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# The Role of Economics in Ecosystem Based Management: The Case of the EU Marine Strategy Framework Directive; First Lessons Learnt and Way Forward.

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# The Role of Economics in Ecosystem Based Management: The Case of the EU Marine Strategy Framework Directive; First Lessons Learnt and Way Forward.


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## 1. INTRODUCTION

Various anthropogenic pressures have caused severe deterioration of marine environments globally (Smith 2003, Diaz and Rosenberg 2008, Rockstrom et al. 2009). In Europe, the EU Marine Strategy Framework Directive (MSFD) addresses this challenge by aiming to achieve Good Environmental Status (GES) of the European marine waters by 2020 (EC 2008) (Figure 1). In particular, it aims to "Protect and preserve the marine environment, prevent its deterioration or, where practicable, restore marine ecosystems in areas where they have been adversely affected" and to "prevent and reduce inputs in the marine environment, with a view to phasing out pollution [...] so as to ensure there are no significant impacts on or risks to marine biodiversity, marine ecosystems, human health or legitimate uses of the sea" (Art. 1(2)).

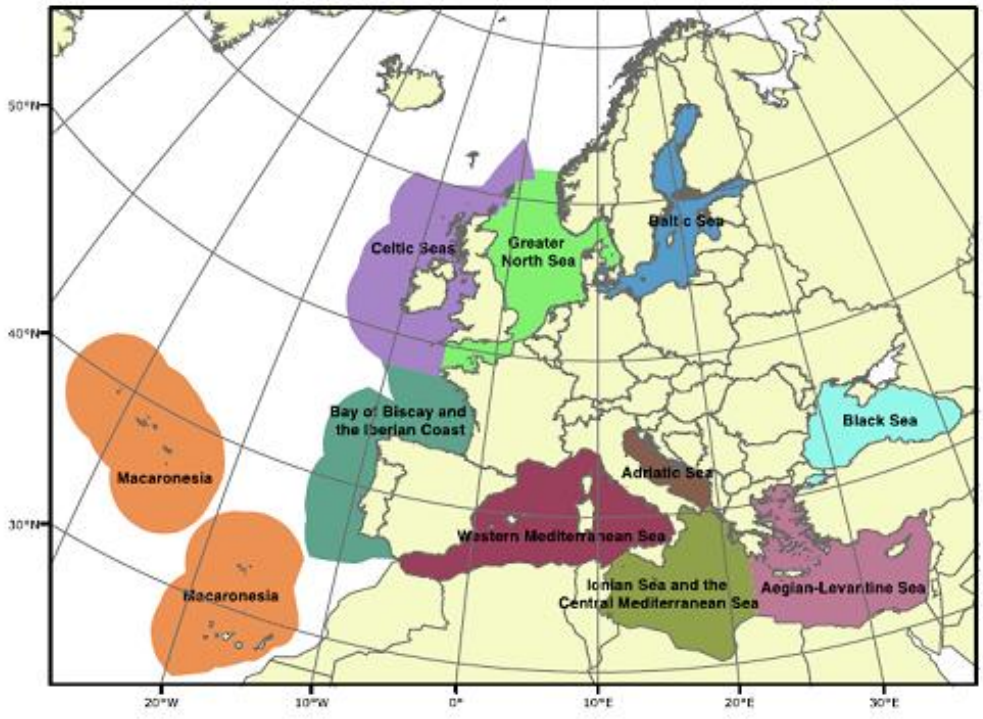


*Figure 1.* Regional seas and sub-seas of Europe according to the Marine Strategy Framework Directive as per the European Marine and Data Observation Network

The implementation of the MSFD attempts to follow the principle of ecosystem-based management in which marine protection and delivery of the ecosystem goods and services are realized jointly (Elliott 2011, Berg et al. 2015). As outlined in the Directive itself, the strategy encourages Member States to "apply an ecosystem-based approach to the management of human activities, ensuring that the collective pressure of such activities is kept within

levels compatible with the achievement of good environmental status" (Art. 1(3)) and the Directive calls for different types of economic analyses. The Member States of the EU are required to implement the Directive in an iterative and adaptive manner, based on a risk-based approach, in management cycles of six years. Each cycle starts with the definition of the environmental objectives and an assessment of the present environmental status of the EU regional seas which include the Black, Mediterranean, North and Baltic Seas as well as EU territorial waters in the Northeast Atlantic (Figure 1). This phase requires the economic analyses of the use of marine waters and an analysis of the cost of degradation. The second step is to establish monitoring programs indicating whether or not GES is being achieved. The last step of the cycle is to develop a Program of Measures (PoMs) designed to close the gap between the current and desired state of the sea. Here, the Directive requires Member States to conduct cost-benefit (CBA) and cost-effectiveness (CEA) analyses. Implementation of the PoMs is scheduled to begin by 2016. In 2018, a new management cycle will start with the re-assessment of the status of the marine waters and a review of the objectives.

The Water Framework Directive (WFD, EC 2000) was the first European directive in which economic analyses were given a prominent place. The WFD requires an economic description of the use of the river basins, cost recovery of water services, the application of the polluter pays principle, and cost-effective Programs of Measures. Experiences from these analyses show that once reliable estimates of the effectiveness and costs of measures are available, a CEA is straightforward, in theory (van Engelen et al. 2008, Balana et al. 2011). An important difference between the economic analyses required for the MSFD and the WFD is that the latter requires that the Program of Measures is cost-effective, whereas in addition to the CEA the MSFD requires the conduction of CBA. Quantification of the economic benefits arising from the improvement in the status of the marine areas is essential but resource extensive research task. Moreover, the two Directives differ in terms of the environmental objective against which cost-effectiveness is evaluated. WFD aims to achieve Good Ecological Status of water bodies with the focus on the ecological and chemical status of surface water bodies. The objective of the MSFD (Good Environmental Status – GES) is equally, if not more complex, being defined using 11 qualitative descriptors (Table 1). This makes the economic analyses not as straightforward as in cases where one can focus on e.g. the emissions of one substance. The overall GES assessment for the MSFD is further complicated by hierarchical linkages between the descriptors.

