Title: Marine Strategy Framework Directive – targets and indicators for Good Environmental Status **IA No:** Defra 1405 **Lead department or agency:** Department for Environment, Food and Rural Affairs **Other departments or agencies:** Department for Transport, Department for Energy and Climate Change, Natural England, Marine Management Organisation, Centre for Environment, Fisheries and Aquaculture Science, Joint Nature Conservation.	**Impact Assessment (IA)** **Date:** 10/10/2011 **Stage:** Final **Source of intervention:** EU **Type of measure:** Other **Contact for enquiries**: Mansi Konar – 0207 2381046

Summary: Intervention and Options

RPC: Awaiting outcome

Cost of Preferred (or more likely) Option				
Total Net Present Value	**Business Net Present Value**	**Net cost to business per year** (EANCB on 2010 prices)	**In scope of One-In, One-Out?**	**Measure qualifies as**
-£1.7m to £23.2m	£4.4m to £39.8m	£528K – £4.8m (i.e. there is a net benefit)	No	N/A

What is the problem under consideration? Why is government intervention necessary?

The marine environment provides us with a wide range of important ecosystem services such as the provision of food (e.g. fish and shellfish), recreational opportunities (e.g. clean water and beaches for watersports and leisure activities) and regulating services (e.g. helping to regulate our climate). Many of these services tend to be provided free of charge outside traditional markets, and can therefore be over exploited and inefficiently used.

Recent assessments of the UK's seas have shown that parts of our marine environment are in a degraded state due to the impacts of human activities. The need for further action to ensure the marine environment is being used in a sustainable way has already been recognised in the Government's overarching objective of clean, healthy, safe, productive and biologically diverse seas and at a national level action is being taken through the implementation of the UK Marine and Coastal Access Act, the Marine Scotland Act 2010, and similar legislation being developed in Northern Ireland.

However, a number of the activities which impact our marine environment are international in nature (e.g. fishing, shipping), and the pressures which they cause (e.g. litter) can spread across national boundaries. For this reason the measures needed to achieve sustainable use of our seas cannot be taken by the UK on its own, and internationally coordinated targets and indicators are necessary if the UK's objectives for its seas are to be achieved.

What are the policy objectives and the intended effects?

The aim of the Marine Strategy Framework Directive (MSFD) is to achieve Good Environmental Status (GES) in Europe's seas by 2020 through (i) protecting Europe's marine environment, (ii) preventing its deterioration and, (iii) where practical, restoring marine ecosystems that have been degraded through the impact of human activities. However, the Directive also recognises the economic value of our seas and achieving GES is consistent with using the marine environment in a sustainable way. These aims are in line with the UK's existing objective of clean, healthy, safe, productive and biologically diverse seas.

In order to achieve GES, European Member States must carry out the following steps before 2020:

- an assessment of the current status of their marine waters by July 2012;
- development of a set of characteristics of GES, with associated targets and indicators by July 2012;
- implementation of a monitoring programme to measure progress towards GES by 2012;
- implementation of any management measures which are needed to achieve GES by Dec 2016 (e.g. measures to reduce the impact of fishing on the marine environment or measures to reduce litter on beaches).

This impact assessment looks at the potential impacts of establishing UK targets and indicators of GES. These targets and indicators, which must be coordinated with other EU countries, are intended to guide progress towards GES and inform the development of future monitoring programmes and management measures. In order to assess the potential implications of the GES targets and indicators we have considered a range of illustrative management measures which experts and policy makers consider to represent a reasonable indication of the types of action which may be needed to achieve the GES targets. These illustrative measures represent a current best assessment of the type of action which could be needed to achieve the targets, but should not be seen as the measures the UK Government and DAs definitely intend to take. The final measures for achieving GES will be subject to a full cost-benefit analysis and impact assessment process between now and 2015.

What policy options have been considered, including any alternatives to regulation? Please justify preferred option (further details in Evidence Base)

The MSFD has already been transposed in to UK law through the Marine Strategy Regulations 2010 and no additional regulation is proposed in this impact assessment.

This impact assessment compares the establishment of UK targets and indicators of GES (Option 1) with a baseline projection for what will happen without MSFD.

The targets set out in Option 1 are considered sufficient to achieve GES, whilst minimising costs to business and avoiding the risk of the UK gold-plating the Directive. They are based as far as possible on targets and monitoring that are already required in existing legislation (e.g. the Birds and Habitats Directives) and do not go beyond the requirements of the Directive or the subsequent Commission Decision on Good Environmental Status 2010. The likely benefits of Option 1 are considered to outweigh the costs.

Will the policy be reviewed? Yes **If applicable, set review date:** Every 6 years (first review in 2018)					
Does implementation go beyond minimum EU requirements?			No		
Are any of these organisations in scope? If Micros not exempted set out reason in Evidence Base. **Impacts on small business will be assessed when final measures are implemented in (2014/15). At this stage the measures being considered are illustrative only.**	**Micro** N/A	**< 20** N/A	**Small** N/A	**Medium** N/A	**Large** N/A
What is the CO_2 equivalent change in greenhouse gas emissions? (Million tonnes CO_2 equivalent)			**Traded:** N/A	**Non-traded:** N/A	

I have read the Impact Assessment and I am satisfied that, given the available evidence, it represents a reasonable view of the likely costs, benefits and impact of the leading options.

Signed by the responsible SELECT SIGNATORY: ..... Date: .....

Summary: Analysis & Evidence

Description:

FULL ECONOMIC ASSESSMENT

Price Base Year 2010/11	PV Base Year 2010/11	Time Period Years 13	Net Benefit (Present Value (PV))		
			Low: -£1.7m	**High:**£23.2m	**Best Estimate:**£10.7m

COSTS (£m)	Total Transition (Constant Price) Years	Average Annual (excl. Transition) (Constant Price)	Total Cost (Present Value)
Low	Optional	Optional	**£6.7m**
High	Optional	Optional	**£27.4m**
Best Estimate			**£17.1m**

Description and scale of key monetised costs by 'main affected groups'

Business: Monetised costs to business have been assessed by looking at the costs of *illustrative* management measures. These costs would fall on the fishing industry and are estimated at between £623k and £1.7m over the appraisal period years from potential measures to reduce the impacts of fishing on seafloor habitats. Although these measures would be delivered through the Common Fisheries Policy, it is assumed that they would be largely driven by the MSFD because they relate to improvements in wider biodiversity (rather than fish stocks). Therefore the costs of these potential measures have been attributed to MSFD.

There are also costs to marinas of potential measures to improve hull cleansing and biosecurity in marinas. These are estimated at between £19.5k and £9.1m over the appraisal period

These costs have reduced since the consultation IA for a number of reasons:

- Costs to the fishing industry associated with lower landings in initial years due to catch control measures under Descriptor 3 are now taken into account in modelling the benefits for improvements in fish stocks (i.e. these benefits are net benefits).
- Various illustrative measures presented in the consultation IA are no longer considered additional (based on ongoing developments in existing policy). For example, costs associated with reducing the risks of introduction and spread of non-indigenous species via commercial shipping under Descriptor 2 are now considered to form part of the baseline scenario due to better information about international measures being take by the International Maritime Organization.
- Further information was provided during the consultation which has reduced costs estimates. For example, specific marinas were identified that were under high risk from invasive species that allowed the refinement of estimates for the measure on hull cleansing (Descriptor 2).

The total quantified costs to industry have been estimated to be 642K to £10.8m over the appraisal period years.

Government: Monetised costs to Government are estimated as follows:

- £4m -£7.3m over 10 years for additional monitoring for Descriptors 1, 2, 3, 4, 5, 6, 7, 9, 10 and 11[1].
- £1.3m-£7.9m over 10 years for implementing potential management measures to remove non-indigenous mammals on key islands for seabirds.
- £602K-£808m for reviewing licensing guidance, enforcement in relation to fisheries management measures, educational campaigns, risk assessments and action plans to reduce risk of non-indigenous species introduction and spread, and setting up a noise registry.

The total quantified costs to Government of implementing the proposed GES targets range from £6.1m to £16.6m over 10 years.

The quantified costs are summarised in more detail in Table 1 in the Evidence Base (Executive Summary).

[1] Due to overlaps between the requirements of the MSFD and Birds and Habitats Directives apportionment scenarios of 10-30% costs to MSFD have been applied to come up with this figures.

Other key non-monetised costs by 'main affected groups'

It has not been possible to monetise the costs of all the potential management measures which may be needed to achieve the proposed GES targets and these costs are described qualitatively in the IA. The main affected group is likely to be the fishing industry, through potential measures to reduce the impact of fishing practices on particular marine species (e.g. seabirds) and seafloor habitats – this is consistent with the UK's approach to CFP reform.

The costs of the following potential measures have not been quantified in the IA:

- *Additional illustrative management measures for fisheries (for seabird by-catch, vulnerable fish, seabed integrity and shellfish).* These include measures to reduce seabird by-catch, measures to protect threatened or vulnerable fish species (as we are unclear of the specific location of the species and hence the extent to which additional measures would need to be applied), measures to modify fishing gear to make it less damaging to the seabed (loss of Gross Value Added to fishermen is likely to be low but one off changes to fishing gear can be significant if changes are to be made in short time scales outside the normal replacement cycle), and measures to protect key shellfish life stages (though costs to fishermen are likely to be low as this would only apply to lobsters in specific areas).
- *Illustrative management measures to prevent invasion of non-indigenous mammals on islands with seabird colonies.* These are likely to imply additional costs to vessels visiting the islands (in terms of setting traps and quarantine measures for packages), and potentially decrease revenue for tour operators running visits to those islands if the measures result in inconvenience for tourists (e.g. due to quarantine of packages).
- *Illustrative management measures to reduce the risk of NIS introduction and spread via the aquaculture industry and recreational boating sector.* The costs of such measures would depend on whether they entailed significant changes to current practices or purchase of new equipment.
- *Litter measures to reduce marine sources of litter* could imply additional costs to Government, business (e.g. fishermen) and the community sector depending on which measures are ultimately taken forward.

BENEFITS (£m)	**Total Transition** (Constant Price) Years	**Average Annual** (excl. Transition) (Constant Price)	**Total Benefit** (Present Value)
Low	Optional	Optional	**£5m**
High	Optional	Optional	**£50.6m**
Best Estimate			**£27.8m**

Description and scale of key monetised benefits by 'main affected groups'

It has only been possible to monetise a small proportion of the likely benefits of achieving the proposed GES targets, mainly those benefits related to the fishing industry. These include the following:

- £761.2K to £39.9m over the appraisal period to fishermen from increased profitability and gross value added if fish stocks are harvested at fishing mortality that corresponds to Maximum Sustainable Yield (MSY) levels[2]. The range is very wide due to scientific uncertainty and represents yield under both a pessimistic and optimistic scenario.
- £4.3m and £10.7m over the appraisal period to the fishing industry from reducing litter levels in marine waters (through reduced damage to vessels).

Other key non-monetised benefits by 'main affected groups'

Where it has not been possible to monetise the benefits of achieving the GES targets these are described qualitatively in the impact assessment. The GES targets are likely to lead to cleaner beaches, less litter in the sea, greater mitigation of climate change impacts on bird populations and more varieties of fish stocks (to benefit recreational activities such as sea angling and diving). This would consequently improve cultural and recreational services, educational benefits and high non use values leading to an increase in the welfare of those individuals that consume these services.

The GES targets will also prevent further deterioration of seafloor habitats that provide key regulating services (such as environmental resilience, regulation of pollution, climate regulation and natural hazard protection), provisioning services (such as fish, fertilizers and wild harvesting) and recreational services (nature watching, tourism and sports). Defra is in the process of commissioning a long term research that looks at quantifying such benefits.

Key assumptions/sensitivities/risks	3.5

[2] Due to overlaps between MSFD and CFP an apportionment scenario of 25% benefits to MSFD has been applied to come up with these figures. These are explained in more detail in the Key Assumptions/Sensitivities/Risks section. These benefits are presented in terms a range of monetary values where the value of operating profit is the lower end of the range and the value of Gross Value Added (GVA) the higher end. The rationale is provided in section E of the evidence base.

Due to the wide breadth of the proposals included in this impact assessment, the significant overlap with other policy areas, and the uncertainty about which management measures might be needed to achieve the proposed targets, it has been necessary to make a significant number of assumptions. These are clearly set out in the Evidence Base, but can be summarised as follows:

- The appraisal time period is 2013-2025 (13 years). This is because the costs and benefits are spread across this time period. The costs and benefits related to commercial fisheries (D3) occur in 2013 while for rest of the Descriptors they occur in 2016 when the management measures will be put in place.
- Within the baseline scenario it is assumed that existing government policies and commitments related to the marine environment are fully implemented and achieve their desired goals. Particularly significant are commitments to reform of the Common Fisheries Policy, the implementation of the Water Framework Directive, the Habitats and Birds Directives and the Environmental Impact Assessment Directive. Since the consultation IA a number of assumptions about what is included in the baseline have changed due to improved understanding about what is likely to be delivered through existing policy commitments. This is particularly the case for measures to reduce terrestrial sources of litter and measures to reduce the risks of introduction of non-indigenous species from shipping, where it is now clear that more will be delivered under the baseline than had been thought. As a result of this the overall monetised costs in the IA have gone down compared to the consultation IA.
- There are significant overlaps between the MSFD and the Common Fisheries Policy. Achieving the proposed targets for Descriptors 1 (biodiversity), 4 (food webs), 6 (seafloor integrity), and 3 (commercial fish and shellfish) will be dependent on successful implementation of fisheries management measures agreed under the reformed CFP (e.g. use of less destructive fishing gears, limits on landings). However, as the MSFD is a key driver in ensuring that the CFP achieves its environmental goals a *proportion* of the costs and benefits of these management measures should be attributed to the MSFD. The following detailed assumptions have been made:
  - For Descriptors 1 (biodiversity), 4 (food webs) and 6 (seafloor integrity) it has been assumed that 100% of the costs of the associated illustrative management measures should be attributed to MSFD because these measures are primarily to protect the wider marine environment rather than to achieve higher levels of commercial fish stocks.
  - For costs and benefits related to commercial fisheries, given the overlap between the objectives of the CFP and MSFD, it has been assumed that the majority of the monetised costs and benefits of achieving the GES targets should be attributed to the CFP (75%), with the remaining 25% attributed to MSFD. These assumptions have been improved compared to the consultation IA (which considered a range of apportionment scenarios from 10% to 50%) to reflect increased certainty about the direction of the CFP Reform process.
- In relation to assessing the benefits of improvements in fish stocks a number of other assumptions and scenarios have been used:
  - Since the consultation IA the assumptions and scenarios used to assess changes in catches have been improved to reflect more sophisticated scientific models of fish stock dynamics. This improved analysis has led to a reduction in the estimated monetised benefits of improvements in fish stocks.
  - It has also been assumed that the landing price remains the same even when the stock improves. A sensitivity analysis has been carried by looking at the impacts on benefits with a 50% and 20% drop in landing prices of North Sea Cod. Results from the analysis show that a significant drop in landing prices following a rise in fish stocks, may result in negative benefits under a pessimistic scenario. However, the best estimate of these range in benefits is positive, which means that even with a decrease in prices, it is still possible to obtain net benefits.
  - Benefits are assessed over 13 years (2013 -2025). However 18 years worth of benefits has also been provided in the evidence base. As uncertainty increases benefits have not been quantified beyond this time period.
- In relation to the monitoring costs associated with the proposed GES targets for biodiversity (Descriptors 1, 4 and 6), there is significant overlap between MSFD and the requirements of the Birds and Habitats Directives. For this reason apportionment scenarios of 10%-30% have been considered.

BUSINESS ASSESSMENT (Option 1)

Direct impact on business (Equivalent Annual) £m:			**In scope of OIOO?**	**Measure qualifies as**
Costs: **£77K -£1.3m**	**Benefits:** **£605K - £6.1m**	**Net:** **£528K - £4.8m**	NO	N/A

Evidence Base

Contents

Evidence Base Executive Summary

Section A – Introduction

1. This section sets out the marine policy context and briefly describes the requirements of the Marine Strategy Framework Directive (MSFD), explaining that this impact assessment looks at the potential costs and benefits of UK targets and indicators for Good Environmental Status (GES). It summarises the approach to assessing costs and benefits taken in this impact assessment.

Section B – Policy rationale and objectives

2. This section sets out the rationale for intervention and also describes the policy objectives of the MSFD in more detail.

Section C – Methodology

3. This section sets out the evidence base for the impact assessment and explains the approach to developing the GES targets.

4. This section also describes the methodology that has been used for assessing the costs and benefits of the GES targets. The potential costs have been assessed by considering the costs of implementing a range of illustrative management measures which experts and policy makers believe represent a reasonable indication of the types of action which may be necessary to achieve the targets. These measures represent a current best assessment of the type of action which could be needed, but should not be seen as the measures the UK Government and Devolved Administrations definitely intend to take to achieve GES.

5. The overall benefits of achieving the GES targets have been considered. A comparison of the gap between the expected state of the marine environment in 2020 without MSFD (i.e. the Baseline scenario) and the expected state of the marine environment in 2020 when the GES targets are achieved has been used to provide an estimate of how degraded the marine environment is likely to be in 2020 without the MSFD. An ecosystem services approach has been used to show how that degradation of the marine environment corresponds to a reduction in human welfare.

6. Wherever possible costs and benefits have been monetised, however, this has not been possible in all cases given the current evidence base and a significant amount of qualitative assessment is included.

7. This section also describes the development of the baseline scenario and the key assumptions behind it. In general the baseline scenario assumes that existing policy commitments will meet their desired goals. However, in the case of the Common Fisheries Policy (CFP) some more complex assumptions have had to be made due to the fact that the reform of the CFP and the implementation of the MSFD are very closely connected. These assumptions are set out in more detail below.

8. Finally, this section also describes key changes between this final Impact Assessment and the consultation Impact Assessment.

Section D – Information on target options and costs

9. The section sets out the GES targets and indicators for each of the GES Descriptors. The summary text for each Descriptor briefly outlines the thinking behind the target proposals and describes the potential additional management measures and monitoring requirements associated with each of the target proposals. The costs of the illustrative measures and monitoring are summarised in tables at the end of each sub-section. A summary of the conclusions for each Descriptor is set out below.

Descriptors 1 (biodiversity), 4 (food webs) and 6 (seafloor integrity)

10. GES targets for these three Descriptors are set out together because of the significant overlap between them. Given the wide range of issues covered by these Descriptors this section is one of the most technically complex of the impact assessment. Targets have been developed for three species groups (marine mammals, birds and fish) and three habitat groups (pelagic habitats, sediment habitats and, rock and biogenic reef habitats).

11. We have high confidence that other countries which are part of the OSPAR Regional Sea Convention[3] will follow the same broad approach to biodiversity targets being proposed in this impact assessment, however, more work is planned over the next few years to improve coordination of targets and indicators across countries.

Target proposals for species

12. Targets have been developed for mammals, birds and fish. Existing targets have been used wherever suitable (e.g. from the Habitats Directive, OSPAR) and the proposals have been based as far as possible around existing indicators and monitoring programmes.

13. Under the baseline scenario there are numerous measures already in place, or planned, which are expected to play a significant role in supporting the achievement of the targets. However, it is not clear at this stage whether these measures alone will be sufficient to achieve GES and for the purposes of this assessment it has been assumed that some additional management measures may be needed, particularly in relation to reducing the impacts of fisheries and the impacts of non-indigenous mammals on seabirds.

14. A range of illustrative management measures have been considered in the assessment, the costs of which would fall primarily on the fishing industry, but also on small businesses operating vessels to small islands with key seabird colonies, and on Government. It has not been possible to monetise the costs to business, but these could include potential costs to the fishing industry in terms of adopting mitigation measures to reduce seabird by-catch and protect vulnerable fish species, and potential costs to vessel operators in terms of additional biosecurity measures to prevent invasion of non-indigenous mammals on islands with key seabird colonies. There are also potential additional costs to Government and regulators (and possibly voluntary organisations such as the National Trust and RSPB) of possible measures to remove marine mammals on key island seabird colonies. Potential costs associated with these kinds of measures are estimated at £1.3m-7.9m over the appraisal period.

15. There are also likely to be additional monitoring costs to Government. A broad initial estimate of these costs is between £2.5m-£3.4m over the appraisal period. However, a significant proportion of these costs are likely to be incurred anyway under the Habitats and Birds Directive, so are not entirely additional under MSFD. To provide a rough scale of costs

[3] The OSPAR Convention is the current legal instrument guiding international cooperation on the protection of the marine environment of the North-East Atlantic. Work under the Convention is managed by the OSPAR Commission, made up of representatives of the Governments of 15 Contracting Parties and the European Commission, representing the European Union.

scenarios of attributing 10% and 30% of the costs to MSFD have been considered. This implies that additional monitoring costs attributable to MSFD are between £255k-£1m over the appraisal period.

Target proposals for habitats

16. For benthic habitats (rock and biogenic reef and sediment habitats) existing targets under the Habitats Directive and Water Framework Directive have been used wherever possible, but new targets have been developed for predominant sediment habitats, which are not covered by the Habitats Directive. For pelagic habitats, there are no suitable targets in existing legislation and all the targets are new.

17. Under the baseline scenario seafloor habitats are expected to remain stable or improve slightly between now and 2020. There are numerous measures already in place, or planned which are expected to play a significant role in supporting the achievement of the targets. For rock & biogenic reef and sediment habitats covered by the Habitats Directive it has been assumed that measures taken under that Directive will be sufficient to achieve the targets. However, for seafloor habitats not covered by the Habitats Directive (primarily predominant sediment habitats, but also some rock habitats) it has been assumed that that additional management measures may be needed to achieve the targets, particularly in relation to fisheries impacts. For pelagic habitats it has been assumed that the proposed targets will be achieved through measures taken to achieve the targets for Descriptor 3 (commercial fish) and Descriptor 5 (eutrophication).

18. A range of illustrative fisheries management measures for seafloor habitats have been considered in the assessment, including a measure to prohibit the use of mobile fishing gears in a proportion of Marine Conservation Zones and a measure to increase the use of less destructive fishing gears. The costs to the fishing industry of the potential measure to prohibit mobile demersal gears in a proportion of Marine Conservation Zones have been estimated at between £622K and £1.7m over the appraisal period. These costs have reduced compared to the Consultation IA due to improved assumptions about the designation of Marine Conservation Zones as part of the baseline scenario.

19. There are also likely to be additional monitoring costs to Government. A broad initial estimate of these costs is between £2.4m-£3.4m over the appraisal period for pelagic habitats and rock & reef habitats. Costs for monitoring sediment habitats were included in the consultation IA, but these are now described qualitatively following concerns from stakeholders that the figures used were not robust.

