate de	Waddenvereniging, Harlingen	GES 10
Buitenhuis, Caroli	Tassenbol (reuse system of plastic bags)	GES 10
Dagevos, Jeroen	Stichting de Noordzee	GES 10
Dijk, Eric van	Stichting Keurmerk Milieu, Veiligheid en Kwaliteit	GES 10
Duin, Robbert van	Bureau B&G	GES 10
Eisma, M.	Port of Rotterdam	GES 10
Employee	Chamber of Commerce, Den Haag	GES 10
Employee	Vereniging GEBRA, belangenorganisatie detailhandel gemengde en speelgoedbranche, Zoetermeer	GES 10
Employee	Amsterdams Ballonnen Bedrijf, balloons wholesale, Zwanenburg	GES 10
Employee	AA drink	GES 10
Franeker, Jan Andries van	IMARES	GES 10
Herder, Kees den	Ministry of Infrastructure and Environment	GES 10
Jongeneel, Tom	ADIC b.v., balloons supplier, Langbroek	GES 10
Klimaatdesk	KNMI, De Bilt	GES 10
Licher, Christa	Ministry of Infrastructure and Environment	GES 10
Meijer, Bert	Air traffic control the Netherlands, Schiphol	GES 10
Prinssen, Maurits	Port of Rotterdam	GES 10
Slagboom, Theo	Koninklijke Bond van Oranjeverenigingen, Culemborg	GES 10
Stee, Stefan van der	Strand Nederland, koepel van strandpaviljoenhouders	GES 10
Teeselink, Henk Klein	Nederland Schoon	GES 10
Weenen, Hans van	Plastic Soup Foundation	GES 10
Veerman, Bert	KIMO, fishing for litter	GES 10
Wit, P.C.B. de	Port of Rotterdam	GES 10
Ainslie, Michael	TNO	GES 11
Brug, Edwin van de	Ballast Nedam Offshore	GES 11
Erkel, Tim van	IHC Hydrohammer B.V.	GES 11
Jong, Christ de	TNO	GES 11
Kasteren, Jurrien van	Maritieme EOD, Den Helder	GES 11
Lam, Frans Peter	TNO	

Glossary; Definition of key terms

GES 2
- *Non-indigenous species (NIS*; synonyms: alien, exotic, non-native, allochthonous) are species, subspecies or lower taxa introduced outside of their natural range (past or present) and outside of their natural dispersal potential. This includes any part, gamete or propagule of such species that might survive and subsequently reproduce. Their presence in the given region is due to intentional or unintentional introduction resulting from human activities. Natural shifts in distribution ranges (e.g. due to climate change or dispersal by ocean currents) do not qualify a species as a NIS. However, secondary introductions of NIS from the area(s) of their first arrival could occur without human involvement due to spread by natural means. - *Invasive alien species (IAS)* are a subset of established NIS which have spread, are spreading or have demonstrated their potential to spread elsewhere, and have an adverse effect on biological diversity, ecosystem functioning, socio-economic values and/or human health in invaded regions. Species of unknown origin which cannot be ascribed as being native or alien are termed cryptogenic species. They also may demonstrate invasive characteristics and should be included in IAS assessments. - *The key term '… levels that do not adversely alter the ecosystems'* is described as the absence or minimal level of 'biological pollution'. The latter is defined as the impact of IAS at a level that disturbs environmental quality by effects on: an individual (internal biological pollution by parasites or pathogens), a population (by genetic change, i.e. hybridisation), a community (by structural shift), a habitat (by modification of physicalchemical conditions) or an ecosystem (by alteration of energy flow and organic material cycling). The biological and ecological effects of biopollution may also cause adverse economic consequences.
Bron: Olenin et al. (2009).

GES 5
- *Eutrophication* is a process driven by enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorus, leading to: increased growth, primary production and biomass of algae; changes in the balance of organisms; and water quality degradation. The consequences of eutrophication are undesirable if they appreciably degrade ecosystem health and/or the sustainable provision of goods and services. - *GES in relation to the descriptor 'human induced eutrophication'* Human induced eutrophication is minimised and in accordance with targets of Water Framework Directive, nitrate directive and OSPAR. - *Contaminants* are defined as substances (i.e. chemical elements and compounds) or groups of substances that are toxic, persistent and liable to bioaccumulate, and other substances or groups of substances which give rise to an equivalent level of concern. This definition is in line with the definition of hazardous substances used in the Water Framework Directive 2000/60/EC (WFD), and by OSPAR and HELCOM. - *Pollution effects* are defined as direct and/or indirect adverse impacts of contaminants on the marine environment, such as harm to living resources and marine ecosystems, including loss of biodiversity, hazards to human health, the hindering of marine activities, including fishing, tourism and recreation and other legitimate uses of the sea, impairment of the quality for use of sea water and reduction of amenities or, in general, impairment of the sustainable use of marine goods and services. - *GES in relation to the descriptor '… contaminants …'* The descriptor is concerned with the pressures exerted by chemical pollution onto marine ecosystems. All contaminant types and pollution effects other than those covered by other GES descriptors are to be considered.

GES 6
- *Sea-floor* includes both the physical structure and biotic composition of the benthic community. - *Integrity* includes the characteristic functioning of natural ecosystem processes and spatial connectedness. - *GES in relation to the descriptor 'sea-floor integrity'* The descriptor is concerned with both physical and biological properties of the sea-floor. The physical properties of the seabed comprise grain size, porosity, rugosity, solidity, topography and geometric organisation (e.g. three-dimensional habitats). Properties like oxygen and contaminant contents should also be considered. Biological properties of the sea-floor habitat comprise species composition, size composition and life history traits of these species, and trophodynamics: primary and secondary production, carrying capacity, energy flows, and food web relationships. Special attention goes out to bioengineers.
Taken from: Rice et al. (2010).

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