For example, increased eutrophication (D5) can have undesirable impacts on food web functioning (D4) (Borja et al. 2013).

*Table 1*. Qualitative Descriptors for Determining Good Environmental Status (GES) in the MSFD (EC 2008, Annex 1)

| | MSFD Descriptor | Short name |
|---|---|---|
| D1 | 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. | Biodiversity |
| D2 | Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems | Non-indigenous species |
| D3 | Commercially exploited fish and shellfish | Commercially exploited fish and shellfish |
| D4 | 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. | Marine food webs |
| D5 | Human-induced eutrophication is minimized, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters. | Human-induced eutrophication |
| D6 | 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. | Sea floor integrity |
| D7 | Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems. | Hydrographical conditions |
| D8 | Concentrations of contaminants are at levels not giving rise to pollution effects. | Concentrations of contaminants |
| D9 | Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards. | Contaminants in fish and other seafood |
| D10 | Properties and quantities of marine litter do not cause harm to the coastal and marine environment | Marine litter |
| D11 | Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment. | Energy, including underwater noise |

The MSFD, however, calls for different types of economic analyses, but provides little guidance on how to conduct them. This provides a certain degree of freedom to use those kinds of economic analyses that best suit the (political) needs and situation in the various Member States or the

requirements of the regional seas, so these analyses can be most useful to support decision making according to the subsidiarity principle of the EU. This paper is therefore written with two kinds of audience in mind. On the one hand it provides a justified set of recommendations for policy makers on how to lead the development of marine strategies that follow the principles of ecosystem based management. On the other hand, it is directed at economists, with recommendations on how to conduct the required economic analyses, given the potential resource limitations related to research for policy support. This paper is an outcome of the Policy Session entitled "Assessing societal costs and benefits of a Program of Measures for the EU Marine Strategy Framework Directive: The first lessons learnt and way forward", held during the Annual Conference of the European Association of Environmental and Resource Economists in Helsinki, June 24-27, 2015. In what follows, Section 2 briefly reviews the economic requirements of the Directive and reviews the academic literature that has examined this issue previously. Section 3 provides some recommendations on the implementation of economic analysis within the MSFD before Section 4 concludes.

*Table 2.* The requirements for Economic Assessment in the Marine Strategy Framework Directive (EC 2008)

| MSFD Section | Requirements for economic analysis |
|---|---|
| Initial Assessment (Article 8) | Economic and social analysis of the use of marine waters and of the cost of degradation of the marine environment |
| Programs of Measures (Article 13) | Member states shall ensure that the measures are cost-effective and shall carry out impact assessment including cost-benefit analysis, prior to the introduction of any new measure |
| Exceptions (Article 14) | Member States shall develop and implement all the elements of marine strategies referred to in Article 5(2), but shall not be required, except in respect of the initial assessment described in Article 8, to take specific steps where there is no significant risk to the marine environment, or where the costs would be disproportionate taking account of the risks to the marine environment, and provided that there is no further deterioration. |

## 2. MSFD REQUIREMENTS FOR ECONOMIC ANALYSIS AND PREVIOUS RESEARCH

Rationale of the use of environmental economic analyses for decision and policy support is to make sure that society's scarce resources are efficiently

allocated and used. In addition, it requires that the environmental objective is achieved with least costs and that the costs are lower than the expected economic benefits arising from the policy. Theory underlying CEA and CBA is well developed but their practical application for policy support in Europe is only taking its first steps. Finally, there are other forms of economic analysis required in the MSFD that go beyond CEA and CBA. These are summarized in Table 2 and expanded upon below (see also Bertram and Rehdanz 2013).

### 2.1. Required Economic Analysis for the MSFD Initial Assessment

MSFD Article 8.1 requires economic and social analysis (ESA) of the use of marine waters, and of the cost of degradation of the marine environment. To support the work the European Commission provided a legally non-binding guidance document describing different approaches that might be used to satisfy these requirements (WG ESA 2010). Two approaches in particular were advised to use in the ESA: the ecosystem services approach and marine water accounts. The ecosystem services approach attempts to identify and where possible value the ecosystem services of the marine area while the marine water accounts approach attempts to identify and value the economic sectors create from using the marine waters. For the cost of degradation analysis three approaches where proposed: the ecosystem services approach, the thematic approach and the cost-based approach. The ecosystem services approach defines the cost of degradation as the difference between the economic value arising from reaching GES and the expected value under a business as usual scenario. The cost-based approach and the thematic approach are rather similar. The cost-based approach assumes that the costs of degradation are equal to the current costs of protecting the marine environment. Studies from Spain, the Netherlands and France show that the cost of degradation is €1.5-2 billion annually (Anon 2012, Walker et al. 2011, Levrel et al. 2014). As noted by the European Commission (EC 2014a) the approach is based on the assumption that current costs for measures to prevent environmental degradation would have only been made if the value of preventing the degradation of the marine environment is higher than the cost of the measures. Therefore, the current costs are taken as a lower bound estimate for the costs of degradation. The thematic approach also includes an analysis of the present costs of protecting the marine environment, but it goes further than the cost-based approach by establishing a reference condition for GES under different thematic headings such as marine litter, eutrophication, oil spills, etc. and assessing the additional cost of achieving those target conditions.