Descriptor 2 (non-indigenous species)

20. The GES targets are new as there are no specific targets for non-indigenous species in existing legislation. They require management measures to reduce the risk from key pathways and vectors of introduction and spread of Non-Indigenous Species (NIS), and the development and implementation of management plans for dealing with key high risk species should they arrive in UK waters. Other Member States are taking a variety of approaches to targets for this Descriptor but the UK's proposals are well aligned with a number of countries including the Netherlands and Denmark.

21. Under the baseline scenario it is assumed that in 2020 there will still be significant issues presented by invasive non-indigenous species and it is likely that additional management measures will be needed to achieve the GES proposed targets for this Descriptor.

22. The costs associated with this Descriptor will depend on which measures are ultimately put in place. This is particularly hard to assess, because implementation of measures will be carried out using a risk based approach. A range of illustrative measures have been considered in the

analysis. The costs to business of potential measures to improve hull cleansing and biosecurity in marinas are estimated at between £19.5k and £9.1m over the appraisal period. Other potential costs to business have been assessed qualitatively and include costs to the aquaculture industry of measures to prevent the spread of NIS and costs to vessel owners from codes of practice for recreational vessels. In the Consultation IA measures to reduce the risk of introduction and spread of non-indigenous species via commercial shipping were costed. These costs have been removed as it has become clear that these measures are already being pursued by the International Maritime Organization and should therefore be considered as part of the baseline.

23. There are potential costs to Government of additional educational campaigns and the development of additional Risk Management Assessments and Invasive Species Action Plans estimated at £22.4k-£230k over the appraisal period. There could also be costs to Government associated with measures such as the development of voluntary codes of practice for recreational vessels and measures to reduce the risk of NIS introduction via the aquaculture industry. There are also likely to be costs to Government of additional monitoring and enforcement. The total costs over the appraisal period to both government and industry is £43.9K to £9.3m.

Descriptor 3 (commercial fish and shellfish)

24. The targets are based on the approach taken to stock assessment in the CFP and would require populations of fish species to be maintained at levels which can produce Maximum Sustainable Yield by 2020. It is likely that most other Member States will take a similar approach based on recent advice developed by the International Council for the Exploration of the Sea (ICES) on methodologies for GES targets for commercial fish.

25. There are significant overlaps between the MSFD and the Common Fisheries Policy (CFP). Although the UK would be pursuing ambitious goals for CFP reform irrespective of MSFD, it is unlikely that the wider EU approach to CFP reform would deliver the outcomes the UK is seeking without the added pressure for environmental outcomes provided by MSFD. For this reason it has been assumed that a proportion of the costs and benefits associated with measures to improve fish stocks should be attributed to MSFD. For the purposes of this assessment it has been assumed that the majority of the monetised costs and benefits associated with improved fish stocks (75%) should be attributed to CFP, with the remaining 25% attributed to MSFD. These assumptions have been improved following the consultation IA (which considered a range of apportionment scenarios from 10%-50%) to reflect increased certainty about the direction of the CFP reform process. The costs of achieving improved fish stocks in terms of changes in fishing mortality have been included as part of the benefit calculation.

26. No additional monitoring costs are anticipated in relation to the proposed targets, but there may be additional enforcement costs to Government of £207.9k over the appraisal period.

Descriptor 5 (eutrophication)

27. The targets are based on existing requirements which the UK is committed to within OSPAR and under the Water Framework Directive. They require nutrient concentrations, and the direct and indirect effects of nutrient enrichment, to be at levels which do not lead to an undesirable disturbance to the balance of organisms present in the water or to the quality of the water. There is a high-level of regional coordination on the approach to assessment of eutrophication and it is likely that other countries in OSPAR will follow a similar approach to the UK.

28. Under the baseline scenario it is assumed that measures taken under existing legislation (e.g the Water Framework Directive and the Urban Waste Water Treatment Directive) will ensure

the GES targets for this Descriptor are achieved by 2020. Therefore, it is concluded that there are unlikely to be any additional costs to business associated with these targets.

29. An initial assessment of additional monitoring implications suggests that there could be additional costs to Government of £75k to £750K over the appraisal period for eutrophication related plankton monitoring.

Descriptor 7 (hydrographical conditions)

30. The target requires developers and regulators to continue to comply with existing legislative requirements through the current marine licensing regime.

31. Under the baseline scenario it is assumed that the existing marine licensing and consents process, in conjunction with the requirements of existing legislation, is likely to be sufficient to ensure that GES for this Descriptor will be achieved.

32. As the target is based on the application of the existing regulatory regime there will be no need for additional management measures and no additional costs to business, assuming there is currently compliance with all the relevant legislation.

33. There will be small additional costs to regulators associated with reviewing the existing licensing regime and updating guidance to developers if necessary (around £20k one off cost for England which is £17.4K taking account of discounting as costs occurs in 2016). There could also be additional monitoring costs to Government and regulators in order to provide a more comprehensive understanding of prevailing environmental conditions and through the development of management and assessment tools to improve our confidence in our GES assessment.

Descriptor 8 (contaminants)

34. The targets are based on existing requirements that the UK is committed to under OSPAR and the Water Framework Directive. They require concentrations and effects of contaminants in the marine environment to be kept within levels agreed in existing legislation and international commitments. There is a high-level of regional coordination on the approach to assessment for contaminants and it is likely that other countries in OSPAR will follow a similar approach to the UK.

35. Under the baseline scenario it is assumed that measures taken under existing legislation will ensure that the GES targets for this Descriptor are broadly achieved by 2020. The only exception to this is in relation to the presence in a few areas of persistent legacy contaminants in sediments. Measures to remove these contaminated sediments would not be practical and the costs would almost certainly be disproportionate taking into account the risks to the marine environment. The UK does not propose to take these types of measures. Therefore, it is concluded that there are unlikely to be any additional costs to business associated with these targets.

36. Existing monitoring programmes under the Water Framework Directive and OSPAR will be used to meet monitoring requirements associated with these targets. No additional monitoring costs to Government are anticipated at the current time.

Descriptor 9 (contaminants in seafood)

37. The GES target for this Descriptor is based on existing thresholds for contaminants set out in EU legislation or other internationally and nationally agreed standards. Since the target proposed reflect existing agreed standards, it is likely that other Member States will take a similar approach to setting GES targets to the UK.

38. Under the baseline scenario it is assumed that measures taken under existing legislation will continue to manage this pressure and will be sufficient to achieve the target for this Descriptor. Therefore, it is concluded that there are unlikely to be any additional costs to business associated with this target.

39. An initial assessment of additional monitoring implications suggests that there could be additional costs to Government and regulators of £300k-600k over the appraisal period for additional monitoring in commercial fishing grounds to extend the scope of current Food Standards Agency monitoring schemes[4].

Descriptor 10 (marine litter)

40. The GES target for marine litter requires an overall reduction in the number of litter items found on coastlines. This target is new because there are no targets for marine litter in existing legislation, however, it is based on a Ministerial commitment made in the OSPAR 2010 Bergen statement to reduce litter levels by 2020. Indicators for the levels of litter on the seafloor and in the water column will also be put in place. Other Member States within OSPAR are following a very similar approach to setting targets for litter on coastlines.

41. Under the baseline scenario it is assumed that there will continue to be 'significant amounts of litter in our seas and on our beaches', and in order to meet the target for litter action will be needed both to address terrestrial sources of litter (this is considered to be the main source) and marine sources (e.g. litter from the fishing industry). Since the consultation it has become clear that existing policy on terrestrial litter, including the 'Love Where you Live' campaign[5], will play a large part in achieving this target. Current litter policies involve a strong focus on action being taken across society (e.g. by communities and businesses) rather than centralised action by Government, and could include measures such as public campaigns to raise awareness and promote changed behaviour on littering and encouraging and facilitating community clean-up activity. As the need for additional action on terrestrial litter has already been acknowledged by Government, the costs associated with it are considered to be part of the baseline, rather than additional costs driven by this Directive. There is also a need to address marine sources of litter, for example through the extension of voluntary codes of practice with the fishing industry, which could lead to additional costs both for Government and business.

42. There are also likely to be some additional monitoring costs for Government and regulators. An initial estimate suggests that these would amount to somewhere between £412.5k to £938K over the appraisal period for England and Wales. Further analysis will be carried during the development of the MSFD monitoring programmes to assess costs for Scotland and Northern Ireland.

Descriptor 11 (underwater noise)

43. The targets for noise cover both impulsive sounds (e.g. those caused by seismic surveys and pile driving) and ambient sounds (e.g. those caused by shipping). All the targets are new because there are no targets for underwater noise in existing legislation. Other Member States are taking a variety of approaches to setting targets for noise, but the UK's targets are based on advice produced by an EU group which was created to consider methodologies for noise

[4] Some additional monitoring in commercial fishing grounds in the relevant MSFD sub-regions (Greater North Sea and Celtic Seas) is likely to be necessary because current Food Standards Agency monitoring schemes are generally not able to identify the source of the samples being tested in their current monitoring programmes.

[5] *Love Where You Live* is a new campaign designed to inspire everyone to take action to reduce litter. The campaign is led by Keep Britain Tidy, with support from Defra. The campaign is about everyone taking responsibility for litter, and to change the way people think and act about littering. We all love something about where we live and this campaign is about everyone working together to make change happen.

targets and monitoring[6], and is consistent with the approach being taken by a number of other Member States (e.g. the Netherlands and Denmark).

44. Under the baseline scenario activities causing impulsive sounds will increase between now and 2020. However, our current understanding indicates that it is unlikely that there would be any significant adverse effects on marine animal populations, provided appropriate measures continue to be taken through the current licensing regime to manage localised noise impacts. For ambient sounds, shipping activity is likely to increase between now and 2020, but existing measures to make ships more efficient should also make them less noisy. It is unclear how this would affect overall ambient sound levels, or what impact ambient noise has on marine animals at a population level.

Impulsive sounds

45. The GES target for impulsive sounds requires the establishment and maintenance of a 'noise registry' which would record in space and time activities generating noise in order that they can be analysed to determined whether they may potentially compromise the achievement of GES. This approach reflects the conclusion by experts that estimated future levels of activity do not currently appear to pose a significant threat to marine animal populations.

46. The costs to industry (e.g. renewable, oil and gas) of submitting information to such a registry are estimated to be low. Costs to Government and regulators of managing the registry are estimated to be in the region of £297.8K over the appraisal period.

Ambient sounds

47. A specific target for ambient sound levels is not being established and instead a surveillance indicator is being developed, with the UK determination of GES for noise being used as a generic, qualitative target. There are no additional costs to industry associated with the development of this indicator.

48. Additional monitoring is necessary to improve our understanding of current ambient sound levels and allow the establishment of a more specific target at a later date. An initial estimate of additional monitoring costs to Government is in the region of 750K - £1.1m over the appraisal period.

Section E – Benefits

49. This section describes the approach to assessing the benefits of the GES targets and then sets out the detailed benefits assessment.

50. Benefits have been assessed in relation to those aspects of the marine environment where it was identified that there would be degradation in the absence of MSFD. This included assessing the benefits attributable to the MSFD of increased abundance of fish stocks, reduction of litter, improvements in seafloor habitats, and a reduction in the impacts on seabird species. It has not been possible to monetise all the benefits and a significant element of the assessment is qualitative, particularly in relation to seabirds and seafloor habitats.

51. The net benefits to the fishing industry of achieving the GES targets are estimated at between £761.2K to £39.9m over the appraisal period[7]. The benefits are referred to as 'net benefits' as

[6] The EU Technical Sub-Group on Noise is a sub-group of the EU Working Group on Good Environmental Status and forms part of the Commission's Common Implementation Strategy for MSFD.

they take into account cost implications to the fishing industry for reducing fishing effort in the initial years to obtain benefits from healthier stocks in the future. Total benefits under this target were arrived at by looking at increases in catch levels of 9 key fish stocks from reaching Maximum Sustainable Yield levels. The benefits assessment has been improved following the consultation to reflect much more sophisticated assumptions and scenarios of changes in fish stock dynamics. Various scenarios relating to stock recruitment (entry of smaller fish into the stock), fishing mortality and effectiveness of discard bans were used to estimate the 'net benefits'. As a result, these benefits have reduced compared to the Consultation IA. Further detail on the assumptions is provided in Section E of the evidence base. It has not been possible to quantify the recreational benefits from improvement in fish stocks.

52. The benefits attributable to MSFD from reducing marine sources of litter have been assessed by looking at benefits from reduction in litter levels causing damage to fishing vessels. These are estimated at £4.3m to 10.7m over the appraisal period.

53. It has not been possible to monetise the benefits associated with achieving the GES targets for seafloor habitats or bird abundance and these have been described qualitatively in Section E.

54. In terms of linking the benefits to the targets and illustrative measures we can say that provisioning and recreational benefits from improvements in fish stocks can be can be attributed to the D3 targets (although the D1,4,6 targets will also play a role in supporting this), the recreational benefits from reduction of litter and the reduction in damage costs caused by litter can be attributed to D10 targets, the benefits from improvement in abundance of birds can be attributed to D1 and D4 targets, and the benefits from improvement of seafloor habitats can be attributed to D1 and D6 targets.

Section F - Conclusion

55. This section provides a brief conclusion.

56. Given the lack of data it has only been possible to quantify part of the costs and benefits of achieving the GES targets. On comparing these quantified costs and the benefits across the GES Descriptors, we arrive at a net present value of -£1.7m to £23.2m (over the appraisal period of 13 years). The quantified benefits are an underestimate of overall benefits as it has not been possible to quantify recreational and cultural benefits from increased abundance of fish stocks and seabirds, reductions in litter and improvement in seafloor habitats. There are also likely to be high non-use values and educational and research benefits from improving the state of marine species and habitats. There are also some illustrative measures (when assessing costs) that it has not been possible to quantify.

57. It is also important to note that the estimates provided in the IA are based on illustrative measures rather than actual measures. All decisions on which measures are taken will be subject to a separate impact assessment which will fully assess the effectiveness of those measures in achieving GES as well as their socioeconomic implications.

58. The net present value figures have reduced compared to the Consultation IA for a number of reasons:

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[7] Due to overlaps between MSFD and CFP an apportionment scenario of 25% benefits to MSFD has been applied to come up with these figures. These are explained in more detail in the Key Assumptions/Sensitivities/Risks section. These benefits are presented in terms of a range of monetised values, where the value of operating profit is the lower end of the range and the value of GVA the higher end. The rationale is provided in section E of the evidence base

- At the time of producing the Consultation IA there was significant uncertainty about the direction of a number of existing policies, making decisions about what to include in the baseline difficult. Based on improved information about the likely outcomes of a number of existing policies the baseline assumptions have been updated, and a number of costs have been removed because these are now considered as part of the baseline. This is particularly the case for: CFP reform, where the direction of the reform process is now much clearer; international shipping, where the direction of internationally managed measures to reduce introduction and spread of non-indigenous species is now clearer; Marine Conservation Zones, where there is now more information about the site designation process; and litter, where it has become clearer that existing policies on terrestrial litter will play a significant role in supporting the proposed GES targets for litter. This has meant lower additional costs and benefits in comparison to the baseline.

- The costs associated with a number of measures and monitoring needs have been removed compared to the Consultation IA because the consultation process indicated that the figures used were insufficiently robust to be included. Instead the impact of these measures has been described qualitatively. These include measures for reducing seabird by-catch, and monitoring costs for sediment habitats.

- The analysis of benefits from increased fish stocks has been significantly improved compared to the Consultation IA, based on much more sophisticated assumptions and scenarios of changes in fish stock dynamics. The new scenarios look at both optimistic and pessimistic assumptions of improvements in fish stocks and hence provide a range for the benefits. In addition the benefits are 'net benefits' to the fishing industry as they also take account cost implications of reducing fishing in the initial years to get benefits of higher stocks in the future. This has led to reduction in these benefits compared to the Consultation IA, which took a very simplistic approach to valuing these benefits.

Table 1: Summary of costs

Target	PV costs over 10 years	Qualitative costs
Descriptors 1, 4 and 6 – Species Marine Mammals, Fish and Birds	Potential costs to business: These costs have been described qualitatively. Measures to reduce seabird by-catch were quantified in the consultation IA, but consultation responses suggested that the costings were misleading. A qualitative assessment has been made based on information in a report on seabird by-catch produced for the EU Commission.	Potential low/medium costs to fishing industry in terms of adopting mitigation measures to reduce seabird by catch. Potential costs to business in terms of measures to prevent invasion of non-indigenous mammals on islands with key seabird colonies. Restrictive measures are likely to impact visitor numbers and consequently profits to business. Potential costs to regulators for enforcement of quarantine measures for vessels visiting islands with key seabird colonies. Potential additional costs to the fishing industry of adopting additional bespoke measures to protect particular threatened or vulnerable fish species – examples include seasonal closures to protect breeding, spawning or nursery areas, or the introduction of minimum and maximum landing sizes to protect the breeding stock. Potential additional costs to government of enforcing these measures.
	Potential costs to government: £1.5m-£8.9m over the appraisal period for monitoring and measures to remove non-indigenous mammals from islands with key seabird colonies. The costs of the latter have reduced compared to the consultation IA due to updated information on the number of seabird colonies requiring such measures.	
	Total potential costs: £1.5m-£8.9m over 10 years.	
Descriptors 1, 4 and 6 – Habitats Rock & biogenic reef, sediment and pelagic	Potential costs to business: £622.7K-£1.7m costs over the appraisal period to the fishing industry for measures to prohibit mobile demersal gears in a proportion of Marine Protected Areas. These costs have reduced compared to the Consultation IA due to improved assumptions about the designation of Marine Conservation Zones as part of the baseline scenario.	Potential costs to the fishing industry in terms of measures to modify fishing gear to reduce damage to the seabed. Costs are likely to be less than banning gear and there could also be fuel savings to vessel owners, reducing the net costs. Costs to Government of implementing monitoring programmes for sediment habitats.
	Potential costs to government: £2.4m-£3.4mover the appraisal period for monitoring. These costs have reduced compared to the Consultation IA due to concerns raised during the consultation about the robustness of the estimated costs for sediment habitat monitoring.	
	Total potential costs: £3m-£5.1m over the appraisal period.	

Descriptors 2 – Non-indigenous species	Potential costs to business: Costs to business from measures to improve hull cleansing facilties and biosecurity in marinas are estimated at between £19.5k-£9.1m over the appraisal period. In the Consultation IA measures to reduce the risk of introduction and spread of non-indigenous species via commercial shipping were costed. These have been removed as it has become clear that these measures are already being pursued by the International Maritime Organization and should therefore be considered as part of the baseline.	Costs to business will be highly dependent on which measures are ultimately taken forward as part of a risk based approach. There could be potential additional costs to the aquaculture of measures to reduce the risk of NIS introduction, although these are likely to be low provided they were linked to existing Biosecurity Measures Plans. There are also potential additional costs to vessel owners from codes of practice for recreational vessels. All of these measures could impact small businesses such as small marinas, yacht charter businesses, small aquaculture businesses etc. There are potential costs to Government of measures to develop voluntary codes of practice for recreational vessels and measures to reduce risk of NIS introduction via the aquaculture industry, but it has not been possible to cost these. There are also likely to be costs to Government of additional monitoring and enforcement.
	Potential costs to government: Additional costs to Government will be highly dependent on which measures are actually taken forward as part of a risk based approach. Potential costs to Government of additional educational campaigns and the development of Risk Management Assessments and Invasive Species Action Plans are estimated at £24.4k-£230k over the appraisal period.	
	Total potential costs: Total monetised costs are £44k-£9.6m over the appraisal period.	
Descriptors 3 – Fish and shellfish	Potential costs to business: Costs to fishing industry from making catch controls more stringent under CFP reform. These costs (in terms of reduced landings during initial years) are assessed as a part of the benefit modelling. No additional technical measures beyond CFP are considered.	Potential costs to business from using less destructive fishing gear. The costs are likely to be low if the need to replace or repair gear is in line with natural gear replacement cycles, but could have cost implications for fishermen who have to switch gears sooner than they would otherwise have done. Improved selectivity could also impact the catch levels of fishermen. Potential costs to regulators and business from national measures to protect the landing of ovigerous lobsters. Since
	Potential costs to government: There are no additional monitoring costs but there are likely to be additional enforcement costs estimated at £215k over 10 years (best estimate).[8].	

[8] Due to overlaps between MSFD and CFP it has been assumed that only a proportion of the costs of enforcing these measures should be attributed to MSFD. Total costs of enforcement are estimated at £861k over 10 years, but an apportionment scenario of 25% has been applied to calculate the figures above.[9] Due to overlaps between MSFD and CFP an apportionment scenario of 25% benefits to MSFD has been applied to

	Total potential costs: £207.9k over the appraisal period	these measures would only effectively extend the scope of existing controls (i.e. applying beyond the IFCA areas) the costs to business and regulators are likely to be low.
Descriptor 5 - Eutrophication	Potential costs to business: No additional costs to business as no measures are anticipated over those that will be taken under existing legislation (e.g. the Water Framework Directive).	No un-quantified costs identified.
	Potential costs to government: Additional monitoring costs estimated at between 75K and £750K over the appraisal period.	
	Total potential costs: 75K- 750K over the appraisal period.	
Descriptor 7 – Hydrographical Process	Potential costs to business: There are no potential costs to business as it is anticipated that GES will be achieved through the current licensing process.	Possible additional monitoring costs to government to provide comprehensive understanding of prevailing environmental conditions and the further development of assessment tools. Costs to government in terms of updating guidance in Wales, Scotland and Northern Ireland.
	Potential costs to government: There will be some costs to government and regulators in terms of updating to guidance. This is estimated to be around £20K (one-off) for England.	
	Total potential costs: Partial estimate of the discounted cost is £17.4K (covers England only)	
Descriptor 8 – Contaminants	Potential costs to business: No costs to business as no additional measures are anticipated over those that will be taken under existing legislation (e.g. the Water Framework Directive)	No un-quantified costs identified at this time, although there could be some additional monitoring costs in the future if new substances are added to the WFD or OSPAR list.
	Potential costs to government: No additional costs are anticipated at the current time.	
	Total potential costs: No additional costs.	

come up with these figures. These are explained in more detail in the Key Assumptions/Sensitivities/Risks section. These benefits are presented in terms of operating profits or GVA where operating profit is the lower end of the range and GVA the higher end. The rationale is provided in section E of the evidence base.

Descriptor 9 – Contaminants	Potential costs to business: There are no costs to business as no additional measures are anticipated over those that will be taken under existing legislation.	There are likely to be smaller additional monitoring costs for government in Scotland.
	Potential costs to government: There are likely to be additional monitoring costs for England and Wales estimated at between £300K and £600K over the appraisal period.	
	Total potential costs: Estimated costs are £300K - £600K over the appraisal period (covers England and Wales only)	
Descriptor 10 – marine litter	Potential costs to business: It has not been possible to estimate the costs to business and these costs have been described qualitatively.	Potential costs to government and business from implementation of measures to reduce litter from marine sources. Such measures could include extending codes of practice for the fishing industry, or extending fishing for litter schemes (although the latter would only be taken forward depending on the impact and effectiveness of existing pilots). Costs to business will depend on which measures are ultimately taken forward and how they are implemented. Potential costs to Government from additional monitoring in Scotland and Northern Ireland.
	Potential costs to government: Costs of additional monitoring for England and Wales are estimated to be £412.5K-£938K over the appraisal period. The Consultation IA included costs to Government of implementing measures to reduce terrestrial sources of litter. These have been removed because it has become clear that action to reduce terrestrial litter will be taken under the baseline scenario through the Government's Love Where You Live campaign and similar policies in the Devolved Administrations.	
	Total potential costs: Estimated costs are £412.5k-£938K over the appraisal period (covers England and Wales only).	
Descriptor 11 – Noise	Potential costs to business: Impulsive sound It has not been possible to quantify the potential costs to business associated with setting up a noise registry but a qualitative description of the costs is provided. Ambient sound No new measures will be required under this option and hence	Impulsive sound Costs to business from setting up a noise registry are likely to be small, arising from the need to submit some additional information during the licensing process. Ambient sound No new measures will be required under this option and hence there will be no additional costs to business.

	there will be no additional costs to business.	
	Potential costs to government: Impulsive sound Costs are likely to be £298K over the appraisal period, arising from the need to create and administer a noise registry. Ambient sound Costs of additional monitoring are estimated at between £750K to £1.1m over the appraisal period.	
	Total Potential costs: Costs are likely to be low for both ambient and impulsive sound. The costs to government of setting up a noise registry and monitoring ambient sound are estimated to be £1m-£1.4m over the appraisal period.	
GRAND TOTAL		
	Potential costs to business: £642k-£10.8m over 13 years	
	Potential costs to government: £6.1m-16.6m over 13 years	
	Total potential costs: £6.7m-£27.4m over 13 years	

Table 2: Summary of benefits

Final ecosystem components and pressures	OPTION 1	
	PV benefits over 10 years	Qualitative benefits
Fish	Benefits to the fishing industry are estimated to be £761.2K to £39.9m over the appraisal period[9]. Benefits were arrived at by looking at increases in catch levels of 9 key fish stocks from reaching MSY. These benefits have reduced compared to the Consultation IA, which used a very simplistic model to calculate the benefits. The improved analysis includes much more	There is also likely to be an increase in recreational services from improvement in abundance of fish species.

[9] Due to overlaps between MSFD and CFP an apportionment scenario of 25% benefits to MSFD has been applied to come up with these figures. These are explained in more detail in the Key Assumptions/Sensitivities/Risks section. These benefits are presented in terms of operating profits or GVA where operating profit is the lower end of the range and GVA the higher end. The rationale is provided in section E of the evidence base.

	sophisticated assumptions and scenarios based on scientific models of changes in fish stock dynamics. The new scenarios considered looks at both an optimistic and pessimistic scenario of improvement in fish stocks and hence provides a range for the benefits. In addition the benefits are 'net benefits' to the fishing industry as it also takes account costs implications of reducing fishing in the initial years to get benefits of higher stocks in the future. These provisioning benefits attributable to D3, although D1,4 and 6 targets will play a role in supporting this,	
Litter	Litter in marine waters could affect the profitability of boats by causing significant damage to gears and propellers. Benefits from 2-5% reduction[10] in litter from marine sources are estimated to be £4.3m to £10.8m over the appraisal period. The benefits are attributable to D10 targets,	There are also likely to be additional benefits to other sectors (aquaculture, harbours, marinas, recreational vessels) from reductions in marine sources of litter which it has not been possible to quantify.
Seafloor Habitats	It has not been possible to quantify the benefits	Benthic habitats provide key regulating services (such as environmental resilience, regulation of pollution, climate regulation and natural hazard protection), provisioning services (such as fish, fertilizers and wild harvesting) and recreational services (nature watching, tourism and sports). The proposed GES targets under this option will lead to an improvement in these services but it is not currently possible to quantify this. Defra is in the process of commissioning research that looks at quantifying such benefits. These (non monetised) benefits from improvement of seafloor habitats can be attributed to D1 and D6 targets.
Birds	It has not been possible to quantify the benefits	Based on RSPB estimates, we found the cultural and aesthetic benefits from existing seabirds reserves. There are

[10] We have estimated benefits from 5% overall reduction in litter. Please refer to section E for further assumptions used to model the benefits.

		likely to be increases in cultural and aesthetic services that result from the implementation of GES targets for birds. It has not been possible to estimate the increase in these benefits but the estimates above show the high benefits that are associated with healthy seabird colonies. These (non monetised) benefits from improvement in abundance of birds can be attributed to D1 and D4 targets.
GRAND TOTAL		
	Quantified benefits are estimated to be £4.9m -£50.1m over 13 years. There are likely to be other significant benefits that have not been quantified such as: Improvement in recreational and cultural benefits from improvement in fish stocks, habitats, seabird colonies and smaller increases in litter on beaches. Improvement in provisioning and regulating services from preventing degradation of habitats. Non uses values from preserving and improving marine biodiversity.	
NET PRESENT VALUE (quantified)	-£1.7m to £23.2m over 13 years	

Section A – Introduction

59. Within Europe marine habitats are continuing to deteriorate and an increasing number of marine species are seriously threatened. The Marine Strategy Framework Directive - 2008/56/EC (MSFD) was developed in response to concerns that although existing legislation protected the sea from some specific impacts, it was sectoral and fragmented. There was also recognition that since some of the activities that impact on the marine environment are managed at a European or international level (e.g. fisheries and shipping), national action on the marine environment needs to be supported by a framework to ensure action is taken across Europe.

60. The MSFD requires Member States to put in place the necessary management measures to achieve Good Environmental Status (GES) in their marine waters by 2020. GES is defined in the Directive[11] and described in more detail by 11 high-level Descriptors (see p.39) which set out what Member States must achieve in their marine waters. GES is not intended to refer to a pristine environmental state, but involves protecting the marine environment, preventing its deterioration and restoring it where practical, whilst at the same time providing for sustainable use of the marine environment.

61. The MSFD requires Member States to go through a number of stages before the eventual implementation of management measures to achieve GES. The first stage, to be completed by July 2012, is for Member States to carry out an initial assessment of the current status of their seas and to determine specific characteristics of GES for their marine waters, setting out specific environmental targets and indicators to underpin this (based on the 11 Descriptors of GES given in the Directive). The second stage, to be completed by 2014, is for Member States to put in place monitoring programmes to measure progress towards GES, and the final stage, to be completed by 2016, is the implementation of management measures to achieve GES by 2020.

62. The aims of the Directive are consistent with the UK Government and Devolved Administrations' aim of clean, healthy, safe, productive and biologically diverse seas, as well as with the commitments made in the Natural Environment White Paper to be the first generation "to leave the natural environment...in a better state than we inherited it"[12]. Charting Progress 2[13], the most recent assessment of the UK's marine environment, recognised that although many aspects of the UK's marine environment are improving (e.g. the impacts of contamination), other aspects (e.g. seafloor habitats, fish populations) are degraded and continue to be subject to unacceptable pressures from human activity. The Government and Devolved Administrations have already committed to taking many measures which will improve the state of the UK's marine environment, most notably through the UK Marine and Coastal Access Act (2009), the Marine (Scotland) Act (2010) and the proposed Northern Ireland Marine Bill. Equally, many existing pieces of EU legislation, such as the Water Framework Directive and the Birds and Habitats Directives are also aimed at improving the state of the UK's marine and coastal environments. These existing measures will all support the achievement of GES under this Directive.

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[11] MSFD, 2008/56/EC Article 3(5) – Good Environmental Status means the environmental status of marine waters where these provide ecologically diverse and dynamic oceans and seas which are clean, healthy and productive within their intrinsic conditions, and the use of the marine environment is at a level that is sustainable, thus safeguarding the potential for uses and activities by current and future generations.

[12] Natural Environment White Paper, p.3 Hhttp://www.official-documents.gov.uk/document/cm80/8082/8082.pdf

[13] http://chartingprogress.defra.gov.uk/

63. The MSFD is transposed into UK legislation via the Marine Strategy Regulations (2010)[14] and an impact assessment for the transposition of the MSFD has already been completed and is available at http://www.defra.gov.uk/environment/marine/msfd/. This current Impact Assessment assesses the cost-benefit implications of the UK targets and indicators of Good Environmental Status. Further impact assessments will be required at later stages in the implementation process (both for monitoring programmes and management measures), and we will continue to work with experts and stakeholders to maintain an evidence-based approach to implementation.

64. Although the UK is able to define its own set of GES targets and indicators, in reality this is constrained by three key factors:
    - The definition of GES and the 11 high-level GES Descriptors are set out in the Directive and must be used by Member States as the basis for their targets and indicators.
    - The European Commission has set out specific criteria and indicators for GES in its Decision on Criteria and Methodological Standards on Good Environmental Status of Marine Waters 2010/477/EU[15] (hitherto referred to as the Commission Decision 2010). Member States must follow the criteria and indicators in this Decision when developing their national GES targets and indicators.
    - The Directive requires Member States within the same region to follow a coordinated approach to implementing the Directive, including the development of GES targets and indicators. For the UK, the region of relevance is the North East Atlantic and the UK has been playing a leading role in the OSPAR Regional Sea Convention[16], and bilaterally with key Member States, to try to ensure the UK's GES targets and indicators are consistent with those of other countries. We are confident that the UK targets and indicators for GES are broadly in line with those being put forward by other countries in OSPAR. Further work will be carried out between now and 2018 to improve coordination and develop common set of MSFD indicators across OSPAR.

    Taking into account these three factors, the GES targets and indicators set out in this impact assessment have been developed on the basis of scientific advice provided by the Centre for Environment, Fisheries and Aquaculture Science (Cefas), the Joint Nature Conservation Committee (JNCC) and a large range of experts involved in the UK Marine Monitoring and Assessment Strategy, as well as socio-economic evidence provided by Eftec[17]. Defra and the Devolved Administrations carried out a joint public consultation on draft GES targets and indicators during the Spring/Summer of 2012. Over 80 responses were received from a mixture of respondents including environmental NGOs, the fishing industry, the ports and shipping sector, offshore energy industries and the water industry. Environmental NGOs commented that they felt the proposed targets and indicators were insufficiently precautionary to achieve GES, whilst the fishing industry felt that there may be insufficient evidence to justify some of the proposed targets. From other sectors there were a number of comments, but also broad support for the proposals. Following the consultation Defra and the Devolved Administrations have made a number of amendments to the consultation proposals. These changes are outlined in more detail in the

[14] http://www.legislation.gov.uk/uksi/2010/1627/contents/made

[15] Commission Decision of 1 September 2010 on criteria and methodological standards on good environmental status of marine waters 2010/477/EU Hhttp://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:232:0014:0024:EN:PDF

[16] OSPAR Convention for the protection of the North East Atlantic.

[17] This advice is summarised in the Cefas Report – *Proposed UK Targets for Achieving GES and Cost Benefit Analysis for the MSFD*, hitherto referred to as the *Cefas CBA report 2012*, Hhttp://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=16817&FromSearch=Y&Publisher=1&SearchText=ME5405&SortString=ProjectCode&SortOrder=Asc&Paging=10#DescriptionH.

Government response to the consultation[18]. The GES targets and indicators presented in this Impact Assessment are the final versions which will be sent to the European Commission later in 2012.

65. The GES targets and indicators do not gold-plate the requirements of the Directive:
    - The targets and indicators are based as far as possible on targets and monitoring commitments set out in existing legislation (e.g. the Habitats Directive, the Water Framework Directive, the Environmental Impact Assessment Directive);
    - The targets and indicators stick closely to the requirements set out in the Directive and the Commission Decision 2010 and do not cover any elements not included in those documents;
    - The targets and indicators are broadly aligned what is being proposed by other Member States.

66. In developing the UK's GES characteristics and associated targets and indicators significant efforts have been made to coordinate the UK approach with that of other countries in the North East Atlantic. The UK has played leading role in the OSPAR Regional Sea Convention for the North East Atlantic, which has produced advice documents for each of the 11 GES Descriptors. The UK has also carried out a series of bilateral meetings with other countries (including France, Ireland, the Netherlands, Germany and Belgium) for the purposes of improving regional coherence. Based on an analysis of the proposals being put forward by other key Member States in the North East Atlantic, we believe that the UK's proposals are relatively well aligned with what is being put forward by other countries. For most of the Descriptors the overall approach being taken across OSPAR countries is quite similar, particularly for those Descriptors such as eutrophication and contaminants where OSPAR has a long history of working on these issues, and commercial fisheries where the CFP provides a common framework. For the other Descriptors, although the overall approaches across different countries are broadly consistent, the detailed approach to GES targets and indicators varies. However, OSPAR has put in place a strong framework for further coordination on these issues and further work is planned between now and 2018 with the aim of agreeing a common set of GES indicators across OSPAR.

67. In this Impact Assessment, the UK-wide costs and benefits of the GES targets and indicators (Option 1) are compared to the projected baseline scenario (Option 0) for what will happen without MSFD. The baseline scenario is informed by a report produced for Government by ABPmer which describes the potential state of the marine environment in 2020 and 2030 based on current trends and existing policy commitments[19]. Assessment of the costs of the proposed GES targets and indicators is based on an assessment of a range of illustrative management measures which experts and policy makers consider to represent a reasonable example of the types of additional measures which may be needed to achieve the GES targets. Further work will be carried out between now and 2015 to define the exact range of additional measures that will be implemented and these will be subject to a full impact assessment in due course. The cost assessment also considers the likely additional monitoring costs associated with the GES targets and indicators. These should be seen as broad initial estimates, with further work being carried out between now and 2014 to refine the monitoring proposals and to establish the most cost effective way of meeting them. Assessment of benefits is based on an assessment of the change in value of ecosystem goods and services between the baseline scenario and the scenario if all the proposed GES targets are achieved.

[18] Due to be published alongside the final version of this Impact Assessment – a copy is available on request from Defra.

[19] 'Business as Usual Projections of the Marine Environment: to Inform the Implementation of the Marine Strategy Framework Directive', ABPmer 2012.
Hhttp://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=17775&FromSearch=Y&Publisher=1&SearchText=ME5104&SortString=ProjectCode&SortOrder=Asc&Paging=10#DescriptionH.

68. It should be noted at this stage that the Directive accepts that there may be some narrow circumstances where it is not possible to achieve GES and includes a number of legitimate reasons[20] why a Member State might, in exceptional circumstances, fail to meet their GES targets. The UK will consider the application of these exceptions if and when the relevant circumstances arise.

69. In addition to these exceptions, Member States do not need to take measures to achieve the GES targets where the costs of taking action relative to the benefits are considered to be disproportionate taking into account the risks to the marine environment, and provided there is no further deterioration[21]. For the purposes of this impact assessment we have tried to indicate where there is a high likelihood that the illustrative measures could be disproportionately costly. Where this is the case the costs of these measures have not been included in the total estimate of costs.

70. It should also be noted that the marine environment crosses national boundaries and cooperation between member states is important in monitoring and taking measures to address common issues - for example mobile species such as birds, fish or marine mammals, or the introduction of potentially harmful non indigenous species

71. This impact assessment does not cover:
    - The UK determination of GES – The Directive requires Member States to determine a set of characteristics for GES. The UK interpretation is that these are high-level characteristics which are given practical effect by the more specific GES targets and indicators. For this reason, the impacts of the UK characteristics of GES are effectively covered by the assessment of the impacts of the associated GES targets and indicators and do not need to be considered separately as part of this Impact Assessment. The characteristics of GES for each of the 11 Descriptors are included for information in the Descriptor summaries in Section D.
    - The UK monitoring programmes for GES – as mentioned above, although this impact assessment gives a broad initial estimate of the monitoring costs associated with the GES targets and indicators, more work will be carried out between now and 2014 to look at what is already delivered by existing monitoring programmes and to define additional monitoring needs. This will be the subject of a separate impact assessment in due course.
    - The UK programmes of measures for achieving GES – as mentioned above, the management measures included in this impact assessment are illustrative examples used to assess the potential costs of achieving the GES targets. Choosing a particular GES target should not be seen as necessarily committing the UK to utilising the measures suggested here. All decisions on which measures are taken will be subject to a separate impact assessment which will fully assess the effectiveness of those measures in achieving GES as well as their socioeconomic implications.

72. A number of changes have been made to this Impact Assessment compared to the consultation Impact Assessment. These have led to a significant reduction in the overall net present value compared to the Consultation IA. A summary of these changes is provided in Section D.

[20] Directive EC/56/2008 – Article 14(1) The exceptions in the Directive include: action or inaction for which the Member State concerned is not responsible; natural causes; force majeure; where meeting targets would go against the over-riding public interest; and natural conditions which do not allow the timely improvement in the status of the marine waters concerned.

[21] Directive EC/56/2008 – Article 14(4).

Section B – Policy rationale and objectives

Policy rationale

73. The UK published the National Ecosystem Assessment (NEA) in 2011[22], the first analysis of the UK's natural environment in terms of the benefits it provides to society now and in the future. The UK also published Charting Progress 2, a comprehensive report on the state of the UK seas, in July 2010. Both these reports emphasise the significant anthropogenic pressures on the marine environment at present.

74. Marine habitats and species provide a wide range of ecosystem services that provide benefits of significant value to society. These include provisioning, regulating, supporting and cultural services and are illustrated with examples in Fig. 1 below[23].

Figure 1 – Summary of ecosystem services

Categories		Relevant Categories		Example of Product or Service
Provisioning services	→	Food	→	Fish for human consumption
				Fish used in animal feeds
		Fibre		Aggregates
		Biochemicals, pharmaceuticals and natural medicines		Fish oil
Regulating services	→	Gas and climate	→	Carbon sequestration
		Bioremediation of waste		Waste remediation, water purification
		Natural hazard		Protection from natural hazard
Cultural services	→	Knowledge and education	→	Scientific knowledge of ecosystem functions, genetic information, and potential for chemical/therapeutics discovery
		Recreation		Recreational sea angling Nature-based recreation Scuba Diving
		Spiritual and religious		Artistic work based on the marine environment
		Cultural and social		Protection of iconic sites or archaeological features
		Aesthetic and inspiration		
		Non-use[24] and option values		Altruistic/Bequest/Existence/Option/Quasi-option

[22] http://uknea.unep-wcmc.org/Resources/tabid/82/Default.aspx

[23] This section of the impact assessment sets out some of the services provided by the ecosystem- but this list is not comprehensive.

[24] Non-use values are where benefits are derived from the marine environment without directly using it (e.g. from knowledge of their existence and from the potential for their future enjoyment of use).

				values
Supporting services	→	Primary production Nutrient cycling Biologically-mediated habitat Resilience and resistance	→	(Not directly analysed to avoid double counting[25])

75. The Marine environment provides a range of ecosystem services which have market values (e.g. the value of fish represented by the price of fish), non-market values (e.g. the value of carbon sequestration of the oceans represented by the price of carbon abated), and values that are not easily expressed in economic terms at all (e.g. cultural value of the sea). Many marine ecosystem services provide "free benefits" to society, which results in their overexploitation (e.g. provision of wild fish species) – this is known as an externality. Additionally, the market price of some marine ecosystem services is an underestimate of the benefits they provide – these represent a market failure.

76. Human activities can cause a range of impacts on the marine environment. These include the loss or degradation of biodiversity, loss of habitats, contamination by hazardous substances and nutrients, and the possible future effects of climate change. All these impacts can have a direct effect on the ability of the marine environment to provide the ecosystem goods and services outlined above.

The Case for Intervention

77. Charting Progress 2 concluded that although many aspects of the UK's marine environment are improving (e.g. the impacts of contamination), other aspects (e.g. seafloor habitats, fish populations) are degraded and continue to be subject to unacceptable pressures from human activity. The UK Government and Devolved Administrations have recognised the need for intervention in order to provide diverse and dynamic oceans and seas which are clean, healthy, safe and productive, and consistent with sustainable use. Improved systems for managing the marine and coastal environment are already being put in place through the UK Marine and Coastal Access Act 2009, the Marine (Scotland) Act 2010 and the proposed Marine Bill in Northern Ireland.

78. Nevertheless, a number of the human activities which impact on the marine environment are managed at the European and international level (e.g. fisheries and shipping) and other pressures on the marine environment (e.g. litter and non-indigenous species) are trans-boundary in nature and can easily spread across national borders. For these reasons national measures alone will not be sufficient to achieve the UK's objectives for its seas.

79. In addition as new evidence becomes available about the effects of pressures on the marine environment the UK needs to be able to respond flexibly, in coordination with its maritime neighbours. For instance, the scale of effects of underwater noise on marine animals is not fully understood and a coordinated approach is needed to ensure the cumulative impact of noisy activities is managed at a level which does not cause significant impact on marine species.

[25] Supporting services are those that are necessary for the production of all other ecosystem services. The important point to emphasise is that they differ from provisioning, regulating, and cultural services in that their impacts on people are indirect and will therefore not be valued directly but by taking account of the impact on these other ecosystem services that are directly 'consumed'.

80. The MSFD requires all Member States to take the collaborative action necessary to achieve GES in Europe's seas. It puts in place a coherent common legislative framework for coordinated action across Europe, covering all the human activities that have an impact on the marine environment. A comprehensive set of GES targets and indicators is required in order that the UK, in coordination with other Member States, can assess the impact of human activities on the marine environment and take effective national and international measures to ensure sustainable use of our marine resources.

Policy objectives: An overview of the Directive's requirements

81. MSFD establishes a framework within which Member States shall take the necessary measures to achieve or maintain GES in the marine environment by 2020 at the latest. The aims of the Directive are to:
    - 'Protect and preserve the marine environment, prevent its deterioration or, where practicable, restore marine ecosystems in areas where they have been adversely affected;'
    - 'Prevent and reduce inputs in the marine environment, with a view to phasing out pollution, so as to ensure that there are no significant impacts on or risks to marine biodiversity, marine ecosystems, human health or legitimate uses of the sea.[26]'

82. Member States must apply an ecosystem-based approach to the management of human activities. In this context this means ensuring that the collective pressure of human activities is kept within the levels compatible with the achievement of GES.