Under the MSFD Initial Assessment, the majority of Member States used the marine accounts approach to address the use of marine waters assessment with only two following the ecosystem service approach. In terms of the analysis of the cost of degradation, half of the Member States used a cost-based approach, five used the ecosystem services approach and two used the thematic approach (EU COM 2014). The main reason for the widespread use of the marine accounts approach was likely the availability of financial data on the major marine industries in Member States from national statistical agencies and Eurostat. While this approach generates financial statistics such as turnover, gross value added and employment figures that are understandable by a broad range of stakeholders and gives an excellent overview to policy makers of the users of marine waters receiving a financial return from their activity it fails to account for the non-market uses of the waters for instance recreational angling, surfing or the aesthetic benefits from the seascape.

Luisetti et al. (submitted) review the European Commission's view of the implementation of the Initial Assessment requirements of the MSFD. The authors point out that the Commission acknowledges the limitations on Member States due to budget constraints and resource reductions at the EU, regional and national levels but it does not address how this has influenced the time mismatch between gathering new appropriate biophysical and socio-economic data required to comply with the MSFD deadlines. Luisetti et al. note that overall, the Commission considered the results of the Initial Assessment (Article 8) 'disappointing' because the Member States' reports consisted of 'an incomplete patchwork' of information largely based on existing assessments. The Commission report in fact also highlights that Member States did not establish any baseline and distance to target, that the methodologies applied for the assessments were neither coherent nor comparable and that the socio-economic analysis emphasizes the many gaps in the availability of scientific and economic information. Considering the outcomes of the review of the Commission report it is therefore striking when Luisetti et al. (submitted) also report that overall the Commission believe that initial assessments have the potential for a 'sound management of the marine resources'. The Commission, however, clearly state that this is in recognition of the efforts made by Member States for the implementation of the first phase of the MSFD with the best currently available data and knowledge, and the worldwide difficult financial situation. Elsewhere, the European Environmental Agency (EEA 2015) concluded that "there is no wide ranging common 'metric' that can be extracted from what Member States have


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reported on the CoD [Cost of Degradation] and used to provide an EU level overview of the outcomes of the analysis, and hence establish the cost of degradation of the use of Europe's seas."

### 2.2. Required economic analyses for the MSFD Program of Measures

MSFD Article 13.3 requires that the measures in the PoMs are cost-effective and that the PoMs should be subject to impact assessment including CBA. The overall aim of Article 13 is to ensure that the chosen Program of Measures results in the achievement of the target level of the Descriptors of GES at least costs. CEA has an obvious role to play here. However, a CBA is more suitable when the targets have not yet been set. In such cases it is used to determine if the benefits of the possible targets are higher than the costs. Since the environmental targets are already defined, the added value of conducting a separate CBA has been questioned (Bertram and Rehdanz 2013, COWI 2010). Bertram et al. (2014) evaluate to what extent marine ecosystem services and their benefits can be quantified for use in CBA for the PoMs. Focusing on German marine waters the authors find that there are still considerable gaps in the scientific knowledge regarding many of the pressures mentioned in the MSFD.

The authors go on to conclude that there is the risk that the more intangible yet important benefits accruing from marine protection measures are systematically omitted in CBA thus raising the question to what extent comprehensive CBAs as required by the MSFD are possible in and across Member States. Along similar lines, an earlier paper by Bertram and Rehdanz (2013) examines the applicability of CBA in the marine context and outlines a number of potential limitations to the use of environmental valuation methods. The authors scrutinize the ability of such methods to capture the total economic value of improvements and achievement of GES and conclude that the current state of knowledge on the functioning of marine ecosystems and the links to socio-economic impacts and human well-being seems insufficient to underpin of the economic and social assessments required by the Directive.

Elsewhere, Norton and Hynes (2014) employed the choice experiment methodology to estimate the value of the non-market benefits associated with achieving GES in Irish waters. The authors carried out a survey of 817 individuals living in Ireland with each respondent being asked to identify a preferred marine environment choice among a given set of alternatives, where each alternative was made up of a number of GES-related attributes that differed in their levels. The levels were described in terms of an improvement,

deterioration or no change in each attribute. A cost attribute was also included in the choice alternatives as the increase in general taxation per person per year needed to achieve the respective environmental state. The choice modeling framework was then used to estimate the potential welfare impacts of a number of hypothetical marine environment degradation scenarios that could materialize should the MSFD not be implemented in full. The results of this analysis demonstrated that there are high values attached with changes in the state of the marine environment by the Irish general public. As noted by the European Environmental Agency (EEA 2015), the research by Norton and Hynes (2014) shows how an economic analysis estimating the economic benefits arising from the GES can be used in the CBA of the PoMs and to quantitatively estimate the cost of degradation.

Hanley et al. (2015) examine a number of marine policies, one of which is the MSFD, and question whether the economic valuation framework used to evaluate marine ecosystem service benefits, and the scientific evidence required to implement it, are "fit for purpose". The authors conclude that even though economic valuation tools are increasingly necessary, the evidence that such valuation exercises are being put to use in the actual management of marine resources is mixed. They argue that this may be due to problems relating to lack of scientific knowledge of key linkages in the valuation framework, a lack of relevant economic valuation studies and methodological problems in applying certain valuation methods to marine issues.

In Germany the identification, scoping and further planning of the PoMs was a continuous multi-level decision process that was accompanied by the German national economic working group. The programmatic approach for measures in Germany contains measures for all environmental objectives with each measure at a different planning level. Since the majority of measures have not yet reached a sufficient level of detailed planning for the sound application of economic valuation methods a general socioeconomic valuation scheme (following the idea of the procedural approach applied under the WFD in Germany) was developed. The scheme displays meta-criteria for the systematic collection of information and data for the performance of a CEA, an impact assessment and a CBA (http://www.meeresschutz.info/oeb-anhoerung.html "Sozioökonomische Bewertung", Annex 2).

Finally, in a bid to support the development of the Finnish Marine Strategy, Oinonen et al. (2016) developed a holistic and probabilistic framework for the CEA of the PoMs. Their analysis is flexible in the sense that it allows to parameterize the effectiveness of each measure based on the best available

information that can range from modeling results, statistics or expert knowledge. The method was used to rank the proposed new measures according to their cost-to-effect score and to provide optional cost-efficient sets of measures with different budgets. The framework also applies utility functions, which could be parameterized using valuation studies, to convert the CEA to a CBA.