83. The aims of the Directive are to be delivered through the development of marine strategies covering the following elements:
    - An Initial Assessment of marine waters analysing the essential features, characteristics and environmental status of those waters (by July 2012[27], with subsequent assessments carried out on a six-yearly basis);
    - Determination of a set of characteristics for GES, based on the 11 GES Descriptors set out below (by July 2012[28], reviewed on a six-yearly basis);
    - Establishment of comprehensive environmental targets and indicators to guide progress towards achieving GES (by July 2012[29], reviewed on a six-yearly basis);
    - Establishment and implementation of a coordinated monitoring programme for the ongoing assessment of GES (by 2014, reviewed on a six-yearly basis);
    - Development of a programme of measures designed to achieve GES by 2020 (by Dec 2015, reviewed and revised on a six-yearly basis);
    - Implementation of the programme of measures described above (by Dec 2016, reviewed on a six-yearly basis).

84. Following the principle of adaptive management, which recognises the fact that our understanding of the marine environment will develop over time, each stage of the marine strategy, including the GES targets and indicators, must be reviewed every six years and revised if necessary[30].

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[26] MSFD 2008/56/EC Article 2

[27] This needs to be submitted to the Commission by 15th October 2012, but we may miss this deadline by a few months.

[28] This needs to be submitted to the Commission by 15th October 2012, but we may miss this deadline by a few months.

[29] This needs to be submitted to the Commission by 15th October 2012, but we may miss this deadline by a few months.

[30] As required under Article 17(2) of Directive 2008/56/EC

85. GES is defined in the Directive and described in more detail by 11 high-level Descriptors of GES which Member States must use as the basis for their GES targets and indicators[31]. The 11 GES Descriptors are set out in the box below.

MSFD Descriptors of Good Environmental Status

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 ("Descriptor 1" or "D1").
2 - Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems ("Descriptor 2" or "D2").
3 - 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 ("Descriptor 3" or "D3").
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 ("Descriptor 4" or "D4").
5 - 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 ("Descriptor 5" or "D5").
6 - 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 ("Descriptor 6" or "D6").
7 - Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems ("Descriptor 7" or "D7").
8 - Concentrations of contaminants are at levels not giving rise to pollution effects ("Descriptor 8" or "D8").
9 - Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards ("Descriptor 9" or "D9").
10 - Properties and quantities of marine litter do not cause harm to the coastal and marine environment ("Descriptor 10" or "D10").
11 - Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment ("Descriptor 11" or "D11").

86. Member States are required to further develop these 11 GES Descriptors by determining a more detailed set of characteristics for GES[32]. The UK characteristics of GES can be found in the individual Descriptor summaries in Section D. In turn, these characteristics must be underpinned by the more specific GES targets and indicators[33] which will be used to assess progress towards the achievement of GES.

87. As explained in the introduction, this impact assessment focuses on the GES targets and indicators, as these will directly influence the future choice of management measures, and

[31] MSFD 2008/56/EC Article 3(5) and Annex 1

[32] As required by Article 9 of the MSFD.

[33] As required by Article 10 of the MSFD.

therefore the costs and benefits of implementing this Directive. The choice of targets and indicators is left to Member States, however Member States must follow the requirements for criteria and indicators set out in the Commission Decision 2010, and must also coordinate their proposed targets with other Member States in their marine region.

Section C: Methodology

Evidence Base

88. The GES targets and indicators and related socio-economic analysis set out in this impact assessment are based on evidence set out in two key reports.

89. The Cefas Cost Benefit Analysis Report 2011 provides the main evidence base for the proposed GES targets and indicators, as well as the evidence to support the economic analysis of the illustrative management measures. This report has been carried out for Government by Cefas, in collaboration with JNCC, Eftec and a wide range of marine experts in the UK Marine Monitoring and Assessment Strategy. The development of the report was overseen by a Steering Group including representatives from Defra and the Devolved Administrations and the Steering Group considers the advice in the report to be robust and transparent. The report has been independently peer reviewed.

90. The ABPmer Business As Usual Scenario Report 2011 (BAU Report)[34] provides the main evidence base for the Baseline Scenario (Option 0). The report was carried out for Government by ABPmer and was overseen by a Steering Group including representatives from Defra, the Devolved Administrations and key Government Agencies and Non-Departmental Public Bodies. A wide range of experts from the UK Marine Monitoring and Assessment Strategy also provided input to the report. The evidence in the BAU report is based on data and information available to consultants at the time the report was drafted and is considered by the Steering Group to represent a robust and transparent assessment. The evidence base provided in this report will be updated over time as more information becomes available – this will then form a living baseline which can be used for future impact assessments[35]. The report has been independently peer reviewed and subsequently updated to further improve the analysis.

Analytical approach to assessing costs and benefits of GES

91. The costs and benefits of the GES targets (Option 1) are compared to the baseline scenario (Option 0). Costs and benefits have been assessed over a timescale of approximately 13 years. The decision to use this timeframe was based on various factors. It provides a sufficiently long period over which environmental benefits may arise and the MSFD measures may be implemented. The benefits and costs related to descriptor 3 (commercial fisheries) occur from 2013 while the benefits and costs related to other descriptors occur between 2016 to 2025. Assessment of the impacts beyond 13 years becomes more uncertain. For example, businesses have greater scope to adjust their activities in the long-term (for example through purchasing new equipment) and may therefore avoid costs that arise in the short-term. However, the analysis assumes that all the environmental benefits accrue within this time

[34] 'Business as Usual Projections of the Marine Environment: to Inform the Implementation of the Marine Strategy Framework Directive', ABPmer 2012, hereafter referred to as the ABPmer BAU Report 2011 Hhttp://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=17775&FromSearch=Y&Publisher=1&SearchText=ME5104&SortString=ProjectCode&SortOrder=Asc&Paging=10#DescriptionH

[35] The draft final report was completed in early July 2011 and its assessment of the state of the GES Descriptors (under the baseline scenario) is based on the best evidence available before then. Given the uncertainty regarding the delivery of certain policies and the projection of future human activity, the report had to make several assumptions to arrive at the state assessments. Since then there has been further new evidence, such as recommendations on sites that will be designated as Marine Conservation Zones, and future versions of the report will incorporate such new evidence to update its assessments.

period. In reality benefits are likely to be realised over a longer time horizon. Costs and benefits are calculated over the period using a discount rate[36] of 3.5%, based on the Green Book[37].

92. Costs of the GES targets relative to the baseline scenario (Option 0) have been assessed by examining a list of illustrative management measures which experts and policy makers believe represent a reasonable indication of the types of action which may be necessary to achieve the GES targets. The illustrative management measures used in this impact assessment are based on measures included in the Cefas Cost Benefit Analysis Report 2011, as well as some additional measures which have been added by policy makers as the proposals for GES target options became clearer. It must be stressed that these measures represent a current best assessment of the type of action which could be needed to achieve the targets, but should not be seen as the measures the UK Government and Devolved Administrations definitely intend to take to achieve GES. More work is needed between now and 2015 to assess the need for additional action to achieve the proposed GES targets and to consider all possible management measures both in terms of their effectiveness in achieving GES and in terms of their socio-economic implications and the potential for measures to be disproportionately costly. The actual programmes of measures for achieving GES will be the subject of a separate impact assessment in due course.

93. The cost assessment in this impact assessment also considers the likely additional monitoring costs associated with the proposed GES targets and indicators. These should be seen as broad initial estimates, with further work being carried out between now and 2014 to refine the monitoring proposals and to establish the most cost effective way of meeting them. This will be subject of a separate impact assessment in due course.

94. Where appropriate the costs of the illustrative measures associated with the GES targets have been aggregated to reach a total cost for each GES Descriptor. However, it has not been possible to cost all the potential measures, some are only estimates or proxies and for others monetary costings are not present. For this reason any aggregated costings for the targets must be considered within this wider context.

95. Given that the management measures used to carry out the cost assessment are only illustrative, it would not have been proportionate to undertake a full cost-benefit analysis of each individual measure. Therefore a different approach has been taken for assessing the benefits of the GES targets.

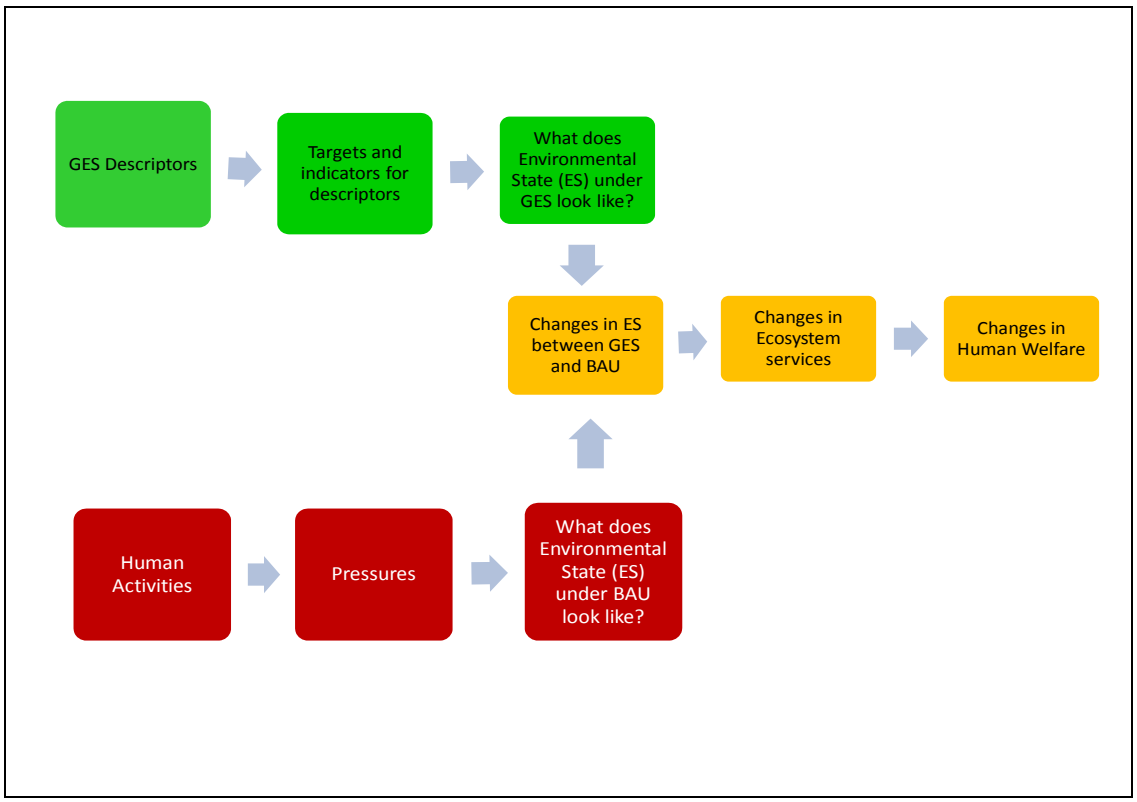
96. To assess the benefits of the MSFD the overall benefits of achieving the GES targets have been considered. Comparison of the gap between the expected state of the marine environment in 2020 without MSFD (i.e. the Baseline scenario) and the expected state of the marine environment in 2020 when the GES targets are achieved, has been used to provide an estimate of how degraded the marine environment is likely to be in 2020 without the MSFD. An ecosystem services approach has then been used to show how that degradation of the marine environment corresponds to a reduction in human welfare. Wherever possible the reduction in welfare has been monetised, however, this has not been possible in all cases given the current evidence base and a significant amount of qualitative assessment is included. Additional work has been carried out between the consultation and this final impact assessment to improve the assessment of benefits. However, further work is needed over the longer-term to support a fully quantified ecosystem services assessment. This approach to

[36] The Discount Rate is used to describe the time preference society attaches to benefits – immediate benefits tend to be valued more highly than future benefits.

[37] HM Treasury, The Green Book: Hhttp://www.hm-treasury.gov.uk/data_greenbook_index.htm

assessing the benefits is set out in Figure 2 below and the benefits are described in more detail in Section E.

Figure 2 – Summary of the approach to assessing costs of degradation and benefits of achieving GES



Changes since the Consultation Impact Assessment

97. There have been no changes to the overall methodology between the consultation IA and this final IA. However, changes to the assumptions associated with the baseline scenario and the benefits analysis have led to a significant reduction in the overall net present value compared to the Consultation IA. The key changes are as follows:
    - At the time of producing the Consultation IA there was significant uncertainty about the direction of a number of existing policies, making decisions about what to include in the baseline difficult. Based on improved information about the likely outcomes of a number of existing policies the baseline assumptions have been updated and a number of costs have been removed because these are now considered to be part of the baseline. This is particularly the case for: CFP reform, where the direction of the reform process is now much clearer; international shipping, where the direction of internationally managed measures to reduce introduction and spread of non-indigenous species is now clearer; Marine Conservation Zones, where there is now more information about the site designation process; and litter, where it has become clearer that existing policies on terrestrial litter will play a significant role in supporting the proposed GES targets for litter (reducing both the costs and the benefits).

    - The costs associated with a number of measures and monitoring needs have been removed compared to the Consultation IA because the consultation process indicated that the figures used were insufficiently robust to be included. Instead the impact of these measures has been described qualitatively. These include measures for reducing seabird by-catch, and monitoring costs for sediment habitats.

- The analysis of benefits from increased fish stocks has been significantly improved compared to the Consultation IA, based on much more sophisticated assumptions and scenarios of changes in fish stock dynamics. The new scenarios considered looks at both an optimistic and pessimistic scenario of improvement in fish stocks and hence provides a range for the benefits. In addition the benefits are 'net benefits' to the fishing industry as it also takes account costs implications of reducing fishing in the initial years to get benefits of higher stocks in the future. This has led to reduction in these benefits compared to the Consultation IA, which took a very simplistic approach to valuing these benefits.

98. Table 3 below compares the headline cost and benefit figures from the consultation IA with those of this final IA.

Table 3 – Summary of key changes since consultation IA		
	Consultation IA	**Final IA**
Overall NPV	£178m - £336m	-£1.8m - £22.6m
Total monetised costs	£91m - £535m	£6.7m - £27.4m
Total monetised benefits	£296m - £871m	£4.9m - £50.1m

Baseline option (Option 0)

99. As described above, the baseline scenario aims to describe what the marine environment would look like in 2020 and 2030 if the MSFD is not implemented; it provides a baseline against which the potential costs and benefits of the GES targets and indicators are compared.

100. The baseline scenario for each of the GES Descriptors is described in the individual Descriptor summaries in Section D. By definition the costs and benefits of the baseline scenario are zero since no additional actions will be taken.

The Business As Usual Report – Methodology for developing the baseline:

101. The baseline scenario was heavily informed by the ABPmer Business As Usual Report 2011. This report was constructed by using the Driver, Pressure, State, Impact, Response (DPSIR) model to relate predicted changes in social, political and economic drivers to changes in the level of pressure on the marine environment exerted by human activities, and ultimately to potential impacts on future ecosystem state[38]. Social, political and economic drivers (e.g. changes in political ambitions, population changes, increased incomes) are likely to influence future trends in activities which affect the marine environment, which in turn are likely to cause changes in the environmental condition of our seas.

102. The BAU report analysis includes an assessment of marine ecosystem services and their links to the GES Descriptors; identification of the key social, political and economic drivers and their influence on achieving GES; identification and prioritisation of key environmental pressures caused by different marine activities and a temporal and spatial analysis of their

[38] European Environment Agency, 2007. Drivers' (D) are the socio-economic and socio-cultural forces driving human activities, which increase or mitigate pressures on the environment. 'Pressures' (P) are the stresses that human activities place on the environment. These pressures result in a change in the 'State' (S) of the marine environment . 'Impacts' (I) are the effects of changes in state that may influence ecosystems, human health, and materials. This approach highlights the number of steps in the causal chain where the chain can be broken by policy action or 'Responses' (R) by society to the impacts.

projected future trends; an assessment of ecosystem sensitivity to these pressures; and finally an assessment of projected future changes in environmental state and ecosystem services.

103. The following categories of marine activities were considered and mapped against the pressures they exert on the marine environment[39]:

- Energy production (e.g. wind turbines)
- Extraction of non-living resources (e.g. sand and gravel extraction, oil and gas extraction)
- Extraction of living resources (e.g. fishing)
- Food production (e.g. aquaculture)
- Habitat modification (e.g. coastal defence, managed realignment)
- Military
- Recreation and tourism
- Survey and research
- Transport
- Waste management – gas (e.g. carbon capture and storage)
- Waste management – liquid (e.g. sewerage disposal)
- Waste management – solid (e.g. disposal of fish waste, land-based sources of litter)

104. In the BAU report analysis, pressures were prioritised on the basis of whether they are likely to have significant impacts on the state of the marine environment. In order to do this the ABPmer team, with support from experts in the UK Marine Monitoring and Assessment Strategy, carried out a detailed analysis of the current spatial and temporal extent of the pressures at all stages in the life cycle of an activity. The ABPmer team also carried out an assessment of the existing management measures which are in place to manage these pressures[40]. The rationale for prioritisation was generally as follows: if activities are already managed through measures taken under existing legislation (e.g. the Environmental Impact Assessment Directive or the Water Framework Directive), then these measures should be sufficient to ensure that the pressures from the activities do not significantly affect the UK marine environment, even if activity increases. The results of this analysis are summarised in the ABPmer Business As Usual Report 2012[41].

105. The assessment then looked at the key social, political and economic drivers behind the prioritised list of pressures and carried out an analysis of the projected temporal and spatial footprint of these pressures in 2020 and 2030 – this is summarised in the APBmer Business As Usual Report 2012, Table 6 (p.54-55). The final step involved using the results of this analysis to assess the potential future state of the marine environment in 2020 and 2030 for each of the 11 GES Descriptors and their implications for ecosystem services. Over the consultation period the business as usual assessment has been updated to reflect more up-to-date information and assumptions regarding the impact of existing policy measures such as the Common Fisheries Policy and Marine Conservation Zones.

Key Assumptions in the baseline scenario:

106. In general, for the baseline scenario, it has been assumed that all existing UK legislative commitments and established policies (both national and international) will be met and their goals achieved[42]. For example, it is assumed that the Water Framework Directive will achieve

[39] This activity-pressure assessment was based on some work originally carried out by JNCC and the UK Marine Monitoring and Assessment Strategy, Healthy and Biologically Diverse Seas Evidence Group. This work was adapted for the purposes of this analysis.

[40] See ABPmer Business As Usual Report 2012, Appendix C: Identification of Drivers and Activities Operating on GES Descriptors (p.114).

41 See ABPmer Business As Usual Report 2012, Table 6 (p.54-55) and Appendix D1:Pressure Prioritisation (p.122)

[42] Existing legislative commitments are summarised in Appendix C of the ABPmer Business AsUsual Report 2012 (p.114)

Good Ecological Status and Good Chemical Status in coastal waters. It is recognised that there is uncertainty surrounding the effectiveness of existing management measures and legislative commitments, however, the only assumption that could be reasonably made at this stage is that they will meet their intended objectives.

107. However, the timing of this impact assessment creates particular problems in estimating the impact of Marine Protected Area designation and subsequent management measures, marine planning and reform of the CFP, since these measures are still at an early stage in their development. It is particularly difficult to anticipate the outcome of the public consultations on MCZs in English waters or Devolved Administration plans for MPA designation. It is equally difficult to anticipate the outcomes of the EU CFP reform negotiations.

108. For Marine Protected Areas it has been assumed that even if a sizeable number of the draft English MCZs are ultimately approved, and sites are designated as planned in the Devolved Administrations, this will not in itself be sufficient to deliver GES for the UK's marine habitats and species. It has also been necessary to make a number of assumptions about displacement of fishing activity in MCZs in order to cost measures for prohibiting use of mobile demersal gears. It has been assumed that for MCZ designation in England, there will be a reduction in the impacts of scallop dredging and demersal trawling on benthic habitats and mobile species in the draft candidate sites, but that this will lead to some displacement of fishing activity elsewhere. During the consultation period some improved assumptions about displacement of activity have been developed in discussion with experts in Cefas. Given the limited overlap of the recommended MCZ sites with core fishing grounds, experts have advised using an assumption that 75% of the effort will be displaced to other areas and 25% will be lost. Of the effort displaced 90% will be in existing fishing grounds and 10% in new fishing grounds. It is clearly critical to the success of the designation process that any displacement does not result in even greater harm to protected habitats or species outside the MCZ areas and the modelling rightly assumes this.

109. Successful reform of the CFP is crucial to the achievement of GES for those elements of the marine ecosystem impacted directly or indirectly by fishing activity. It is critical for Descriptor 1 (biodiversity), Descriptor 3 (commercial fisheries), Descriptor 4 (food webs) and Descriptor 6 (sea-floor integrity). The scope for the UK to take unilateral action to achieve the kinds of fisheries measures potentially necessary to achieve GES for these Descriptors is limited. For these reasons the CFP is seen as the key delivery vehicle for any fisheries management measures necessary to achieve GES and successful reform of the CFP is critical to this.

110. For the purposes of the baseline scenario, however, it is particularly difficult to distinguish how far CFP reform has been driven by the introduction of the MSFD and what would have happened anyway as a result of pressure to improve the environmental outcomes of the policy. The UK has long been pursuing the aim of sustainable, ecosystem-based fisheries management, which reduces the impact of fisheries on the wider marine environment and would be taking this approach to CFP reform irrespective of MSFD. It could, therefore, be argued that from a purely UK perspective reform of the CFP and the associated measures needed to achieve sustainable fisheries should be included within the baseline scenario. However, it is unlikely that the wider EU approach to CFP reform would deliver the outcomes the UK is seeking without the added pressure for environmental improvement provided by the MSFD. For this reason a proportion of the costs and benefits of achieving the UK's desired outcomes under a reformed CFP have been attributed to the MSFD.

111. Given the close overlap between MSFD and CFP it has been difficult to quantify how much of these costs and benefits should be included within the baseline scenario and how much

should be apportioned to MSFD. For the GES targets for Descriptors 1 (biodiversity), 4 (food webs) and 6 (seafloor integrity) it has been assumed that 100% of the costs and benefits should be attributed to MSFD because these targets are primarily aimed at protecting the wider marine environment rather than achieving higher levels of commercial fish stocks (which is the primary objective of the CFP). For benefits related to Descriptor 3 (commercial fish), given that it now looks likely that the key objective of the reformed CFP will be to achieve Maximum Sustainable Yield (MSY) for fish stock by 2020 or before, it has been assumed that the majority of the benefits of improvements in fish stocks (75%) should be attributed to the CFP, with the remaining 25% attributed to MSFD. These assumptions have been improved compared to the consultation IA (which considered a range of scenarios of between 10% and 50% apportionment to MSFD) due to greater certainty about the direction of the CFP reform process.

112. Similarly, successful implementation of marine planning will be a useful tool in helping to achieve GES for some descriptors. Although the implementation of marine planning is included within the baseline scenario it is currently difficult to quantify its impact because it is still in its early stages across all UK administrations. Based on the impact assessment which was carried out for marine planning in England in 2009[43], it has been assumed that marine planning will support the achievement of GES both through the Sustainability Appraisal process undertaken during the development of marine plans and by providing a framework for decisions on the licensing of marine activities.

[43] http://archive.defra.gov.uk/environment/marine/documents/interim2/20110221mps-ia.pdf

Section D: Information on target options and costs

113. This section sets out the GES targets and indicators, the associated illustrative management measures, and an assessment of the costs associated with these. The proposals and costs are set out Descriptor by Descriptor as this was considered to be the simplest way of presenting the information. However, it should be noted that there is some overlap between the different Descriptors and a number of the illustrative management measures will support the achievement of targets under more than one Descriptor. Where this is the case it has been clearly indicated.

114. GES targets and indicators for Descriptors 1 (biodiversity), 4 (food webs) and 6 (sea-floor integrity) are set out first and are dealt with together in one sub-section due to the significant degree of overlap between them. The approach for these Descriptors is the most complex to describe due to their wide coverage. The overall approach to setting GES targets and indicators for these Descriptors is set out first, followed by separate sections describing the targets for species (mammals, fish and birds), and the targets for habitats (pelagic habitats, sediment habitats and rock and biogenic reef habitats). The GES targets, illustrative measures, associated costs, and assumptions and risks are set out in 6 summary tables.

115. There are then separate sub-sections setting out the GES targets and indicators for Descriptors 2 (non-indigenous species), 5 (eutrophication), 7 (hydrographical conditions), 8 (contaminants), 9 (contaminants in seafood), 10 (litter) and 11 (noise). For each Descriptor the information is arranged in the following format:

- A background section, which includes the UK characteristics of GES;
- A section describing the baseline scenario (Option 0);
- A section describing the GES targets and indicators and their implications;
- A summary table setting out the GES targets, the illustrative measures, the associated costs, and the key assumptions and risks.

116. The cost assessment has been monetised as far as possible, but still contains a number of aspects which it has only been possible to describe qualitatively. More detailed cost benefit analysis will be carried out as part of the development of the Programme of Measures between now and 2015 and stakeholders will be engaged throughout this process.

Descriptors 1, 4 and 6 – Biodiversity, Food Webs and Seafloor Integrity

Background

Descriptor 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.

117. This Descriptor has a very broad scope. To achieve GES a multi-species and multi-habitat approach is needed, together with a robust assessment of the impact of human pressures on these components[44]. Most activities in the marine environment affect biodiversity in some way and achieving GES for the other Descriptors will help achieve GES for this Descriptor.

118. The UK characteristics of GES for this Descriptor are as follows:

[44] ICES-JRC Report on Descriptor 1, 2009.

- At the scale of the MSFD sub-regions, and in line with prevailing conditions[45], the loss of biodiversity[46] has been halted[47] and. where practicable, restoration is underway:
    - The abundance, distribution, extent and condition of species and habitats in UK waters are in line with prevailing environmental conditions as defined by specific targets for species and habitats.
    - Marine ecosystems and their constituent species and habitats are not significantly impacted by human activities such that the specific structures and functions for their long-term maintenance exist for the foreseeable future.
    - Habitats and species identified as requiring protection under existing national or international agreements are conserved effectively through appropriate national or regional[48] mechanisms.

Descriptor 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.

119. A properly functioning marine food web is crucial to the overall health of the ecosystem. This Descriptor is intended to cover the functional aspects of food webs (particularly energy transfer) and levels of productivity. However, there is not currently enough known about energy transfer between trophic levels[49] and species interaction to meaningfully cover these within the targets for this Descriptor. In the medium term a pragmatic approach has been put forward, which focuses on the abundance, distribution and productivity of key species and trophic groups[50] within the food web. This means there is significant overlap with Descriptor 1.

120. The UK characteristics of GES for this Descriptor are as follows:
    - At the level of the MSFD sub-regions, populations of key species groups within the food web have an age and size structure indicative of sustainable populations and occur at levels that ensure the long-term sustainability of the marine ecosystem of which they are part, in line with prevailing conditions, as defined by specific targets for species and pelagic habitats.
    - There should be no significant adverse change in the function of different trophic levels in marine food webs as a result of human activities, including as a result of by-catch and discards.

Descriptor 6: 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.

[45] Prevailing conditions are defined as "in accordance with the intrinsic physiographic and climatic conditions of the different geographic regions". Prevailing conditions are understood to include climatic changes caused by human induced climate change. Prevailing conditions (including climatic changes) will need to be monitored in order for a full assessment of progress towards GES to be carried out and targets will need to be revised if prevailing conditions change in such a way as to make them no longer relevant or achievable.

[46] According to the Convention on Biological Diversity (CBD), biodiversity is defined as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems".

[47] This is in line with the updated CBD Target 12 "By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained."

[48] The term 'regional' refers to the scale of the regions and subregions in the Directive e.g. the Greater North Sea, The Celtic Seas.

[49] The **trophic level** is the position that an organism occupies in a food chain - what it eats, and what eats it.

[50] Trophic group refers to a category of organisms within a trophic structure, defined according to their mode of feeding (e.g. primary producers).

121. This Descriptor is intended to ensure that human pressures on the seabed do not prevent the ecosystem from retaining its natural diversity, productivity and dynamic ecological processes. The seabed and associated benthic habitats[51] underpin key elements of the marine ecosystem, supporting both primary and secondary production. Human pressures are known to reduce the diversity of benthic habitats. One of the most significant single activities contributing to the pressure on sea-floor habitats is bottom trawl fishing. There is significant overlap with Descriptor 1.

122. The UK characteristics of GES for this Descriptor are as follows:
- Sea-floor habitats (physically and structurally) are both productive and sufficiently extensive at the level of the MSFD sub-regions, to carry out natural functionality, including the necessary ecological processes[52] which underpin ecosystem goods and services[53], and are capable of supporting a healthy and sustainable ecosystem for the long term.

123. The goals of these Descriptors are in line with existing UK Government commitments e.g. the Natural Environment White Paper 2011 and the England Biodiversity Strategy 2011 goals to halt overall biodiversity loss and support healthy well-functioning ecosystems and establish coherent ecological networks of Marine Protected Areas. They are also in line with similar commitments made by the Devolved Administrations.

124. There are a significant number of measures already in place which will support the achievement of the GES targets for these Descriptors. This impact assessment attempts to assess how far existing measures will achieve the targets and what additional measures might be needed.

Approach to developing target options for these Descriptors

125. The GES targets and indicators for these Descriptors have been developed on the basis of advice from experts in the UK Marine Monitoring and Assessment Strategy Healthy and Biologically Diverse Seas Evidence Group (UKMMAS - HBDSEG), facilitated by JNCC[54]. The targets and indicators closely follow the requirements of the Directive and of the Commission Decision 2010 and some of them have been updated based on comments received during the consultation process.

126. The GES targets and indicators for these Descriptors have been developed on the basis of three species groups (birds, mammals and fish) and three habitat groups (pelagic, rock and biogenic reef and sediment), rather than Descriptor by Descriptor. This reflects the fact that there is significant overlap between the three Descriptors, and tackling the targets in this way has allowed experts to use many of the same targets across the Descriptors, minimising duplication. Experts have also proposed a range of more detailed indicators, which underpin the targets and explain how they would be assessed and monitored – these are set out at Annex A.

[51] Benthic habitats are those on the seafloor. It is a generic term that refers to both rocky and sedimentary seafloor habitats.

[52] For example, cycling of carbon and nutrients.

[53] For example, food security and climate regulation.

[54] This advice is included in the Cefas CBA Report 2012, Section 3.

127. The approach to setting targets for these Descriptors has been coordinated with other Member States across OSPAR. We have high confidence that other OSPAR countries will follow the same broad approach being proposed in this impact assessment, although further work will be needed between now and 2018 to improve coordination, with the aim of developing a common set of biodiversity indicators across OSPAR.

Targets for species (mammals, birds and fish)

Option 0: Baseline scenario

128. Charting Progress 2 gives a mixed picture of the current status of marine birds, fish and mammals. The state of demersal fish has improved since the 1980s due to recent reductions in fishing effort, but there are still considered to be problems and there is some way to go before the majority of commercial fish stocks are considered to be at safe levels. The state of cetaceans is thought to be relatively stable, but there are problems in some areas, thought to be due to by-catch by historic fisheries. There is a low level of confidence in the assessment due to lack of data. Grey seals are generally not experiencing any problems, but harbour seals have been decreasing in abundance dramatically in some areas and the causes are unknown. The state of most coastal waterbird species is good, but breeding numbers of some seabird species have declined substantially in north and north-west Scotland where the main causes are thought to be climate change and the introduction of non-indigenous species on key island colonies. Fishing has had both positive and negative impacts on seabirds, but evidence is lacking on the extent of these impacts[55].The Business As Usual report concluded that the future status of marine species is difficult to predict given the wide range of pressures on them and our lack of knowledge regarding species interactions[56].

129. There are numerous measures already in place, or planned under the baseline scenario, which are expected to reduce the key human pressures on these species and support the achievement of the GES targets. These include: measures required under the Birds and Habitats Directives; management measures for the MPA network; measures to achieve more sustainable fisheries under the CFP; work on monitoring and mitigating marine mammal by-catch in UK waters, and; measures to reduce levels of contaminants.

Option 1: GES Targets

130. GES targets and associated indicators have been developed for mammals, fish and birds covering Descriptor 1 (biodiversity) and Descriptor 4 (food webs). These include targets for species distribution, population size and condition, as well as the productivity of key species/trophic groups and the abundance/distribution of key trophic groups. The approach to setting targets for these different species groups is set out in more detail in the Cefas CBA Report 2012[57]. Existing targets have been used wherever suitable (e.g. from the Habitats Directive, OSPAR) and the proposals have been based as far as possible around existing indicators and monitoring programmes.

131. For marine mammals the proposed targets are all based on existing commitments under the Habitats Directive, which covers all marine mammal species. The targets aim to ensure

[55] See Charting Progress 2 – http://chartingprogress.defra.gov.uk/

[56] Business As Usual Report, ABPmer 2012, Introduction(ii).

[57] Cefas CBA Report 2012, pages 117.

that marine mammal distribution is not significantly affected by human activities and that their abundance is not decreasing as a result of human activities, using baselines consistent with those used for the Habitats Directive. Specific targets have also been developed for the condition of marine mammals, looking at species productivity and the impacts from key pressures, such as fisheries by-catch.

132. For birds the proposed targets for population distribution and abundance are based on work carried out in OSPAR to develop an Ecological Quality Objective for birds and aim to ensure that bird distribution and abundance are not significantly impacted by human activities. For birds, good historic data is available and the baseline for the targets will be based on data from a time when the impact from human activities is thought to be minimal. Specific targets have also been developed for the condition of bird species, looking at species productivity and the impacts from key pressures, such as the impact of non-indigenous mammal species on key island seabird colonies.

133. For fish, there are few targets in existing legislation which are suitable as indicators of fish biodiversity. For this reason most of the GES targets developed for fish are new. Targets have been developed which aim to ensure that the distribution and abundance of sensitive fish species is not significantly impacted by human activities, using a baseline which is set as the mean value for each species throughout the entire time series of available data. Targets have also been developed which use the size of the fish community as an indicator of the condition of the fish community and wider food web, particularly in relation to the impacts of fishing. These fish community size targets are based on indicators which have been developed within OSPAR (often known as the Large Fish Indicator).

134. As set out in the previous section, the management measures included in the baseline scenario are likely to play a significant role in achieving the GES targets for mammals, birds and fish. However, it is not clear at this stage whether these measures alone will be sufficient and in this assessment it has been assumed that some additional measures may be needed to further reduce the key human pressures on birds and fish. Fisheries impacts remain a significant pressure both through by-catch and potentially through competition for prey species. For birds, predation by non-indigenous species on key seabird island colonies is also considered to be a significant pressure, and for fish additional measures may be needed to protect particularly sensitive species not covered by existing legislation. Examples of the potential additional management measures needed to manage these pressures, and the costs associated with these are set out in Tables 4-6 below.

135. Broad initial estimates of the additional monitoring costs to Government and regulators associated with the GES targets and indicators for species are also set out in Tables 4-6 below. Monitoring of species for MSFD will be closely linked to monitoring for the Birds and Habitats Directives and at this point in time it is difficult to say what proportion of these additional monitoring costs should be attributed to MSFD. The actual monitoring costs will also be highly dependent on the design of monitoring (e.g. how regular or spatially intense it is). Work is on-going to determine how MSFD monitoring can be designed to focus on key risks and how the use of resources can be optimised through sharing of facilities (e.g. ships). In some cases the need to develop a properly informed basis for these approaches will mean that monitoring programmes will be established in a staged approach with it not being possible to establish effective monitoring of some aspects until after 2014.

Table 4 – Targets for Marine Mammals (Descriptors 1 and 4)	
TARGETS	
Targets – Species distribution	At the scale of the MSFD sub-regions the distribution of cetaceans is not contracting as result of human activities: in all of the indicators monitored there is no statistically significant[58] contraction in the distribution of marine mammals caused by human activities[59]. At the scale of the MSFD sub-regions the distribution of seals is not contracting as result of human activities: in all of the indicators monitored there is no statistically significant contraction in the distribution of marine mammals caused by human activities[60]
Targets – Population size	At the scale of the MSFD sub-regions abundance of cetaceans is not decreasing as a result of human activity: in all of the indicators monitored, there should be no statistically significant decrease in abundance of marine mammals caused by human activities[61]. At the scale of the MSFD sub-regions abundance of seals is not decreasing as a result of human activity: in all of the indicators monitored, there should be no statistically significant decrease in abundance of marine mammals caused by human activities[62]
Targets – Population condition	At the scale of the MSFD sub-regions cetacean populations are in good condition: mortality of cetaceans due to fishing by-catch is sufficiently low so as not to inhibit population targets being met[63]. At the scale of the MSFD sub-regions seal populations are in good condition: there is no statistically significant decline in seal pup production caused by human activities; and mortality of seals due to fishing by-catch is sufficiently low so as not to inhibit population targets being met[64]

[58] The way in which statistical significance of an event is determined will vary because indicators for different species are based on very different types of data e.g. trends, or proportions etc. Because of the mobile nature of marine mammal populations and the inherent variability in monitoring abundance and distribution, it is essential that a pragmatic approach is taken. The level of significance at which decisions will be made will be decided once the monitoring option has been agreed and we have a good idea of our ability to detect change (i.e. the statistical power of the monitoring programme), It is likely that our ability to detect change will be greater for some species than others and highest for grey seals. Such an approach allows the utilisation of different p values for different species if that is considered appropriate depending on the power to detect change. This is something that the ICES WGMME has proposed.

[59] This target will not be operational until 2018.

[60] This target will be based on indicators for grey seal and harbour seal distributional range.

[61] This target will not be operational until 2018.

[62] This target will be based on indicators for grey seals and harbour seal abundance.

[63] This target will be based on by-catch indicator thresholds for harbour porpoise and common dolphin.

[64] In 2012 this target will be based on indicators for grey seal and harbour seal pup production, and by-catch threshold indicators for harbour seal and grey seal. Indicators for contaminants and algal toxins in seals will be added in 2018.

Targets – Productivity of key species	At the scale of the MSFD sub-regions] marine mammal productivity is not significantly affected by human activities: There should be no statistically significant decline in seal pup production caused by human activities[65]
Targets - Abundance/ distribution of key species/ trophic groups	At the scale of the MSFD sub-regions abundance of cetaceans is not decreasing as a result of human activity: in all of the indicators monitored, there should be no statistically significant decrease in abundance of marine mammals caused by human activities[66] At the scale of the MSFD sub-regions abundance of seals is not decreasing as a result of human activity: in all of the indicators monitored, there should be no statistically significant decrease in abundance of marine mammals caused by human activities[67]

ASSESSMENT OF COSTS

Many of the known human pressures on marine mammals, including by-catch and the impacts of contamination and noise, are already dealt with under existing legislation[68]. As the GES targets for marine mammals are consistent with the requirements of the Habitats Directive (which covers all marine mammal species) it has been assumed that measures that are being taken, or will be taken in the future, under that Directive will be sufficient to achieve the GES targets. For this reason, no additional measures are attributed to MSFD in relation to these targets.

Monitoring costs

A broad initial estimate of additional monitoring costs associated with these targets are as follows:

- Up to £10kpa for extension of monitoring programmes on seals to ensure MSFD needs are covered[69].
- Progress towards MSFD targets for distribution and abundance of cetaceans will be measured through decadal censuses of cetacean populations at the MSFD sub-regional level. These censuses are also important for meeting the requirements of the Habitats Directive and the regulation of marine infrastructure developments. The total cost of a decadal census is estimated at £2-5m which would need to be shared with other Member States sharing the same marine region. At this point in time it is difficult to say what proportion of these monitoring costs should be attributed to MSFD, but it has been assumed that the UK would only pick up a maximum of 30% of these costs (with other countries in the NE Atlantic picking up the other 70%). Due to difficulties in attributing these costs between MSFD and the Habitats Directive, scenarios of apportioning 10% and 30% of these cost to MSFD have then been considered to give a rough scale of additional costs.

[65] In 2012 this target will be based on indicators for grey seal and harbour seal pup production only.

[66] In 2012 this target will be based on indicators for grey seals and harbour seals abundance only. Cetacean species indicators are likely to be added in 2018.

[67] This target will be based on indicators for grey seals and harbour seal abundance.

[68] Relevant legislation includes the Habitats Directive, EU Regulation 812/204 and the Water Framework Directive. There are also relevant existing commitments under ASCOBANS and OSPAR in relation to by-catch, and under OSPAR in relation to contaminants.

[69] Cefas CBA Report 2012, page 243. Additional costs presented here assume that no additional survey work is needed. Costs cover possible extra analysis costs to interpret the data to meet MSFD assessment requirements. Staff costs etc are already covered by the work undertaken for other obligations and are not included here.

SUMMARY
Potential costs to business – No additional costs likely. **Potential costs to government** – Costs to Government from monitoring based on the assumptions above, £67k-£472k over the appraisal period is attributed as an additional cost under MSFD. **Total potential costs** – Overall costs are likely to be low with monitoring costs estimated at £67k-£476k over 10 years.
KEY ASSUMPTIONS AND RISKS
The analysis above assumes that the existing policies in the baseline (e.g. Habitats Directive, CFP, action to mitigate marine mammal by-catch) will address pressures on marine mammals. In relation to monitoring costs it has been assumed that the costs will be split with other Member States in the North Sea and Celtic Seas and that the UK would pick up a maximum of 30% of the costs. It is also unclear what proportion of monitoring costs should be attributed to MSFD and what proportion to the Habitats Directive. Two scenarios have been considered – with 10% and 30% of the costs being apportioned to MSFD. These are scenarios rather than informed estimates.

Table 5 – Targets for Birds (Descriptors 1 and 4)	
TARGETS	
Targets – Species distribution	At the scale of the MSFD sub-regions distribution of marine birds is not significantly affected by human activities: No major shifts or shrinkage in the population distribution of marine birds in 75% of species monitored[70].
Targets – Population size	At the scale of the MSFD sub-regions abundance of marine birds is not significantly affected by human activities: Changes in abundance of marine birds should be within individual target levels in 75% of species monitored[71].
Targets – Population condition	At the scale of the MSFD sub-regions marine bird productivity is not significantly affected by human activities: Annual breeding success of black-legged kittiwakes should not be significantly different, statistically, from levels expected under prevailing climatic conditions (i.e. sea surface temperature,and widespread seabird colony breeding failures should occur rarely[72] in other species that are sensitive to changes in food availability. At the scale of the MSFD sub-regions, the risks to island seabird colonies from non-native mammals are reduced.
Targets – Productivity of key species	At the scale of the MSFD sub-regions marine bird productivity is not significantly affected by human activities: Annual breeding success of black-legged kittiwakes should not be significantly different, statistically, from levels expected under prevailing climatic conditions (i.e. sea surface temperature).

[70] In 2012 this would be based on indicators for breeding seabirds, non-breeding shorebirds and coastal breeding waterbirds. Indicators for seabirds at sea and non-breeding waterbirds are likely to be added in 2018.

[71] In 2012 this would be based on indicators for breeding seabirds, non-breeding shorebirds and coastal breeding waterbirds. Indicators for seabirds at sea and non-breeding waterbirds are likely to be added in 2018.

[72] The percentage of colonies [per species] experiencing breeding failure does not exceed the mean percentage of colonies failing over the preceding 15 years, or 5%, whichever value is greater.

Targets Abundance/ distribution of key species/ trophic groups	At the scale of the MSFD sub-regions abundance of marine birds is not significantly affected by human activities: Changes in abundance of marine birds should be within individual target levels in 75% of species monitored[73].

ASSESSMENT OF COSTS

Gear restrictions/modifications to prevent bycatch of birds[74].

Seabirds can suffer incidental mortality by becoming snared in fishing nets or hooks. Such by-catch could be reduced by cost-effective mitigation measures in the relevant fisheries. The consultation IA provided an estimate of costs (£150K – £6m over 10 years) based on very rough assumptions made by policy leads. These figures were challenged during the consultation and have therefore been removed. Instead impacts have been described qualitatively using information from a European Commission report[75] that provides a preliminary impact assessment on plausible mitigation measures to reduce by-catch of birds. The impact assessment was primarily based on findings from case studies which involved surveying a small sample of fishermen[76]. For longline fisheries three measures potentially cost-effective measures were identified. Adding streamer lines to nets was estimated to lead to a 4% reduction in profit, a 2% reduction in income and a 1% increase in cost, whilst measures to make bait sink more quickly and measures to ensure offal discharge is not carried out while fishing is taking place were estimated to lead to no change to profits, cost or income. For gillnets, two potentially cost effective measures were identified. The use of buoys with visual deterrents was estimated to lead to a 7% reduction in income, 5% increase in costs and13% reduction in profits from status quo, however, for some fisheries the current practice of setting nets at night limited the benefit of such a measure. The use of red corks spaced throughout the net was estimated to lead to a 5% reduction in income, 4% increase in costs and 9% reduction in profits, and was considered to be a low cost measure that was only thought to impact the fishing efficiency of the gear in some instances, although for those fishing at night or in murky water, the efficacy of such visual measures is limited.

If UK were to adopt these measures then the costs are likely to be small, especially as some UK fishermen are already likely to be implementing some of these measures voluntarily. These estimates were not used to arrive at cost estimates as it is not clear whether the current cost structure (status quo) of UK fishermen is similar to those EU fishermen surveyed[77] or the extent

[73] In 2012 this would be based on indicators for breeding seabirds, non-breeding shorebirds and coastal breeding waterbirds. Indicators for seabirds at sea and non-breeding waterbirds are likely to be added in 2018.