### 2.3. Disproportionate Costs

MSFD Article 14.4 might also call for economic analyses. The Member States may be granted exception to take specific measures if the costs of implementing PoMs to achieve GES would be 'disproportionate taking account of the risks to the marine environment, and provided that there is no further deterioration.' An explicit definition of disproportionate costs however has not been included in the MSFD. Bertram and Rehdanz (2013) speculate that economics may provide key arguments for justifying exceptions from the GES objective.

COWI (2010) point out that "the term 'disproportionate' indicates that there must a proportionate relationship (i.e. ratio) between costs of taking measures to achieve good environmental status and some comparator" (p. 33). Options for such a comparator include the benefits of measures, the resources available to pay for the PoMs and comparable measures in other locations. This list shows that there is still significant room for the criterion of disproportionate costs.

## 3. RECOMMENDATIONS FOR THE THEORETICALLY SOUND AND PRACTICALLY USEFUL CONDUCTION OF ECONOMIC ANLYSES FOR THE MSFD

Based on the presentations and discussions during the Policy Session at the EAERE meeting 2015 and on the scientific and non-scientific literature, this section provides a number of recommendations regarding the use of economic analysis within the MSFD framework.

### Recommendation 1: Develop a multi-step approach for the economic analysis used in the identification and prioritization process for the development of the PoMs

CBA and CEA have the potential to support the decision making by illustrating the trade-offs of positive and negative consequences of the

Programs of Measures under the MSFD. CBA can further be used to prioritize among a set of potential PoMs to select the one with the highest net present value. When marine managers apply the Drivers-Pressures-State Changes-Impact-Responses (DPSIR) framework (EEA 1999, Atkins et al. 2011), the measures in the response-part need to be well defined to be able to perform economic analyses. Therefore, a multi-step approach is proposed:

1. Develop a conceptual model e.g. using influence diagrams, which depicts the scope of a measure and the most important cause-effect linkages. This could also be part of the impact assessment process.
2. Develop a standardized socio-economic assessment that can be applied as soon as the measure is further developed and enough data is available. This requires data from existing models, statistics, expert knowledge and surveys.
3. Decide upon the possible and necessary level of detail of both data and the analyses, where 'possible' refers to the availability of data and time, and 'necessary' refers to what is needed to best support decision making.

This three-step approach enables the analyst to select the most feasible measures to be developed further. Moreover, it helps to identify the type of economic analysis that is suitable for any particular measure. For instance, reducing marine litter and sea bed protection may call for different economic approaches to produce information useful for decision making. While for marine litter reduction there are hardly any societal tradeoffs (i.e. there is an overall consensus that marine litter has to be reduced), sea bed protection might be seen differently by different stakeholders. Here, the ecological benefits are often unclear and uncertain, whereas the relevant measure, closures of certain areas for fisheries and other economic activities, has a direct impact on incomes of fishermen.

In the current process, socio-economic analysis is expected to take place before public consultation and it therefore provides information that relates to the preparation of a PoMs. As a consequence, there could be a need to repeat parts of the analyses after the feedback from public consultation has been taken into account, especially when public consultation results in exclusion of certain proposed measures and inclusion of new ones. The results of all these analyses are information on the cost-effectiveness of the proposed measures, as well as the total costs of the PoMs, and an overview of the costs in relation to their benefits. All this information can be used to support the final decision regarding the PoMs.

In the European Commission's "Recommendation on Program of Measures" the Members States have defined the various types of measures (1a, 1b, 2a, 2b) as follows:

- Category 1.a: Measures relevant for the maintenance and achievement of GES under the MSFD, that have been adopted under other policies and implemented;
- Category 1.b: Measures relevant for the maintenance and achievement of GES under the MSFD that have been adopted under other policies but that have not yet been implemented or fully implemented;
- Category 2.a: Additional measures to maintain and achieve GES which build upon existing implementation processes regarding other EU legislation (e.g. WFD) and international agreements but go beyond what is already required under these;
- Category 2.b: Additional measures to maintain and achieve GES which do not build upon existing EU legislation or international agreements. Examples of measures in these categories as implemented by Member States are provided in Table 2.

*Table 2:* Categories of Measures and Examples Brought Forward by Member States (WG ESA 2015)

| Category | Measures |
|---|---|
| **1a** | • Fertilizer related requirements<br>• Fisheries policies<br>• Port reception facilities<br>• Marine protected areas<br>• Wastewater treatment<br>• Beach cleaning |
| **1b** | Enhancement of existing policies, e.g.<br>• Fisheries policies, including discard ban<br>• Nitrate Directive, including buffer strips<br>• Wastewater treatment and sewerage<br>• Ballast water convention<br>• Designation of new MPAs<br>• WFD |
| **2a** | • MPAs<br>• Natura 2000 related regulations |
| **2b** | • Litter related measures |

The PoMs is therefore a combination of new measures and measures that have been adopted and implemented based on other EU legislations (e.g. WFD) or international agreements. The requirement to conduct CEA and CBA considers the new measures only. To allocate society's resources economically efficiently it could be worth conducting the economic analysis for both the existing and new measures. However, the sunk costs related to measures already implemented and their removal may be regarded politically too high although it would be more economically sound to cost all measures.