[74] Information on this measure is taken from the Cefas CBA Report 2012 and an EU commissioned report entitled 'Contribution to the preparation of a plan of action for seabirds' 2012.

[75] '*Contribution to the preparation of a plan of action for seabirds'* 2012.. Produced for the European Commission by a consortium involving MRAG, Poseidon Aquatic Resource Management Ltd and Lamans s.a.

[76] A set of 12 separate mitigation measures for longline and 9 separate mitigation measures for gillnet fisheries were presented to fishers in each case study. Fishers were asked to estimate the impact of each mitigation measures in terms of how they expected them to impact on catch levels and total costs (e.g. a 5% increase in total costs). They were also asked to explain how they thought these changes in cost would occur (e.g. increased gear costs). In some instances fishers gave estimated changes to specific cost categories. Interviewers then derived the % impact on total costs following the interview based on responses to earlier questions on proportion of cost categories making up total costs. Estimates of percentage impacts of mitigation measures on income and total cost were averaged for each fleet and applied to the AER data for that fleet, i.e. extrapolated to the entire Member State fleet operating in that metier, to derive the impact on income, costs and the resulting impact on profitability. Given the small sample sizes in relation to numbers of vessels within these fleets, the analysis focused on a comparative analysis of measures resulting in a ranking rather than on the specific costs calculated

[77] For longline fisheries: the Gran Sol (demersal) (ICES area VIIj); the western Mediterranean (pelagic and demersal) (Spain) (GSA 5 & 6) and Maltese and Greek waters (pelagic and demersal) (GSA 15, 20, 21, 22, 23). For gillnet fisheries: the 'eastern' , Baltic Sea (Estonia, Latvia, Lithuania) (ICES area IIId); The 'western' Baltic Sea (Germany, Denmark, Sweden) (ICES area IIIb, c, d); and The eastern North Sea (Netherlands) (ICES area IV).

to which fishermen are already adopting some of these measures voluntarily. There may also be benefits to fishermen from implementing these measures e.g. increased fishing efficiency, reduced loss of bait, less time lost through removing dead birds from nets. There will be no additional enforcement costs to Government over and above those indicated in the illustrative measures for D3.

Removal of invasive, non-indigenous mammals in seabird colonies[78].
Two thirds of the total population of seabirds in the UK breed in offshore islands[79]. In some of these islands predation by non-indigenous mammals (e.g. rats) can have a significant adverse impact on the seabird populations and action to remove them may be necessary. Costs associated with removing non-indigenous mammals depend on the area where the planned removal will take place and the species to be eradicated. The costs incurred will be due to planning, the purchase of equipment (including bait/poison/drugs), the time involved, and the necessary follow-up such as monitoring the status of the non-indigenous species. The need for removal measures would be assessed on a case by case basis, however, for the purposes of this assessment costs of removing rats on both the 8 highest priority islands and the 16 highest priority islands[80] have been calculated in order to give a range of potential costs (the consultation IA just looked at the costs of removal in the 16 highest priority islands, however it is unlikely that removal would be carried on all these islands and so a range of costs are considered here). Removal costs ranging from £150 per hectare (2004 prices)[81] to £440 per hectare (2009 prices)[82] have been used. Based on these assumptions the range of costs for removal of non indigenous mammals on key island seabird colonies would be between £1.3m-£7.9m. This is a rough estimate and it should be noted that cost per hectare are generally less for smaller islands and are likely to increase in line with island size[83]. These costs would fall on Government, regulators (and possibly voluntary organisations such as the National Trust) and likely to be one off provided there are no re-introductions.

Measures for preventing invasion of non-indigenous mammals on islands with seabird colonies[84].
Invasive mammals such as rats can stow away in vessels which visit key island seabird colonies and colonise these islands, causing negative impacts on seabird populations. Measures can be put in place to prevent invasion of non-indigenous mammals on these islands (e.g. putting out traps on vessels, quarantine measures for food packages delivered by vessels, other biosecurity measures). The costs would be borne by the owners/ operators of the vessels which visit these islands (e.g. costs of putting traps, keeping records, quarantining packages). There may also be costs to regulators of implementing quarantine regulations or guidelines and monitoring compliance of vessels. Effective quarantine measures may also increase the inconvenience for tourists visiting these islands, decreasing the number of visits[85] and reducing tour operator revenue.

Other measures

[78] Information on this measure is taken from the Cefas CBA Report 2012.

[79] Mitchell and Ratcliffe 2007.

[80] Based on prioritisation of islands as set out in Ratcliff et al 2009 - 'How to prioritize rat management for the benefit of petrels: a case study of the UK, Channel Islands and Isle of Man', For the purposes of this cost estimate islands in the Channel Islands, Isle of Man and Scilly Islands have been excluded as they are not covered by MSFD.

[81] Based on correspondence between JNCC and Natural England giving information on an internal review of past eradication costs by Natural England.

[82] Costs based on the cost per ha of eradicating rats from Canna/Sanday during 2005–2006 (R. Luxmoore pers. comm).

[83] This is because eradication measures on larger islands will generally require more extensive use of helicopters to deploy bait.

[84] Information on this measure is taken from the Cefas CBA Report 2012.

[85] Oppel et al, 2010

The targets proposed under Descriptor 3 (commercial fish) are also likely to support the achievement of targets for birds, although their effectiveness would depend on how the associated measures are implemented[86]. Costs associated with achieving these targets are attributed to D3 (further details on p.67, Table 10).

Monitoring costs

A broad initial estimate of additional monitoring costs are as follows, but at this point in time it is difficult to say what proportion of these additional monitoring costs should be attributed to MSFD because monitoring programmes for the Birds Directives are so closely interlinked with those that will be required under MSFD [87]:

- >£100k pa for monitoring aggregations of seabirds and waterbirds at sea.
- <£100k pa for continuation of regular census of breeding seabird colonies.
- <£50k pa for monitoring of winter aggregations of shorebirds.
- Additional costs for monitoring seabird by-catch .

Actual monitoring costs will also be highly dependent on the design of monitoring (e.g. how regular or spatially intense it is). Work is on going to determine how MSFD monitoring can be designed to focus on key risks and how the use of resources can be optimised through sharing of facilities (e.g. ships). For monitoring of aggregations of seabirds and waterbirds at sea the need to develop a properly informed basis for these approaches will mean that it will not be possible to establish effective monitoring of some aspects until after 2014.

SUMMARY

Potential costs to business – There could be costs to business in terms of measures to prevent invasion of non-indigenous mammals on island seabird colonies. There could also be costs to the fishing industry associated with measures to prevent seabird by-catch – although costs are likely to vary considerably depending on the type of measure and some measures may bring benefits to fishermen.

Impact on small businesses – Since fishing enterprises tend to be small, measures to prevent by-catch of birds will have impact on small to medium sized enterprises. Measures to prevent invasion of non-indigenous mammals would also be likely to have impacts on small to medium sized enterprises as some of these tourist businesses can be can small/ medium scale. It has only been possible to provide a qualitative description of these costs.

Potential costs to government –Costs to government from monitoring are estimated at £ 2.1m over 10 years. Due to the difficulties in attributing these costs between MSFD and the Birds Directive, scenarios of apportioning 10% and 30% of the costs to MSFD have been considered to provide a rough scale of costs. This implies that the costs to MSFD range from between £187K - £562K over the appraisal period. Potential costs to government and regulators of measures to remove non-indigenous mammals on island seabird colonies are estimated at £1.3m -£7.9m. There could also be costs to regulators for enforcement of quarantine measures for vessels visiting island sea-bird colonies.

Total potential costs – The total costs are estimated to be £1.5m-£8.4mover 10 years.

KEY RISKS AND ASSUMPTIONS

It has been necessary to make a significant number of assumptions in developing these cost estimates. The cost assessment of measures to remove non-indigenous mammals on island seabird colonies assumes that removal would be carried out in all 16 islands recommended in Ratcliffe et al (2009) – in reality a smaller number of islands could be targeted for action, hence the costs could be lower.

In relation to monitoring costs it is unclear what proportion of costs should be attributed to MSFD

[86] Some species benefit from discards, but the GES target proposals for birds have been developed such that these positive impacts do not bias the achievement of GES.

[87] Cefas CBA Report 2012, pages 243

and what proportion to the Birds Directive. Two scenarios have been considered – with 10% and 30% of the costs being apportioned to MSFD. These are scenarios rather than informed estimates.

Table 6 – Targets for fish (Descriptors 1 and 4)	
TARGETS	
Targets – Species distribution	At the scale of the MSFD sub-regions distribution of sensitive fish species is not significantly impacted by human activities: the geographic and depth distribution of sensitive fish should meet individual indicator targets in a statistically significant proportion of species monitored.
Targets – Population size	At the scale of the MSFD sub-regions populations of sensitive fish species are not significantly impacted by human activity: the population abundance density and population biomass density of sensitive fish species should meet individual indicator targets for recovery in a statistically significant proportion of species monitored.
Targets – Ecosystem structure	The size-composition of fish communities should reflect a healthy status and not be significantly impacted by human activity[88]: More than 30% (by weight) of demersal fish in the Greater North Sea and 40% (by weight) of demersal fish in the Celtic Seas exceed a length of 40cm and 50cm respectively.
Targets – Proportion of selected species at the top of the top of food webs	The size composition of fish communities should not be impacted by human activity such as to indicate any adverse change in trophic function within the community[89]: A specified proportion (by weight) of fish in any defined marine region should exceed a stipulated length threshold.
ASSESSMENT OF COSTS	
The targets proposed under Descriptor 3 (commercial fish) will play a significant role in supporting the achievement of biodiversity targets for fish. Costs associated with achieving these targets are attributed to D3 (further details on p.67, Table 10). **Other measures** Additional, bespoke measures may be necessary for threatened or vulnerable species which are not specifically addressed under existing legislation e.g. elasmobranchs or highly migratory fish species. We are already exploring the extent to which bespoke management measures might be appropriate for the conservation of particularly vulnerable fish species like sharks, skates and rays. The costs of such measures are difficult to estimate given their specific (spatial, temporal, species etc) and bespoke nature. However, examples may be voluntary or regulatory seasonal closures to protect breeding, spawning/birthing or nursery areas or the introduction of minimum and maximum landing sizes to protect the breeding stock. These may incur enforcement costs to regulators or costs associated with lost access for industry. An estimate of enforcement costs is provided under D3 (please refer to p.67, Table 10). Other bespoke and low cost measures include establishing voluntary communication networks similar to the cetacean bycatch network run by the Cornwall IFCA which, when an incident of bycatch is reported skippers are alerted in	

[88] Variation in the size composition of fish communities is indicative of change in their status, such that communities with relatively high proportions of large fish are considered "healthy".

[89] Food web structure in fish communities is linked to size composition such that the proportion of fish exceeding an appropriate length threshold is indicative of the fraction of top-predators in the community.

order that they can either avoid areas or be extra vigilant. Similar approaches could be employed for some elasmobranch species. Educational measures may also be employed such as the production of identification guides for sensitive species similar to that produced and updated annually by the Shark Trust for elasmobranchs (27 species of shark, skate and ray over 18 pages). These provide information for those engaged in commercial fishing in order that they can identify vulnerable/protected species and act accordingly. These cost an initial c. £5k to produce and c. £1k per annum to update which would result in a cost of £12K from 2016 to 2025. A assuming that similar educational measures will be taken for 5 species the costs to government would be £55K over the appraisal period.

Monitoring costs

There are no additional monitoring costs associated with these targets as they are based on existing groundfish surveys.[90]

SUMMARY

Potential costs to business – Costs to business from D3 measures are described on page p.67, Table 10. Costs of adopting additional bespoke measures for particular species will depend on their range and extent. All the costs for the latter will fall on Small to Medium Size Enterprises (SMEs) as fishing enterprises tend to be small.

Potential costs to government – There are no additional monitoring costs. There could be additional enforcement costs depending on the nature of any bespoke measures for threatened or vulnerable species. The costs of potential additional educational measures are estimated at £55k over the appraisal period.

Total potential costs – Costs specific to these targets are currently uncertain, but costs of additional educational measures are estimated at £55K over the appraisal period. The costs of adopting measures for D3 are described separately.

KEY RISKS AND ASSUMPTIONS

There is significant uncertainty about what management measures might be needed to achieve these targets. For the purposes of this cost assessment it has been assumed that achieving the proposed GES targets under Descriptor 3 for Maximum Sustainable Yield in commercial fish stocks would be likely to play a significant role in supporting the achievement of the targets for fish biodiversity. However, it is actually very unclear at this stage whether these measures alone would be sufficient, or what additional measures might be needed.

Targets for Habitats (benthic habitats and pelagic habitats)

Option 0: Baseline scenario

Benthic habitats:

136. The Business As Usual report concluded that the status of benthic habitats is expected to remain stable, or improve slightly between now and 2020. The main sources of pressure on benthic habitats arise from benthic fishing activity, which is predicted to decrease in spatial extent between 2010 and 2020 (and beyond to 2030). Therefore, there is likely to be an overall improvement in benthic habitats, depending on the spatial extent of new conservation measures that exclude demersal fishing activity and depending on the recovery rates of benthic habitats[91]. However, despite projected improvements, the area of benthic habitats likely to be impacted by fishing pressure remains significant, particularly for certain habitat

[90] Cefas CBA Report 2012, pages 246

[91] Business As Usual Report, ABPmer 2012, Introduction(i).

types[92]. This corresponds with assessments made under Charting Progress 2 which suggest that there are still significant problems for shallow subtidal sediments and shelf subtidal sediments.

137. There are numerous measures already in place, or planned under the business as usual scenario, that are expected to reduce the key human pressures on benthic habitats. These include measures required under the Habitats Directive, management measures for the MPA network, the marine licensing regime, and existing measures to achieve more sustainable fisheries under the CFP.

Pelagic habitats:

138. Many changes are likely in the composition and distribution of plankton due to climate change pressures, although the precise nature of these changes is not known and their likely impact on food webs is unclear[93].

Option 1: GES Targets

139. GES targets and associated indicators have been developed for pelagic, sediment and rock and biogenic reef habitats covering Descriptor 1 (biodiversity), Descriptor 4 (food webs) and Descriptor 6 (seafloor integrity). These include targets for habitat distribution, habitat extent and habitat condition, as well as physical damage (to the seabed), and condition of the benthic community. The targets for pelagic habitats also cover the abundance/distribution of key trophic groups. The approach to setting targets for these different habitats is set out in more detail in the Cefas CBA Report 2012[94].

Seafloor Habitats:

140. For rock and biogenic reef habitats the targets are all based on existing targets for these habitats under the Habitats Directive. The aim here has been to ensure consistency with the requirements of the Habitats Directive, which already provides protection for these the vast majority of rock and biogenic reef habitats. The targets require the distribution and extent of rock and biogenic reef habitats to be stable or increasing, using Favourable Reference Area and Favourable Reference Area under the Habitats Directive as a baseline. They also require these habitats to be in good condition – not significantly impacted by human activities.

141. For listed sediment habitats (i.e. those habitats covered by existing legislation) the targets are also based on existing targets under the Habitats Directive and the Water Framework Directive. However, a large proportion of sediment habitats are not protected by existing legislation. These are known as predominant sediment habitats[95] and new targets have been developed to cover these habitats. The targets for these habitats have been particularly hard to develop because there is a significant lack of evidence and understanding on both current and desired state, meaning that it is not possible to set ecologically meaningful GES target thresholds. For this reason the targets for the condition of predominant sediment habitats are trend-based, pressure targets, requiring a reduction in damaging human impacts on these habitats. It is not currently possible to define the necessary level of reduction in impacts in

[92] The Business As Usual report suggests that in 2020 30% of moderate energy circa littoral rock habitats could be impacted at medium or high intensity by surface abrasion from demersal trawling; around 65% of subtidal mud could be impacted at medium or high intensity by surface abrasion from demersal trawling, and; around 19% of subtidal coarse sediment could be impacted at medium or high intensity by surface abrasion from demersal trawling and around 10% by structural abrasion from fisheries dredging. Business As Usual Report, ABPmer 2012.

[93] Business As Usual Report, ABPmer 2012, Introduction(ii).

[94] Cefas CBA Report 2012, pages 61-117

[95] These are broadscale, sediment habitats which cover a large % of the UK's seafloor. They are not currently protected by any existing legislation.

quantitative terms, but further research will be carried out with the aim of setting specific, quantified targets for predominant sediment habitats as soon as possible in the future.

142. As stated in the previous section, there are numerous measures already in place, or planned under existing commitments, which are expected to reduce the pressures on seafloor habitats and support the achievement of the GES targets. For those rock & biogenic reef and sediment habitats that are covered by the Habitats Directive it has been assumed that measures taken under that Directive will be sufficient to achieve the targets. However, for those seafloor habitats not covered by the Habitats Directive (primarily sediment habitats, but also some rock habitats), although MPAs designated under national legislation are likely to play a key role in achieving the proposed targets, additional measures may be needed to further reduce the key human pressures on them. Fisheries impacts remain the most significant pressure on sediment habitats and where unsustainable impacts are identified it is likely that more significant fisheries management measures will be needed under the reformed CFP or national inshore measures in order to reduce these (e.g. additional controls on the use of mobile demersal gear, modification of gear which is most damaging to the seabed).

143. Monitoring costs for seabed habitats will be highly dependent on the design of monitoring (e.g. how regular or spatially intense it is) and how well the use of resources for monitoring can be optimised through sharing of facilities (e.g. ships). Work is on-going to determine how MSFD monitoring can be designed to focus on areas at risk and how an optimal use of monitoring facilities can be achieved. A broad initial estimate of additional monitoring costs to Government and regulators associated with the targets and indicators for rock & reef habitats is set out in Table 7 below. For sediment habitats it has not been possible to provide a robust estimate of potential monitoring costs, and estimates included in the consultation IA have been removed due to concerns from stakeholders that the assumptions used to develop them were not sufficiently robust. MSFD monitoring for seabed habitats will be closely linked to information requirements under the Habitats Directive and evidence associated with commitments on Marine Protected Areas. At this point in time it is difficult to say what proportion of the additional monitoring costs should be attributed to MSFD.

144. For seabed habitats the need to develop a properly informed basis for these approaches will mean that monitoring programmes will be established in a staged approach with it not being possible to establish effective monitoring of some aspects until after 2014.

Pelagic Habitats:

145. For pelagic habitats[96], there are no suitable targets in existing legislation and all the targets are new. The targets and indicators all focus on plankton, which plays a crucial role in the pelagic food-web and the whole marine ecosystem. Changes in plankton are driven by climate but are also affected by human pressures, particularly eutrophication and fishing. The targets and indicators are designed to identify changes in plankton caused by human pressures, and require that the distribution, structure, condition and abundance of the plankton community 'are not significantly influenced by anthropogenic drivers'. Detailed quantitative indicators to measure progress towards the achievement of these targets are currently under development and are expected to be in place by 2014 to support the MSFD monitoring programmes.

146. It is unclear at this stage whether additional measures would be needed to achieve the targets. The targets under Descriptor 3 (commercial fisheries) should support the achievement

[96] Pelagic habitats refer to the water column. The focus of pelagic habitats is plankton. Plankton is the collective name for the small and microscopic organisms that drift with the waters of the sea; it includes bacteria, microscopic algae (phytoplankton), single-celled protozoans, microscopic animals (zooplankton) such as copepods (which are crustaceans), young fish, and larger animals such as jellyfish.

of these targets, as should the targets for Descriptor 5 (euthrophication). Provided these targets are achieved it is considered unlikely that additional measures would be necessary in relation to pelagic habitats.

147. In terms of monitoring an initial estimate of the additional monitoring costs associated with the proposed targets are set out in Table 8 below – these costs would fall primarily on Government and regulators.

Table 7 – Targets for benthic habitats (Descriptors 1 and 6)	
TARGETS FOR ROCK & BIOGENIC REEF HABITATS	
Targets –Habitat distribution	At the scale of the MSFD sub-regionsrock and biogenic[97] reef habitats are stable or increasing: For all listed (special) and predominant habitat types range and distribution are stable or increasing and not smaller than the baseline value (Favourable Reference Range[98] for Habitats Directive habitats).
Targets –Habitat extent	At the scale of the MSFD sub-regions rock and biogenic[99] reef habitats are stable or increasing: For all listed (special) and predominant habitat types area is stable or increasing and not smaller than the baseline value (Favourable Reference Area[100] for Habitats Directive habitats).
Targets – Habitat condition; Physical damage; Condition of the benthic community	At the scale of the MSFD sub-regions of rock and biogenic[101] reef habitats is not significantly affected by human activities: For all listed (special) and predominant habitat types the area of habitat in poor condition (as defined by condition indicators) must not exceed 5% of the baseline value (Favourable Reference Area for Habitats Directive habitats).
TARGETS FOR SEDIMENT HABITATS	
Targets –Habitat distribution	Predominant habitat types: No target proposed – see target below for Criterion 1.6 Listed (special) habitat types: At the scale of the MSFD sub-regions the range and distribution of listed (special) sediment habitat types is stable or increasing and not smaller than the baseline value (Favourable Reference Range for Habitats Directive habitats)
Targets – Habitat extent	Predominant habitat types: No target proposed – see target below for Criterion 1.6 All Listed (special) habitat types: Listed (special) habitat types: At the scale of the MSFD sub-regions the area of listed (special) sediment

[97] Built-up by dense growths of a species that changes the habitat (eg certain shellfish or deepwater corals).

[98] Favourable Reference Range is part of the assessment of Favourable Conservation Status under the Habitats Directive.

[99] Built-up by dense growths of a species that changes the habitat (eg certain shellfish or deepwater corals).

[100] Favourable Reference Area is part of the assessment of Favourable Conservation Status under the Habitats Directive.

[101] Built-up by dense growths of a species that changes the habitat (eg certain shellfish or deepwater corals).

	habitat types is stable or increasing and not smaller than the baseline value (Favourable Reference Area for Habitats Directive habitats) WFD extent targets for saltmarsh and seagrass should be used within WFD boundaries as appropriate.
Targets – Habitat condition; Physical damage; Condition of the benthic community	Predominant habitat types: At the scale of the MSFD sub-regions damaging human impacts on predominant sediment habitats are reduced: The area of habitat which is unsustainably impacted by human activities (as defined by vulnerability criteria) is reduced and the precautionary principle is applied to the most sensitive habitat types and/or those which are most important for ecosystem functioning. Listed (special) habitat types: At the scale of the MSFD sub-regions the area of special (listed) sediment habitat types below GES (i.e. unacceptable impact / unsustainable use) as defined by condition indicators must not exceed 5% of baseline value (favourable reference area for Habitats Directive habitats). WFD targets (km2 thresholds) for area of unacceptable impact for benthic invertebrates, macroalgae, saltmarsh and seagrass should be used within WFD boundaries as appropriate.

ASSESSMENT OF COSTS

For those rock & biogenic reef and sediment habitats which are already covered by the Habitats Directive, no additional measures are considered necessary as measures taken under that Directive should be sufficient to achieve the GES targets.

For those habitats that are not covered by the Habitats Directive (mainly predominant sediment habitats, but also some rock habitats) some additional management measures may be necessary. The major pressure on benthic habitats is considered to be bottom trawl fishing. Potential additional management measures which may need to be taken through the CFP or national inshore measures include:

Prohibiting use of mobile demersal gear (MDGs) in a proportion of Marine Conservation Zones

This illustrative management measure considers the additional costs of prohibiting the use of mobile demersal gears (MDGs) across all Marine Conservation Zones (MCZs). The cost estimates have been revised following the consultation based on updated assumptions regarding the proportion of Marine Conservation Zones where the use of MDGs is already likely to be prohibited as part of the baseline scenario. Improvements have also been made to the assumptions about the impact this kind of measure could have on displacement of fishing activity to other areas[102]. Total costs could therefore range from approximately £83K to £232K in loss of profitability, per year, implying costs of £622K-£1.7m over the appraisal period[103].

[102] Please refer to the Business as Usual report for more information

[103] This analysis in the Cefas CBA report 2012 has been revised to reflect updated assumptions. For the purposes of this measure it is assumed that use of mobile demersal gears is banned in all proposed Marine Conservation Zones. In reality decisions about which management measures are necessary to protect MCZs will be based on the individual conservation objectives of the site. The report uses proposed Marine Conservation Zones in non-Scottish UK waters as representative areas of the seabed. Costs have been estimated on the following basis:

- Estimates of the level of fishing effort and value of landings from use of Mobile Demersal Gears in the proposed MCZs.
- Assumption that under a ban, 75% of this activity would continue elsewhere in UK waters, and 25%- would cease to occur altogether (would be lost to the economy). These assumptions have been improved following the consultation based on the advice of experts in Cefas.

The impacts are assessed relative to a baseline which assumes that the use of MDGs would be prohibited in 50% of MCZs. This may not be realistic given the ongoing process of CFP reform, but is a necessary simplification for this analysis. There may be also be additional costs relating to impacts on the landings of MDG vessels and on the entire fishing industry, which is not captured in the data used for this analysis.

Modification of fishing gear most damaging seabed[104]
This measure would involve alterations to mobile demersal gear, rather than completely prohibiting it as considered above. This kind of measure could help to reduce impacts on seafloor habitats not just within MPAs, but potentially over a much wider area. Both the costs and benefits of this measure would be expected to be lower than those of a ban. Benefits would be lower because disturbance to seabed habitats would still take place. Costs would be lower because the reduction in GVA from the fishing industry would be expected to be smaller. However, the one-off costs of changing fishing gears could be significant, particularly if undertaken over shorter timescales than existing cycles of reinvesting in fishing gear. It should be noted that the relatively high cost of fuel is already encouraging a transition to lighter towed gears. For example, Dutch and UK beam trawlers have been experimenting with electronic pulse trawls (which are more fuel-efficient and less damaging to the marine environment). These have been found to reduce fuel costs by between 20% and 40%, discards by 20%, by-catch by 80% and the costs of the crew processing the catch by 50%. The cost of converting a traditional beam trawler to pulse trawling is estimated to be around £300,000. So far three of the UK beam trawl fleet have converted.

Use of less destructive fishing gear[105]
It has been difficult to cost this measure without a specific description new gear types. Further qualitative description of the costs has been provided under D3 (see p.67, Table 9).

Monitoring costs
An initial estimate of additional monitoring costs for rock and reef habitats is as follows, but it should be noted that some, if not all, of this monitoring is likely to be needed anyway to meet the requirements of the Habitats Directive[106]:
£250-500k pa for operational ship based monitoring of deep sea biogenic structures.
£80k pa for rotation density assessment programme of rock and biogenic reef.

It has not been possible to estimate the costs of additional monitoring programmes for sediment habitats at this stage due to a significant number of uncertainties about the way in which they will be developed.

The actual monitoring costs for both rock & reef and sediment habitats will also be highly dependent on the design of monitoring (e.g. how regular or spatially intense it is). Work is on going to determine how MSFD monitoring can be designed to focus on areas at and how the use of resources can be optimised through sharing of facilities (e.g. ship). The need to develop a properly informed basis for these approaches will mean that monitoring programmes will be established in a staged approach with it not being possible to establish effective monitoring of some aspects until after 2014.

SUMMARY

Potential costs to business – Costs to business from prohibiting the use of MDGs in a proportion of MPAs in terms of loss of GVA is estimated to be £622K-£1.7m over 10 years. Modification of gear to reduce damage to the seabed is likely to cost less than prohibiting the use of gear and there could also be fuel savings to vessel owners, reducing the net costs. All these costs are likely to fall on small businesses as these fishing enterprises tend to be small.
Potential costs to government – costs to Government from monitoring rock & biogenic reef

[104] Information on this measure is taken from the Cefas CBA Report 2012, although additional information has been added. Cost estimates are provided by the Dutch industry.
[105] Information on this measure is taken from the Cefas CBA Report 2012.
[106] Cefas CBA Report 2012, pages 243

habitats are estimated at £2.5m-£4.3m over 10 years. However, it should be noted that a significant proportion of these costs are likely to be incurred anyway under the Habitats Directive, so are not entirely additional under MSFD. To provide a rough scale of costs scenarios of apportioning 10% and 30% of the costs to MSFD have been considered. This implies that the costs to MSFD range from between £247K-£1.3m over the appraisal period. Costs to Government for monitoring sediment habitats cannot be estimated at this time.
Total potential costs – Total costs are likely to be moderate. The total monetised costs are £870k-£3.04m over the appraisal period.

KEY RISKS AND ASSUMPTIONS

Rock and reef
The analysis above assumes that the existing policies in the baseline (e.g. Habitats Directive,) will address the pressure on those rock & biogenic reef habitats and sediment habitats which are covered by the Habitats Directive.
Some significant assumptions have been made in developing cost estimates for the illustrative measure of a prohibition on the use of MDGs in MPAs, particularly in relation to displacement of fishing activity. The modelling assumes that under this measure, 75% of this activity would continue elsewhere in UK waters, and 25% would cease to occur (would be lost to the economy). There are quantitative gaps in the costs assessment of the remaining measures and qualitative information is provided to fill these gaps. For the measure on modification of fishing gear most damaging to the seabed, it has been assumed that costs to the fishing industry would be lower than for a prohibition in the use of MDGs in MPAs because the implied changes in fishing practices are less significant and could be fitted into the existing cycle of replacing fishing gear. These costs are also likely to be lower due to behaviour changes already happening in the fishing industry brought about by the need to be more fuel efficient.
In relation to monitoring costs for rock & biogenic reef habitats it is unclear what proportion of costs should be attributed to MSFD and what proportion to the Habitats Directive. Two scenarios have been considered – with 10% and 30% of the costs being apportioned to MSFD. These are scenarios rather than informed estimates.

Table 8 – Targets for pelagic habitats (Descriptors 1, 4 and 6)	
TARGETS	
Targets – Habitat distribution	At the scale of the MSFD sub-regions , distribution of plankton community is not significantly adversely influenced by anthropogenic drivers, as assessed by indicators of changes in plankton functional types (life form) indices.
Targets – Habitat condition	At the scale of the MSFD sub-regions, condition of plankton community is not significantly adversely influenced by anthropogenic drivers.
Targets – Ecosystem structure	At the scale of the MSFD sub-regions, structure of plankton community is not significantly adversely influenced by anthropogenic drivers, as assessed by indicators of changes in plankton functional types (life form) indices.
Targets – Abundance/distribution of key species/trophic groups	At the scale of the MSFD sub-regions, abundance/distribution of plankton community is not significantly adversely influenced by anthropogenic drivers, as assessed by indicators of changes in plankton functional types (life form) indices.
Targets – Condition of the benthic	At the scale of the MSFD sub-regions, condition of the meroplanktonic (plankton with benthic life phase) community is not significantly adversely

community	influenced by anthropogenic drivers, as assessed by indicators of changes in plankton functional types (life form) indices.

ASSESSMENT OF COSTS

The key anthropogenic pressures on pelagic habitats are considered to be fishing and eutrophication. No additional measures are considered necessary in relation to eutrophication. In relation to fisheries, the targets for Descriptor 3 (commercial fish) will play a role in supporting the achievement of targets for pelagic habitats. Costs associated with these targets are attributed to D3 (further details on p.67, Table 10).

Monitoring costs

An initial estimate of additional monitoring costs are as follows[107]:

£72k pa for additional inshore zooplankton monitoring.

£210k pa for extension of monthly Continuous Plankton Recorder routes to fill gaps in UK waters.

SUMMARY

Potential costs to business – None – costs of D3 fisheries measures are considered on page p.67, Table 10.

Potential costs to government – costs to government from monitoring are estimated at £2.1m over the appraisal period.

Total potential costs – Costs are likely to be low. Total monetised costs are estimated to be £2.1m over the appraisal period.

KEY RISKS AND ASSUMPTIONS

For the purposes of this cost assessment it is assumed that measures necessary to achieve the targets for Descriptor 3 (fisheries) and Descriptor 5 (eutrophication) would be sufficient to achieve the targets for pelagic habitats. The costs of those measures are attributed to D3 and D5 in order to avoid double counting. This assumption is based on scientific understanding of the key human pressures on pelagic habitats, but given the uncertainties in knowledge of pelagic ecosystems it may prove to be inaccurate.

Descriptor 2 – Non-indigenous Species

Background

148. It is widely accepted that one of the greatest threats to biodiversity across the globe is posed by non-indigenous species (NIS) which become invasive, known under the Convention on Biological Diversity as invasive alien species (IAS). Globalisation and a growth in trade and tourism have greatly increased the human-assisted movement of species over vast distances to new habitats where they may become invasive. It has been estimated that damage caused by terrestrial and marine invasive species worldwide amounts to almost five percent of the world economy[108]. The cost to the British economy alone is estimated to be £1.7 billion per annum[109] and is predicted to increase exponentially[110].

149. Invasive NIS may alter ecosystem processes[111], decrease native species abundance and richness via competition, predation, hybridization and indirect effects[112], change community structure[113] and alter genetic diversity[114].

[107] Cefas CBA Report 2012, pages 243.

[108] Defra, (2008) The Invasive Non-Native Species Framework Strategy for Great Britain

[109] Williams, F. et al (2010) The Economic Cost of Invasive Non-Native Species on Great Britain. This includes terrestrial, freshwater and marine IAS.

[110] Institute for European Environmental Policy http://www.ieep.eu/work-areas/biodiversity/invasive-alien-species/

[111] Raizada, P., Raghubanshi, A.S., & Singh, J.S. (2008) Impacts of invasive alien plant species on soil processes: a review.

150. There is currently insufficient information to be able to properly assess NIS abundance and distribution in the marine environment. For IAS in particular, a lack of data on their abundance, distribution, introduction routes and ability to survive in new environments has resulted in limited assessment of their impacts. However, invasive NIS are already present in the marine environment and it should be recognised that these generally cannot be removed. GES for NIS in UK waters can therefore best be achieved by reducing the risk of new introductions and taking measures to manage newly established invasive NIS where feasible and cost effective.

151. The UK characteristics of GES for this Descriptor are as follows:
- The risk from pathways and vectors which facilitate the introduction and spread of NIS as a result of human activities is significantly reduced, leading to a reduction in the risk of introducing new species some of which may have adverse impacts.

Option 0 - Baseline Scenario

152. The BAU report 2012 concludes that by 2020 there will still be significant issues presented by invasive NIS and that these are unlikely to be resolved by 2030. The main anthropogenic activities that contribute to the introduction of NIS are maritime transport (both commercial and recreational) and aquaculture. Boats and ships may transport NIS either in ballast water or as biofouling (i.e. attaching to hulls, anchor chains and other parts of the vessel). Aquaculture activities can also cause unintended introduction of NIS when transporting species intended for cultivation. Whilst these activities are likely to increase over the next twenty years, there has also been an increase in the number of controls over these activities. In addition, climate change may create conditions which are more suitable for non indigenous species to establish themselves in UK waters[115].

Option 1 – GES Targets

153. Due to the lack of information on current abundance, distribution and impacts of IAS, and the very high costs and lack of feasibility associated with widespread management or eradication programmes, the targets for this Descriptor are operational targets, focused on:
- Taking measures to reduce the risk of introduction and spread of NIS (by managing key pathways and vectors more effectively), and;
- Putting in place management plans for dealing with key high risk species should they arrive in UK waters.

154. The targets are based on the advice in the Cefas CBA Report 2012[116], but the full range of targets proposed in that report has not been put forward in this impact assessment because several of them were felt to need significant further development work before they could be implemented. An additional operational target has also been developed by policy makers: 'Species specific action plans are developed for key high risk marine non indigenous species by 2020'. This is based on Cefas advice that efforts should focus on reducing the impact of

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[112] Gaertner *et al*., (2008) Understanding biodiversity consequences of habitat change, *Journal of Applied Ecology* **45** pp883-893.

[113] Hejda *et al* (2009) Impact of invasive plants on the species richness, diversity and composition of invaded communities, *Journal of Ecology*, **97** pp 393-403.

[114] Ellstrand, N.C., & Schierenbeck, K.A. (2000) Hybridization as a stimulus for the evolution of invasiveness in plants? *National Academy of Sciences USA* **97**, pp 7043-7050.

[115] BAU Report 2012, ABPmer.

[116] Cefas CBA Report 2012, section 2.1.

NIS through the implementation of effective management measures, but the target proposed by Cefas has been changed to make it more specific.

155. The abundance, distribution and numbers of new introductions of NIS in high risk areas and hotspots of introduction (e.g. ports) will also be monitored as a surveillance indicator. This will allow assessment of whether measures to reduce the risk of new introductions are succeeding and would give useful information about which pathways and vectors of introduction may need additional management. It will also help to develop a baseline for NIS in high risk areas which could be used to develop a more specific, quantitative target for the next cycle of the Directive in 2018.

156. The proposed targets and surveillance indicator are in line with the Invasive Non Native Species Framework Strategy for GB[117] approach of (i) prevention, (ii) early detection and rapid management (including eradication where feasible) of new threats; and (iii) longer term containment and management of established IAS. This approach derives from the Guiding Principles on Invasive Alien Species agreed globally under the Convention of Biological Diversity and should also align with the approach taken by the European Commission in its forthcoming EU strategy on Invasive Alien Species Strategy (which is expected to emerge in late 2012 as a proposed new EU Directive).

157. Some statutory and voluntary measures are already in place to manage the key pathways and vectors of introduction of NIS, including controls on aquaculture and shipping. Legislation is also in place to prevent the movement of NIS through aquaculture operations and ban the deliberate release of NIS into the wild[118]. Most measures to reduce the risk of introductions of NIS need to be implemented at an international scale (e.g. through the International Maritime Organisation) to ensure success across the region. A range of possible illustrative measures are costed in Table 9 below. These have been updated based on the conclusions of a recent report carried out by the Cefas which analyses the key pathways and vectors of introduction and spread of NIS and uses modelling to identify the highest risk locations across the UK[119].

158. Development of action plans for key species is something which has already been committed to in the Invasive Non Native Species Framework Strategy for GB and action plans for certain species have already been developed. However, very few marine species have been covered so far and this activity would need to be expanded to cover key marine species between now and 2020, implying additional costs for those developing and implementing the plans.

159. The targets and indicators would also result in additional monitoring costs to government and regulators - primarily related to monitoring the abundance and distribution on NIS in high risk locations (e.g. ports).

Table 9 – Targets for non-indigenous species (Descriptor 2)
TARGETS

[117] https://secure.fera.defra.gov.uk/nonnativespecies/downloadDocument.cfm?id=99

[118] Section 14 of the Wildlife and Countryside Act (1981), The Conservation of Habitats and Species Regulations (2010), and the Offshore Marine Conservation Regulations (2009).

[119] Peace, F.Peeler, E. and Stebbing P.D. (2012). Modelling the risk of the introduction and spread of non-indigenous species in the UK and Ireland. Cefas report.

Targets - Abundance and state characterisation of non-indigenous species	Reduction in the risk of introduction and spread of non native species through improved management of high risk pathways and vectors. Indicator looking at the abundance, distribution and numbers of new introductions of NIS in areas which are at a high risk of new introductions (with a view to being able to develop a baseline for the rate of establishment of new NIS).
Targets – Environmental impact of invasive non-indigenous species	Action plans are developed for key high risk marine non indigenous species by 2020.

ASSESSMENT OF COSTS

Based on a study assessing the high risk pathways and vectors of introduction, together with an analysis of the risk regarding the potential establishment and spread of species, a number of illustrative management measures have been identified:

Commercial Shipping

From initial research the key pathways of introduction identified with regard to large commercial vessels which travel vast distances are through ballast water exchange and biofouling of hulls:

Management of ballast water in large vessels[120]

The International Maritime Organization (IMO) Ballast Water Convention is considered to be the main driver for action to improve management of ballast water[121], and appropriate management measures for ballast water (e.g. onboard ballast water treatment systems) will need to be implemented internationally to ensure their success. For this reason, no additional measures relating to ballast water for commercial shipping are considered necessary as a result of MSFD. This assumption has been changed compared to the consultation IA (where this measure was costed and included in the overall cost summary) due to improved information about the direction the IMO is taking in relation to action on ballast water.

Management of hull cleansing for large vessels[122]

As with ballast water management, finalisation of current IMO work on biofouling[123] will form the basis of management of NIS introductions from this pathway. Although not fully developed, additional measures could include more extensive record keeping and monitoring, prevention of in-water cleaning, and more regular on-shore cleaning of vessels using bio-secure methods.

[120] This measure is taken from the Cefas CBA Report 2011 (see Appendix 13, Section 5.1, page 263), but has been further developed following discussions with DfT.

[121] Before the IMO Ballast Water Convention is enters into force existing IMO guidelines will be crucial in tackling the movement of NIS in the marine environment.

[122] This measure is based on information in the Cefas CBA Report 2011 (see Appendix 13, Section 5.1, page 263), but has been significantly amended following discussions with the Maritime and Coastguard Agency, such that it is only applicable to large vessels and guidance is developed via an IMO convention.

[123] Biofouling is the gradual accumulation of waterborne organisms on the surface of structures in the water, such as a ship's hull or mechanical equipment.

However, as the development of these management measures is already being driven by the IMO they are not considered as additional costs under the MSFD. This assumption has been changed compared to the consultation IA (where this measure was costed and included in the overall cost summary) due to improved information about the direction the IMO is taking in relation to action on ballast water.

Fishing and Recreational vessels

From initial research, the highest risk pathway regarding the introduction and/or spread of NIS within the fishing and recreational fleet has been identified as biofouling.

Additional hull cleansing and biosecurity measures in marinas[124]

Biofouling of vessels' hulls is considered to be a key way in which NIS are spread around the UK. Fishing and recreational vessels tend to be treated for biofouling either by scrubbing the hull whilst the vessel is in the water or by removing vessels from the water, to improve the vessel's operational performance and extend the life of the antifouling system (antifouling paint). This potential measure would involve improving the hull cleansing facilities available in marinas that are at a high risk from introduction of non-native species being transported by recreational vessels. This kind of measure would help limit the introduction and spread of NIS from high risk to medium/low risk areas. Based on an assessment carried out by Cefas, 52 marinas have been identified as being potentially at the highest risk[125]. There are a number of hull cleansing facilities available, ranging from low cost provision of scrubbing equipment (up to £0.5k[126] spread over 10 years), to high-cost closed loop cleaning systems (£50k-£200k for dry dock closed loop facilities, and up to £400k for closed loop in water cleaning[127]). The type of facility which needs to be implemented will vary from marina to marina depending on the design of the marina and the risks in that particular area. For the purposes of this assessment in order to calculate overall costs to marinas of establishing such facilities a cost range of £0.5 to £200k over 10 years (2016 -2025) has been used, based on advice that very few marinas would need to implement the more expensive in-water facilities. This would result in total potential costs to marina operators of £19.5K to £9m over the appraisal period. It should be noted that it is very unlikely that actual costs would reach the upper end of this range, because the higher cost facilities are not likely to be needed in the majority of marinas.

Voluntary code of practice for the recreational fleet for limiting the spread of NIS

There are a number of examples of voluntary Codes of Practice which act as 'toolkits' and guidance to recreational users. Examples include the Invasive Species Ireland Water Users Code of Practise[128] and the Scottish Code of Practice on Non-Native Species[129], which can reduce the introduction and movement of NIS. Codes of Practice are usually developed through Government together with industry, relevant stakeholders and key experts, and proposals formally presented in

[124] This measure is taken from the Cefas CBA Report 2011 (see Appendix F, page 41), but has been further developed following discussions with DfT.

[125] This is based on an assessment carried out by experts in Cefas. The criteria used to identify the highest risk marinas were: Usage (marinas identified as having heavy use); Size (marinas with 100+ berths); Proximity (marinas that are within 150km of a foreign land mass). The analysis covered RYA marinas for Northern Ireland, Wales, Scotland and England.

[126] Estimated by policy makers based on the costs of providing brushes, scraping equipment etc.

[127] http://sealift2.com

[128] http://invasivespeciesireland.com/wp-content/uploads/2010/07/Water_Users_CoP.pdf

[129] http://www.scotland.gov.uk/Topics/Environment/Wildlife-Habitats/InvasiveSpecies/legislation/CodeofPracticeonNonNativeSpecies

a Government Consultation. This measure would involve extending the use of such codes of practice. There could be some additional time costs to Government, regulators and industry in developing codes and ensuring compliance. There could also be additional costs to vessel owners depending on the kind of measures recommended.

Measures to limit the spread of NIS from aquaculture[130]

There is existing legislation that covers NIS in aquaculture their movement. However, in UK there is no overarching code of practice for the aquaculture industry controlling the movements of native species in order to limit the spread of NIS. There would be additional costs to industry, Government and regulators if measures were to be put in place to reduce the risk of the transfer of NIS by aquaculture practices. One way of achieving this would be to require aquaculture businesses to include specific assessment of the risks of NIS introduction within existing Biosecurity Measures Plans (BMP). These plans, which currently only cover introduction and spread of pathogens, are already a requirement under the Aquatic Animal Health Regulations. Costs to business would be relatively low in addition to existing enforcement costs. Costs to business would vary, but would be likely to be relatively low for most businesses because of the significant overlaps between biosecurity measures for pathogens and NIS.