**Recommendation 2: Develop objectives and response functions in a coordinated and interdisciplinary way**

In a CEA and a CBA the analyst must first assess the current status of the sea, contrast it with the desired target state and determine the gap that needs to be closed. Once these tasks have been implemented the analyst should identify a number of candidate measures to close the gap and assess for each candidate measure its expected effects on pressures or state expressed in some quantitative metrics, and the costs and economic benefits associated to each measure. Piroddi et al. (2015) have made an overview of the most commonly used capabilities of the modeling community to provide information about indicators outlined in the MSFD, particularly on biodiversity, food webs, non-indigenous species and seafloor integrity descriptors. They built a catalogue of models and derived indicators to assess which models were able to demonstrate: (1) the linkages between indicators and ecosystem structure and function and (2) the impact of pressures on ecosystem state through indicators. They concluded that the vast majority of models require further work to show how sensitive and specific they are to different pressures. Biodiversity and food webs MSFD descriptors were better addressed by models than the non-indigenous species and sea floor integrity descriptors. Furthermore, modeling approaches showed that it is possible to address the complex, integrative ecosystem dimensions and ecosystem fundamental properties, such as interactions between structural components of the marine ecosystems (such as species and habitats) and the ecosystems services provided. In fact if all the EU marine models were applicable in all regional seas, most of biodiversity related indicators could be modeled. However, currently there is not a comprehensive set of models in any of the regional seas to adequately cover all the requested needs of the MSFD and thus a number of gaps still remain (Piroddi et al. 2015)

Selecting the least-cost combination of measures to meet GES can be described as a binary optimization problem. When all information about the current state of the marine environment, GES and effectiveness and costs of

candidate measures are available, integer programming optimization algorithms may be applied to compute cost-effective combinations of measures to achieve GES. These results can then guide the decisions on which measures to include in the final PoMs.

A multidimensional environmental objective, such as for the Descriptor for biodiversity (D1), involves a number of complexities and data collection problems:

1. For most regional seas and for most Descriptors, there are no integrated assessment models available that give a quantitative description of the relationship between multiple drivers and pressures and the marine ecosystem, which would allow for the depiction and quantification of the impacts of measures on different descriptors in a coherent manner. Thus, analysts are forced to gather information from various sources, including expert assessment, and partly depend on unverifiable qualitative data[1].
2. Assessing the multidimensional impacts of several candidate measures is a laborious task. An analyst must evaluate the expected impacts of *n* candidate measures on *m* descriptors, resulting in *n***m* assessments in total. In addition, if the measures are believed to have antagonistic or synergetic effects on each other – as they tend to do – the assessment has to be repeated for all alternative combinations of measures. The number of assessments doubles for each additional measure with antagonistic or synergetic impacts. Assessment of joint impacts of measures is particularly difficult for some Descriptors of GES, such as biodiversity, that are ultimately multidimensional by nature.
3. Possible solutions to these challenges include the following:
4. Instead of a large number of descriptors, the environmental target could be defined as one objective. To this end, the eco-point approach has been developed to assess the impact of marine management measures on biodiversity (e.g. Liefveld et al. 2011). According to this approach eco-

[1] For example, while benefits of sea bed protection are claimed to be manifold, their full extent is unknown. The same can be said for the reduction of microplastics in the marine environment. It is stated that it is important because it might have desired health impacts, however, a quantitative relationship cannot yet be established. Hence the precautionary principle is applied in these cases. Consequently, the Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR Convention) is currently attempting to reach agreement over the adoption of measures to reduce emissions of microplastics. In this case, benefits are clearly not outweighing costs, but the aim is to prevent further harm to the marine environment.

points are computed based on habitat surface area, number of species and a weighting factor which indicates the importance of a specific habitat for supporting overall biodiversity. This method (Sijtsma et al. 2009) is one such approach that is used to calculate ecological values or gain in values of a certain area before and after implementation of measures. It is an extension of the Natural Capital Index (ten Brink et al. 2002), that is defined as the product of nature quantity (%) and quality (%). The eco-point method takes into account the same formula, but adds a weighting factor based on the fraction of the total biodiversity that is represented by the specific ecosystem or habitat (Sijtsma et al. 2009). The method has been applied in previous cost-benefit studies and evaluated to be feasible to quantify ecological features such as biodiversity and the impact of measures (Sijtsma et al. 2009, Liefveld et al. 2011). Ecological values per measure are expressed as dimensionless values based on available biodiversity data and habitat information, instead of using qualitative data (e.g. plusses and minuses). For decision making in the context of the MSFD this type of analyses might generate useful information, even though not everything is presented in monetary terms.

5. A second way is the fitting of (abatement) cost curves (Lise and van der Veeren 2002). This approach, however, requires a great amount of (generated) data and econometric modeling, which is not transparent, and might be difficult to explain to policy makers.

6. One open question is how remaining gaps in different GES Descriptors should be weighted if the target state of all Descriptors is not achievable, or turns out to be too costly to achieve. Then the question arises whether achieving the target state of one Descriptor is more valuable than meeting the target of another. Related to this is the question whether a slight improvement for all Descriptors would be politically more preferable than goal attainment for only a few of them.

Interdisciplinary cooperation is a key requirement in the development of such objectives and response functions. Such cooperation is also a two-way process. Economic analysis as exemplified above must clearly be tailored to the needs of the particular environmental issue and regional circumstances under study. In addition, the availability of marine science data and the knowledge and modeling applied in the analyses determine the possible level of detail of the economic analysis. Therefore, the requirements of economic analysis should inform the collection of marine science data as well as the modeling to derive the measure-(response)-state-impact link in the level of

detail that is necessary to support decision making. For instance, environmental indicators and respective units have to be defined in a way that the collected data is usable and communicable (transparent) in stakeholder or public surveys (Kragt et al. 2011, Hattam et al. 2015). Marine scientists should work together with economists to develop response functions that the latter could use. Further interdisciplinary research, including targeted work session of economists, ecologists and marine managers, will be needed to improve the understanding of the many linkages that occur between ecosystems' functions and the final goods and services that provide welfare value to society (Börger et al. 2014, Hanley et al. 2015). Interdisciplinarity is an extensive learning process that needs to be facilitated by agreeing to a methodological epoché between the disciplines and by formulating the research questions together (Haapasaari et al. 2012).

It could be argued that economic analyses could have played a role in determining GES in the first instance. According to economic theory, maximization of social welfare requires the production of public goods and services (including marine ecosystem services) to be adjusted to the level where the marginal benefits to society equal marginal costs of production (i.e. environmental protection). Thus, economic models might have also been useful by giving guidance on the target level of the marine protection, provided that the ecological-economic models and data are available. Even though numerical models are not always available, tentative CBA or conceptual models would have helped to set realistic and reachable environmental targets. Indeed, given that the implementation of the MSFD attempts to follow the principles of the ecosystem-based management in which marine protection and delivery of ecosystem services are realized jointly it could be further argued that a Descriptor and associated targets and measures should have been set for sustainable marine economic activity as well. However, the MSFD's goal of achieving GES by 2020 can be considered a political objective based on insights from natural sciences irrespective of social and economic consequences (Bertram and Rehdanz 2013).

**Recommendation 3: Focus effort on those descriptors that are not covered by other policies**

Several of the Descriptors of GES are already regulated by existing legislation. Therefore, economic analysis for the implementation of the MSFD should place particular emphasis on those Descriptors that are not covered by any other piece of legislation, such as underwater noise (D11). The distinction

between existing and new measures (category 1 (existing) and 2 (new) measures – see Recommendation 1) is relevant here because the MSFD requires CBA to be performed for new measures. Article 13 explicitly 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". While the default approach is to treat the achievement of all Descriptors as equally important, expert opinion and structured interviews could improve the understanding of the interrelation between Descriptors. This could ultimately lead to a ranking or at least a classification of Descriptors in terms of ecological importance. It could further advise policy makers on the order of priority by which to pursue the Descriptor targets.

For the next round of implementation (2018 to 2024) there might be a revised Commission Decision[2] 2010/477/EU and further revisions to MSFD Annex III, which aims to provide better coherence and clarity for the determination of GES by introducing clear and minimum list of elements and/or parameters for determination of GES under each descriptor (e.g. specified lists of contaminants, species, litter types, etc.). The revision under discussion puts biodiversity-related descriptors (D1, D4 and D6) and criteria into the central position of the environmental assessment, where the other descriptors are basis of pressure assessment (D2, D3, D5, etc.) impacting the core (the 'pizza and satellite' approach). The on-going revision is aimed at producing simpler and clearer requirements that would be coherent with regional assessment methods and with other EU-legislation. It is further envisaged that future assessments may be carried out by the regional sea conventions e.g. Baltic Marine Environment Protection Commission (HELCOM) and with other EU-legislation. The revision process is on-going, and the final decision is still pending at the time of writing this paper.

However, it remains beyond current revision, whether it should also be necessary to take into account the societal desirability of the targets for the assessment of environmental status. Particularly, information on the societal desirability of the targets could be useful in case if ecosystem services are to be estimated and assessed in order to evaluate the benefits that are dependent on structure and functions of the marine ecosystem (as provided as an option under Art. 8 and 13). There is a link to the concurrent implementation of the EU Biodiversity Strategy 2020 that calls for assessment and valuation of

[2] Commission decision on criteria and methodological standards on good environmental status of marine waters (2010/477/EU)

ecosystem service benefits for all ecosystem types, including marine (Maes et al. 2013). Operational links between MSFD GES environmental assessment (indicators and targets) and the marine ecosystem services and the benefits derived from those would be useful to increase the societal approval of the measures and the related economic and social costs of the measures. Economics provides a theoretically founded and well-tested methodology for the assessment of societal preferences with respect to such public policy goals.

Moreover, when planning and conducting economic analyses to support the implementation of the MSFD, it is important to keep in mind and search for potential synergies between other EU marine policies. As explained earlier, the WFD calls for economic analyses. Further, the EU Marine Spatial Planning directive (Directive 2014/89/EU) acknowledges the link between healthy marine ecosystem and their services by stating that "healthy marine ecosystems and their multiple services, if integrated in planning decisions, can deliver substantial benefits in terms of food production, recreation and tourism, climate change mitigation and adaptation, shoreline dynamics control and disaster prevention."

**Recommendation 4: Create common data collection and analysis platforms at the regional seas level and between countries sharing marine waters**

Section 2 reviewed the different approaches that might be used to conduct economic and social analyses of the use of marine waters, as recommended by the European Commission (EC 2010). As noted by Long (2011), under the requirements of the MSFD, Member States are expected to make every effort to ensure that assessment methodologies are consistent across the marine region or sub-region. This implies "the need to define and collate marine socio-economic data in a consistent manner across member states – particularly in the case of those member states that are bordering common seas" (Foley et al. 2014, p. 3). The EU Commission (EU COM 2014) also highlighted the fact that there were issues surrounding the availability of marine industry information and data when it came to reporting by Member States on the economic and social analysis of the uses of marine waters as required in Article 8(1c) of the Directive.

A number of countries have gathered and reported on marine socio-economic data at a national level in order to quantify the size and value of marine activities in their waters (Foley et al. 2014, Kildow and McIlgorm 2010, Surís-Regueiro et al. 2013, Zhao et al. 2014). For those Member States

that followed the marine accounts approach in the Initial Assessment there were possible differences in marine activity definitions, timescales, data collection procedures, potential double counting across Member States and other methodological problems, which made comparison and aggregation of data difficult. However, if data based on Eurostat definitions are used, these differences may not be that significant. This is why within OSPAR (Regional Sea Convention on the North East Atlantic) there is an attempt to set up a list of data that every contracting party (country) should collect, when updating the data for the second round of economic description of the use of the marine environment, as part of the update of the Initial Assessment.

If the assessment under the MSFD is to be integrated at the regional seas level, a comparable set of marine socio-economic data, using the same industry definitions will have to be agreed upon by all littoral countries. Where possible the same data sources should be used to inform policy and to link change in environmental quality to industry activities. With the exception of fisheries, aquaculture and seafood processing, which are covered by the EU Data Collection Framework (Council Regulation (EC) No 199/2008), there is no single methodology for marine economic data collection in the EU. One attempt to produce such a framework was the EU INTERREG Marnet project (www.marnetproject.eu). This project aimed to create an EU Atlantic marine socio-economic network that would develop a methodology to collect and collate comparable marine socio-economic data across the Atlantic region and to use this data to support marine socio-economic development initiatives along the Atlantic region (Foley et al. 2014). Marnet developed a technical framework for marine socio-economic data across the Atlantic Arc Member States (Portugal, Spain, France, the UK and Ireland) and mapped the resulting data that was collected across the Member States. The comparative marine socio-economic information system could provide a template for other non-Member States to follow that could potentially facilitate the construction of a Europe-wide marine economic information system as envisaged under the EU Integrated Maritime Policy and for use in future MSFD assessments.

The ecosystem services approach outlined in Section 2 attempts to identify and where possible value ecosystem services provided the marine environment. This approach also requires consideration of spatial and regional sea scale issues. Different authors have applied slightly different ecosystem services approaches to the valuation of the societal benefits (TEEB 2010, UK NEA 2011). Fisher et al. (2009) suggest, for economic valuation purposes, to distinguish between intermediate and final services, and resulting ecosystem

benefits. In doing so, the analyst may avoid any double-counting. Elsewhere, Morse-Jones et al. (2010) discuss the interdependency of many ecosystem services and the need of spatially explicit valuation of their benefits. The MSFD focuses on European regional seas and requires economic analysis to be conducted on this spatial level (Articles 8 and 13). Spatial analysis is further complicated by the dynamic nature of the marine environment, where pressures originating in particular marine waters might impact those of another Member States.

To minimize contradiction of data gathering and findings about GES at the regional sea scale, harmonized ecological indicators at the regional level are therefore necessary (Luisetti et al. 2015). For that and an accompanying valuation of ecosystem benefits to happen, current and good environmental status and related targets have to be clearly defined at national and regional sea levels to take into account specific local and regional characteristics, but at the same time promoting harmonization (EC 2014a). Natural scientists need to be able to assess any change between the current status and hypothetical GES, through the realization of its related targets, of the ecosystem services provided by the marine environment within each MSFD Descriptor. Once the ecosystem state changes have been assessed, a joint team of analysts (e.g. natural scientists and economists) can determine how to translate that ecosystem state change into human welfare change. In other words, the changes in intermediate and final ecosystem services have to be translated into changes in societal benefits, which has to be done in a manner that is consistent across Member States. It is at that stage that economic valuation can take place (Turner et al. 2010). This information is needed to allow decision makers to implement measures to improve the state of the marine environment and hence human welfare. It may also be the case that if the required economic analysis is carried out at the regional seas level different alternatives that were not obvious at the Member State level may be revealed. This could result in more regional cost effective alternatives being chosen to achieve GES.

To collect harmonized biophysical data for economic analysis under an ecosystem services approach, the role of governance within each regional sea is fundamental to agree on common monitoring and data gathering methods that could be comparable and applicable at the regional sea, and possibly at the European, levels with the aim of the coherent implementation of measures (EC 2014a). Finally, if the welfare effects resulting from a change in marine environmental policy are being assessed at the regional seas level, using stated or revealed preference valuation methods, comparable techniques should be

employed in different Member States. This will enhance policy makers' confidence when comparing the welfare impacts resulting from such valuation exercises. However, the integration of ecosystem service valuation into marine policy formation remains challenging due to the fact that these ecosystems tend to be large and often overlap multiple political jurisdictions (Hanley et al. 2015), which emphasizes the role of governance within regional seas. Hanley et al. (2015) point to the fact that even in Europe where the MSFD provides an integrated institutional framework for the governance of regional seas, Member States have not yet been able to collaborate effectively at the regional seas level when carrying out relevant economic assessments.

**Recommendation 5: Provide guidelines for the use and interpretation of numerical outputs of economic analyses**

When providing information in different formats, numerical information tends to be dominant and therefore might bias perception of all relevant information. Hence there is a risk that non-numerical and qualitative information is neglected. Similarly, there is a risk that quantitative information, economic value estimates in particular, are not interpreted in an appropriate way. One way to limit the second risk is to provide better guidance on the use of outputs of economic studies. Such studies are capable of assessing a wide range of value types (use and non-use). Revealed preference methods, such as the travel cost and contingent behavior methods as well as hedonic pricing, assess use values only. Stated preference methods, such as contingent valuation and choice modeling, are capable of eliciting total economic values, i.e. use and non-use values. While valuation focuses on the assessments of the value at the margin (i.e. changes in ecosystem service flows), accounting deals with the inventorying of natural capital assets (i.e. ecosystem stocks) and their values[3]

[3] Within the context of ecosystem assessment, valuation and accounting, the European Commission published two technical reports related to the Mapping and Assessment of Ecosystem Services (MAES) project. The first MAES report (EC 2013) sets the general aims of the technical reports: to support the national assessment and economic valuation of the ecosystems and the services they provide within Action 5 of the European Biodiversity Strategy to 2020 (EC 2011). In the second MAES report (EC 2014b) the Common International Classification of Ecosystem Services (CICES) is applied to some case studies with the main purpose of an assessment of the ecosystem services to support environmental accounting as CICES is strictly connected to the UN System of Environmental Economic Accounts (SEEA). In the first MAES report it is deemed that the issue of valuation will be developed by 2020 but a specific report with the related scenarios for valuation has not been published yet. The second report further notes that the use of economic valuation of ecosystem

(Luisetti et al. 2013, Costanza et al. 2014). Obst et al (2015) argue that the issues related to the valuation of ecosystem services and their relationship with ecosystem assets for their consideration for national accounting purposes need to be better articulated because several conceptual and measurement challenges still have to be resolved.

To facilitate the interpretation of quantitative information that might be generated through the ecosystem service approach to the economic and social assessment and cost of degradation requirements of Article 8 or that might be used in the CBA and CEA of the PoMs, a number of questions should be asked to clarify the nature of that value estimates[4]:

- **Does the valuation study report prices or values?**

From a philosophical standpoint, there are several definitions of 'value' (Turner 1999). In ecosystem services valuation the focus is on the benefits provided to society (Turner et al. 2003, Bateman et al. 2011). The societal benefit is therefore defined as instrumental anthropocentric value. The market price (i.e. financial/accounting value) of a good or service is obtained by the trade in the market between the supply and demand for that service. Often times, the market price of a service constitutes only a portion of the underlying value of that service. However, for those goods produced and consumed under reasonably competitive market conditions (provided that there are no other prevailing market distortions), their prices are an acceptable approximation of their value. For those services (like many marine environmental services) that are not traded in markets and for which therefore a market price is not available, their economic value can be expressed as the 'willingness to pay' for a marginal (i.e. small incremental) change in its provision (Turner et al. 2010). For ecosystem services provision at the practical policy level, however, the decision on whether the 'next unit' is meaningful in terms of marginal analysis is conditioned by the scale (local, regional or global) of the policy decision (Fisher et al. 2008) as the consequences of the 'marginal' change may acquire a completely different perspective and meaning at different scales. Furthermore, within the national green accounting context, Obst et al. (2015)

services for the integration of the ecosystems and their services within national accounts is complex and still under development.

[4] The issues surrounding the use of environmental valuation have been discussed in detail elsewhere (e.g. Billé et al. 2012, Laurans et al. 2013) and it is beyond the scope of this article to go into a major discussion around those issues. For further discussion of the main measurement issues and challenges confronting the valuation of marine ecosystem services benefits the interested reader is directed towards Bateman et al. (2011) and Barbier (2012).

highlight the distinction between market price and exchange values that they define as "the value at which goods, services, and assets are exchanged regardless of the prevailing market conditions".

- **What is the type of value that is being assessed?**

Two recent publications studying the recreational value of the Baltic Sea illustrate the difference between use value only and total economic value. Both studies value water quality in nine Baltic Sea littoral countries using contingent valuation (Ahtiainen et al. 2014) and travel cost (Czajkowski et al. 2015). While Ahtiainen et al. (2014) value changes in the objective level of water quality to society generally (i.e. the attainment of objective nutrient reduction targets), Czajkowski et al. (2015) assess the change in use values of the ecosystem due to quality changes. The latter study estimates a recreational value of the Baltic Sea of €14.8 billion. If the status of the Baltic Sea improves, the recreational value is estimated to be €16 billion annually. Thus, the value of improvements in the state of the Baltic according to this study is €1.2 billion annually, and this amount reflects the use value. The contingent valuation study by Ahtiainen et al. (2014) establishes that the recreational value of improvement in state of the Baltic Sea is €3.6 billion annually. This estimate reflects both the use and non-use values of the environmental improvement, and thus includes wider range of values. While the environmental improvement considered in these two studies is similar, the types of values assessed are different.[5]

- **Whose value is being assessed?**

Reported aggregate values in particular are sensitive to the size of the study site, the sampling of respondents (in survey-based valuation studies) and the resulting representativeness of the valuations for the population at large. Such information is usually reported in valuation studies and should be carefully reviewed before values are used (Hynes et al. 2013).

## 4. CONCLUSIONS AND WAY FORWARD

This paper has discussed the key role of economic analysis in the implementation of the EU MSFD. While the Directive calls for such analyses,

[5] It should be noted, however, that "it is inherently difficult to compare benefits that result from different valuation methods or even across identical stated valuation methods if these do not value the same change in environmental quality or quantity" (Czajkowski et al. 2015).


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and CEA and CBA of new Programs of Measures in particular, the specific application of methods and uptake of resulting information are currently still evolving in the ecosystem-based and adaptive management framework that the Directive stipulates. Compared to earlier EU Directives the MSFD particularly emphasizes the role of economic analysis in assessing the Programs of Measures to achieve GES in EU waters. Challenges regarding the conduction of economic analysis, however, are manifold. Therefore, the present paper provides recommendations that could facilitate the use of economic analysis in the MSFD context.

Environmental economic analyses are interdisciplinary, and sound analyses cannot be produced by economists working in isolation. EU legislation with multidimensional environmental targets poses a true challenge for analysists aiming to provide policy support. Authorities need solutions and numbers that are transparent and fulfil the legal requirements. However, having knowledge of the methods underlying the provided numbers is paramount to avoid misuse or tyranny of numbers. Therefore, methods flexible enough to systematically synthetize quantitative and qualitative data and transparently show the underlying uncertainties may provide fit for purpose results.

Bayesian networks, for example, are such a tool (Uusitalo 2007, Levontin et al. 2011, Kragt 2013). Perhaps the systematic approach of combining environmental and economic aspects of the problem at hand is more valuable than the actual quantitative or semi-quantitative outcome of the CEA or CBA. The application of CEA and CBA calls for clear and measurable target setting, measurement on how far we are from the target, and systematic and preferably quantitative explanation on how the proposed measures are going to achieve the target. All this needs to be determined before the planning of the CEA or CBA starts. Thus, in order to get theoretically sound, reliable and usable results, authorities leading the process of developing and implementing marine strategies, should create interdisciplinary working groups early and reserve reasonable time for economic analyses. The rationale of using environmental economic analyses to support policy making is to provide information for an efficient allocation of resources, i.e. the environmental targets will be achieved with the least cost. However, social aspects of potential conflicts that may arise have to be taken into account too. This highlights the role of governance and stakeholder involvement in such complex interdisciplinary decisions.

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