Education and awareness

General (large scale) awareness campaigns

Raising public awareness could be used as a management tool to help educate the general public. Large awareness campaigns are aimed at behavioural change relating to NIS and the introduction and spread of such species. A number of current examples include the Be Plant Wise and the Check, Clean, Dry campaigns. These types of campaigns cost between £20K-200K (one off cost) depending on the coverage, and could be used to promote some of the measures set out above. Assuming one large scale campaign is carried out the costs would be between £20k-£200k (one off cost).

Species specific campaign

If a particular species has been identified as having an adverse impact, awareness campaigns could be considered as a potential measure to reduce the threat of spread, to contain the species and raise awareness. This type of education is approximately £3k[131] per species, per campaign, based on developing factsheets and promoting general awareness of the risk posed by a particular invasive species. In most cases this kind of measure would be carried out as part of the measure on species specific action plans set out below and therefore this has not been costed separately.

Risk management assessment and development of action plans for key high risk species

Risk management assessments (RMA) are conducted to consider the risk posed by specific species. These can be used to aid prioritisation, to help enable effective rapid responses and for underpinning decision-making. Risk assessments are advisory and therefore are part of the suite of information on which policy decisions are based. Risk management assessments range between £2K - £30K per assessment, depending on the level of detail in the study.

If a species is considered a high risk to native biota (based on the RMA) Invasive Species Action Plans (ISAPs) are developed. The development of an ISAP costs £2K per plan. The actions identified in the action plans could also imply additional costs for both stakeholders and regulators - the costs will vary depending on the actions that are identified. As an example, the types of

[130] This measure is based on information in the Cefas CBA Report 2011. See Appendix F, page 43-44.

[131] Species specific awareness campaigns would include the development of identification sheets/alert posters, alerts posted on the GB Non Native Species Secretariat website and hard copies of information sent to relevant stakeholders,

actions recommended in a recent plan for Water Primrose included increased public awareness raising, additional monitoring and eradication in certain locations. Eradication is likely to be the most costly action, for example CCW will again attempt to eradicate the Carpet Seasquirt (Didemnum vexillum) from Holyhead harbour at a cost of £420K over 3 months after an unsuccessful 8 month eradication project[132].

Both RMAs and ISAPs are already undertaken through the Invasive Non Native Species Framework Strategy for GB and are included within the baseline. However, as MSFD is likely to raise the level of effort needed to identify and manage NIS it has been assumed that MSFD could drive the development of 2 additional 2 RMAs and ISAPs[133]. Costs to government agencies for the development of 2 RMAs will range between £4K-60K for the period, and the estimated costs of developing 2 ISAPs will be approximately £4K over the same period. This implies £6.9K and £55.7K over the appraisal period.

Monitoring costs

Some additional monitoring costs to government and regulators are also expected. Existing monitoring programmes could be adapted to include sampling for NIS species. Additional monitoring at high risk/hot spot areas of introduction will be needed. This type of assessment may form part of the larger ports exemptions from the IMO requirements as part of an ecological assessment, although these requirements are not yet finalised. Additional monitoring may also be required for the species specific action plans, but these will be reviewed and developed on a case by case basis. It has not been possible to provide estimates for any additional monitoring required at this stage.

SUMMARY

Potential costs to business – The illustrative measures presented above are based on initial research into the high risk pathways and vectors aiding the introduction and spread of NIS. It has not been possible to monetise these costs and they would, in any case, depend on which measures are ultimately taken forward. Measures for additional hull cleansing and biosecurity facilities in marinas would lead to additional costs to marina, port and vessel owners estimated at between £19.5k and £9m over the appraisal period. There could be potential additional costs to the aquaculture industry of measures to limit the spread of NIS from aquaculture, although these are thought to be relatively low if existing Biosecurity Measures Plans were used. There could also be potential additional costs to vessel owners from codes of practice for recreational vessels. All of these measures could impact small businesses such as small marinas, yacht charter businesses, small aquaculture businesses etc.

Potential costs to government – Additional costs to Government will depend on which measures are actually taken forward. Potential costs to Government of additional educational campaigns and development of additional Risk Management Assessments and Species Action Plans are estimated at between £24.4k-£230k over the appraisal period. Measures to develop voluntary codes of practice for recreational vessels and measures to limit the spread of NIS from aquaculture would also involved additional costs to Government, but it has not been possible to cost these. There are also likely to be costs to Government of additional monitoring.

Total potential costs – Costs could potentially be moderate. Total monetised costs are £44k to £9.3m over the appraisal period.

[132] Rohan Holt and Ashley Cordingley, 'Eradication of the non-native carpet ascidian (sea squirt) Didemnum vexillum in Holyhead Harbour: Progress, methods and results to spring 2011.'

[133] For the purpose of costing this illustrative measure it has been assumed that MSFD would drive the development of 2 additional Risk Management Assessments and Action Plans. This is based on the fact that 3 Risk Management Assessments and 1 ISAP have been developed over the period 2007-2012 under the GBNNSS, and the presumption that additional monitoring will highlight more invasive species in the marine environment over that period.

KEY RISKS AND ASSUMPTIONS
Assessment of the potential measures needed to achieve GES for this Descriptor are very challenging because of uncertainty about future risks posed by NIS. The cost analysis for the different measures makes a number of specific assumptions which are set out in the footnotes. Several of the assumptions are based on advice from policy experts in Defra, DfT GBNNSS and the MCA. For the measure on additional hull cleansing and bio-security in marinas it is considered very unlikely that actual costs would reach the upper end of the range presented here, because the higher cost facilities are not likely to be needed in the majority of marinas.

Descriptor 3 – Commercially exploited fish and shellfish

Background

160. MSFD requires commercially exploited fish and shellfish to be within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock. This means that commercial species will be exploited sustainably (consistent with the highest sustainable long term yield), species will have adequate reproductive capacity for replacement (able on average to reproduce at least once before being caught) and that stocks will have an age and size distribution that avoids impaired recruitment.

161. Although, there has been a substantial increase in the number of fish stocks that are harvested sustainably over the period 2000 -2010, a significant proportion of indicator stocks (>60%) continue to be harvested at rates that are unsustainable and/or have reduced reproductive capacity. Further reductions in fishing pressure on approximately half of stocks in UK waters would be needed to ensure levels expected to provide the highest long term yield.

162. The CFP is the principle legal mechanism for managing fish stocks in EU waters, ensuring consistency across Member States. Although for some nationally important species national or local management measures exist, the achievement of Maximum Sustainable Yield (MSY)[134] is largely dependent on the success of the fisheries management measures that will be determined and agreed under the reformed CFP[135].

163. The UK is an international leader in the field of fish and shellfish stock assessment and is able to draw on extensive data sets, some dating back over 100 years for a number of species. In more recent times, the EU Data Collection Framework[136] has standardised data collection requirements across the EU.

164. The UK characteristics of GES for this Descriptor are as follows:

- The level of stock mortality generated by fishing activity (F) is equal to or lower than Fmsy - the level capable of producing Maximum Sustainable Yield (MSY). The spawning stock biomass is within safe biological limits and all stocks are sustainably exploited.

[134] Maximum Sustainable Yield, or MSY, is the largest average catch that can be taken from a particular fish stock for an indefinite period i.e. without threatening its long-term viability.

[135] The Common Fisheries Policy (2002, and due for revision in 2012) is the EU's instrument for the management of fisheries and aquaculture. It is highly centralised with EU Ministers making decisions each year on catch limits on 'quota' stocks and related measures such as the time fishermen can spend at sea. The CFP also provides financial support through the European Fisheries Fund as well as providing the regulatory framework for monitoring, control and enforcement.

[136] Council Regulation (EC) No 199/2008 concerning the establishment of a community framework for the collection, management and use of data in the fisheries sector and support for scientific advice regarding the CFP.

Option 0 – baseline scenario

165. For the purposes of the baseline scenario it is particularly difficult to distinguish how far the achievement of the proposed targets is additional due to MSFD and how much would be achieved anyway as a result of pressure to improve the environmental outcomes of the CFP. The UK would be pursuing environmental integration as one of its goals for CFP reform irrespective of the MSFD. It could, therefore, be argued that from the UK's perspective all costs and benefits of achieving the targets proposed for this Descriptor should be included within the baseline. However, it is unlikely that the wider EU approach to CFP reform would deliver the outcomes the UK is seeking without the added pressure for environmental outcomes provided by MSFD. For this reason for the purposes of this impact assessment we have assumed that 25% of the costs and benefits of achieving the proposed targets are attributable to MSFD – these are described in more detail in Table 10 below.

Option 1 – Target Proposals

166. Fish stock management within the CFP currently utilises "safe biological limits" within the Precautionary Approach (PA). These limits are defined in terms of thresholds for the upper level of fishing mortality and lower level of (adult) spawning stock biomass. This prevents high levels of fishing mortality reducing stock size and impeding reproductive potential. Where possible, scientific evaluation of each stock's status relative to its safe biological limits is published annually by the International Council for the Exploration of the Sea (ICES) – based on information provided by Member States' scientific authorities. ICES also provide an assessment against more ambitious stock specific targets for fishing mortality rates to achieve high levels of average yield.

167. For this Descriptor it is proposed that MSFD targets are based on the achievement of stock specific targets for fishing at levels consistent with the Maximum Sustainable Yield (MSY). Achieving a fishing mortality rate of MSY for all stocks is considered to be equivalent to safe biological limits, while also reducing fishing pressure on the wider ecosystem[137].

168. The UK Government has accepted the principle of MSY under a number of different commitments including the World Summit on Sustainable Development (WWSD). For this Descriptor the UK will consider all stocks for which the UK has an obligation to provide information under the Data Collection Framework. Currently ICES provides assessments in relation to MSY or alternative sustainability criteria for a subset of these stocks, based on available data. For those stocks considered to be data poor, ICES has developed a series of data limited approaches which have been implemented in the 2012 catch advice.

169. There is also good alignment with other Member States and recent ICES advice on methodologies for GES targets for commercial (shell)fish has provided further consistency in approaches.

170. Delivering the GES targets for this Descriptor will, with the exception of measures for most shellfish species (with the exception of nephrops) and other stocks where there is some scope for national measures, be dependent on the success of fisheries management measures that will be determined and agreed under the reformed CFP. The targets for this Descriptor reflect the UK's approach to CFP reform and the achievement of sustainable stock levels.

171. For shellfish, as most commercial species (all except nephrops) are not managed directly through the CFP, we have considered the potential costs of other measures which could be

[137] More information on the proposed approach can be found in the Cefas CBA Report 2012, Section 2.2

taken on a national or more local basis; e.g. technical conservation[138], national limits on landings, use of less destructive gear and the protection of key shellfish life stages.

172. No new monitoring programmes will be required in relation to stocks already covered by the EU Data Collection Framework. There could however be some additional monitoring and assessment costs in relation to shellfish stocks (e.g. for scallops, crab and lobsters) to ensure accurate assessments can be made.

Table 10 – Targets for commercial fish and shellfish (Descriptor 3)	
TARGETS	
Targets – Fishing Mortality	The exploitation of living marine biological resources restores and maintains populations of harvested species at least at levels which can produce MSY. This exploitation rate shall be achieved by 2015, where possible, and by 2020 for all stocks at the latest. The exploitation rate of each stock is either at or below F_{MSY}, or within the range of plausible fishing mortalities consistent with $F_{MSY.}$ Where data does not allow FMSY, or FMSY proxies, to be calculated exploitation of each stock will be based on the precautionary approach with limits defined by agreed proxies for sustainable exploitation.
Targets – Reproductive Capacity of Stock	The reproductive capacity of the stock shall be maintained at, or above levels that will support the long term exploitation of stocks at F_{MSY}, as indicated by spawning stock biomass of all stocks being above Bpa.
ASSESSMENT OF COSTS	
A range of potential measures are likely to be necessary to achieve the proposed targets. Many of these would need to be taken through the CFP and they are in line with the UK's position on CFP reform. It has not been possible to identify how far these measures should be seen as additional under MSFD, but MSFD is considered to be one of the key drivers of environmental integration in the reformed CFP. For this reason all potential additional fisheries measures are covered here for the sake of simplicity, even though it is acknowledged that the CFP is the primary delivery mechanism: **Technical measures**[139] Technical measures are a catch-all term for the whole range of rules governing how and where fishers may fish. Technical measures include minimum/maximum landing sizes, minimum mesh sizes for nets, closed areas and seasons, limits on bycatch, requirements to use more selective fishing gear etc. Technical measures will be delivered through the CFP. Beyond the CFP, national measures (for shellfish excluding nephrops) such as increasing the minimum and maximum landing sizes for crustaceans within certain areas can be taken. In the consultation IA the potential costs of applying these kind of measures in Marine Protected Areas were calculated. However, since the consultation it has become clear that these measures would already be taken (if needed) under the baseline scenario, and hence there will be no additional cost to MSFD.	

[138] For instance changes to fishing gear and minimum and maximum landing sizes.

[139] This measure is based on information in the Cefas CBA Report 2012, but has been further developed with a specific costed example for shellfish.

Use of less destructive gear [140]

A move towards less destructive gear should provide greater protection to habitats as well as having a positive impact on the health of many stocks. Fishing gear is extremely costly, and although there is a need to replace or repair gear through natural wear and tear, fishermen would not routinely change major items of equipment (such as trawl nets) regularly. There would be some additional cost for improvements to the selectivity of gears e.g. by adding a square mesh panel. There would be significant additional costs to fishermen to completely replace equipment, such as replacing the whole net to increase the mesh size overall, or to change the type of gear they use e.g. move from beam trawling or scallop dredging to less destructive fishing gear. In addition, the improved selectivity could detrimentally alter the catch levels of fishermen (or their species composition). It has not been possible to quantify the cost of this measure.

Limit on landings [141]

Limitations of this sort are an important additional measure which can be applied at national level, particularly for national important stocks which are not covered by the CFP. For fish and shellfish stocks which are covered by the CFP, most species are already subject to catch controls – although these may need to be more stringent to enable the GES targets to be met. This is in line with the UK approach to CFP Reform. Costs of such a measure in terms of decreased landings due to catch controls are assessed under the benefit section (section E) – the benefits modelling looks at net benefits of achieving MSY which implies netting off the costs of lower landings during initial years (when fishing effort is controlled) from the benefits of higher landings in later years (due to recovery of stock to MSY levels).

Measures to protect key shellfish life stages [142]

This relates primarily to a prohibition on the landing of certain crustaceans when they are ovigerous (carrying or bearing eggs). There are already such measures for crabs nationally and lobsters in some Inshore Fisheries and Conservation Authority (IFCA) areas (0-6nm of English coast). Further measures to protect the landing of ovigerous lobsters nationally could increase the long term benefit for all lobster fishermen. Since this measure would only effectively extend the scope of the controls (i.e. applying them beyond those IFCA areas) the costs to business and government are likely to be low, but then the marginal increment to benefits in the short term is also likely to be low.

Monitoring and enforcement costs [143]

Some additional monitoring costs are likely in relation to shellfish stocks, although these are anticipated to be relatively small.

No additional monitoring costs are anticipated in relation to CFP stocks.

There are also potential additional enforcement costs (additional for shellfish, incremental for CFP stocks). To provide very rough estimate of enforcement costs, estimates in the MMO's business plan have been used. They have projected c£200K increase between 2011 and 2013 and hence we assume the additional costs of CFP reform (and MSFD) will be £100K per annum[144].

SUMMARY

[140] This measure in based on information in the Cefas CBA Report 2012, but has been developed further.

[141] This measure is based on information in the Cefas CBA Report 2012, Appendix 13.

[142] This measure is based on information in the Cefas CBA Report 2012.

[143] Cefas CBA Report 2012, p.246

[144] This has been simply arrived at by dividing the £200K figure by 2 as the increase is over a two year period (2011-2013).

Potential costs to business – Costs for changes in fishing gear and landing sizes for shellfish are not additional (as these measures are already included in the baseline). The costs of measures relating to restrictions on less destructive fishing gear are likely to be low if the need to replace or repair gear is through natural wear and tear, but could have significant cost implications for fishermen who have to switch gears outside the natural gear replacement cycle. Also, gear changes might also have negative implications for catch levels. Limits on lands will have cost implications for fishermen, but these costs are included as a part of the benefit assessment and not presented separately here. Measures to protect shellfish life stages are likely to have low incremental costs for business. Most of these costs will fall on small businesses as fishing enterprises tend to be small and medium scale. **Potential costs to government** – There are not ikely to be any significant additional monitoring costs but there may be additional enforcement costs in the region of £861K over 10 years. However, only 25% of the enforcement costs have been attributed to MSFD as some will fall under CFP. The costs to MSFD alone are estimated at £208K over 10 years. **Others** – There are also likely to be social and distributional effects and certain fishing communities may be forced to adapt their activities if these measures were implemented. **Total potential costs** – The costs are likely to be moderate and are mostly accounted for under benefit assessment (section E). The enforcement costs are estimated to be £208K.
KEY RISKS AND ASSUMPTIONS
Most of the costs have been assessed qualitatively. The key assumption driving the enforcement cost figures is the one related to the apportionment of costs between MSFD and CFP. 25% of the enforcement costs are attributed to MSFD based on conclusions of policy experts that the majority of costs should be attributed to CFP as this is considered to be the main driver for the necessary measures.

Descriptor 5 – Eutrophication

Background

173. Eutrophication[145] is one of the major threats to the health of estuarine, coastal and shelf sea ecosystems around the world. Anthropogenic nutrient enrichment mainly from sewage and agricultural sources can result in undesirable disturbances to the balance of organisms in the marine environment, adversely affect water quality, and cause changes to the structure and function of ecosystems.

174. We have a high confidence in our assessment of eutrophication in UK coastal and offshore areas[146] due to the availability of extensive datasets and the enhanced monitoring employed in regions previously reported as being of concern.

175. The UK characteristics of GES for this Descriptor are as follows:

- Human-induced eutrophication in UK seas is minimised and all UK marine waters are non-problem areas:
    - Nutrient concentrations do not lead to an undesirable disturbance to the balance of organisms present in the water or to the quality of the water concerned resulting from accelerated growth of algae; and

[145] Eutrophication is the enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorus, causing an accelerated growth of algae and plant life which produces undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned.

[146] OSPAR Comprehensive Procedure for the identification of eutrophication status in 2007 and assessments prepared under relevant EU Directives (including UWWT, Nitrates, and Water Framework Directives).

- The direct effects of nutrient enrichment associated with algal growth do not constitute or contribute to an undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned ; and
- Indirect effects of nutrient enrichment associated with growth of macroalgae, sea grasses, and reductions of oxygen concentrations do not constitute an undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned.

Option 0 – Baseline scenario

176. The projected baseline set out in the BAU report concludes that there are few problem areas in relation to eutrophication at present and that current management measures are considered likely to be sufficient to ensure improvements in remaining areas of concern by 2020[147]. Also, it can be argued that due to the very small scale of these problem areas, eutrophication is already minimised in the relevant sub-regions. It is concluded on this basis that the UK will achieve GES for this Descriptor under the baseline scenario.

177. The targets for eutrophication reflect the conclusions above and are all based on existing OSPAR or Water Framework Directive targets and how these are used to assess eutrophication. Whilst no common targets for this Descriptor have yet been agreed by OSPAR countries, the level of ambition across these countries is similar and it is clear that the assessment criteria developed in the WFD and OSPAR will be used to determine eutrophication status.

178. It should be noted that these targets must be considered holistically, keeping in mind the overall eutrophication goal of ensuring no undesirable disturbance (adverse effects) resulting from human-induced nutrient inputs. This reflects the methodology used to determine eutrophication status under the OSPAR Common Procedure i.e. failure to meet an individual target does not, on its own, necessarily signify eutrophication problems[148].

179. The UK will utilise existing monitoring programmes under the WFD and OSPAR to meet monitoring requirements for MSFD. There are likely to be small additional monitoring costs to cover the cost of plankton related eutrophication monitoring, estimated at between £10k and £100k per annum[149]. These costs should be treated as broad initial estimates at this stage and further work is on-going to identify the best way of taking this forward linked to existing coastal water monitoring undertaken for WFD. Any measures which would be required to meet our targets for GES would already be taken under the WFD, the Nitrates Directive and the Urban Waste Water Treatment Directive; therefore our assessment is that there will be no additional cost implications from these targets beyond the additional monitoring costs mentioned above.

Table 11 – Targets for eutrophication (Descriptor 5)[150]		
TARGETS		
Commission	Non Problem Areas 2007/2010	Problem Areas 2007/2010

[147] BAU Report 2011, ABPmer, Introduction(ii)

[148] For example, it might be acceptable to have nutrient levels in the sea which exceed the target in a particular area provided that this does not lead to eutrophication effects such as elevated levels of chlorophyll or other undesirable disturbances.

[149] Cefas CBA Report 2012, page 246.

[150] These targets are assessed holistically to determine whether eutrophication is occurring. Failure with respect to any individual target does not, on its own, necessarily lead to identification of eutrophication problems.

Criterion		
Targets – Nutrient levels	No increase in the assessed dissolved inorganic nitrogen and phosphorous concentration, resulting from anthropogenic nutrient input using data from periodic surveys.	A downward trend in dissolved inorganic nitrogen and phosphorous concentration, resulting from decreasing anthropogenic nutrient input over a 10 year period.
Targets – Direct effects of nutrient enrichment	No increase in the chlorophyll 90 percentile in the growing season (linked to increasing anthropogenic input) based on periodic surveys. AND If there is evidence of human induced nutrient enrichment and accelerated growth, then: No trend in a eutrophication relevant plankton index that is attributable to increases in nutrient loading, winter nutrient concentrations or trends in nutrient ratios.	A downward trend in the chlorophyll 90 percentile in the growing season over a 10 year period (linked to decreasing anthropogenic input). AND Changes in a eutrophication relevant plankton index that is attributable to decreases in human induced nutrient loading, winter nutrient concentrations or trends in nutrient ratios[151].
Targets – Indirect effects of nutrient enrichment		WFD macroalgae and seagrass tools at good status. Oxygen (concentrations/5 percentile) in bottom waters should remain above area-specific oxygen assessment levels (e.g. 4-6 mg/l). There should be no kills in benthic animal species as a result of oxygen deficiency that are directly related to anthropogenic input of nutrients.
ASSESSMENT OF COSTS		
No measures are anticipated over those that will be taken under the WFD. Therefore there will be no additional costs above the baseline. **Monitoring costs** There are likely to be small additional monitoring costs for eutrophication related plankton monitoring – a broad initial estimate of these costs is £75k to £750k over 10 years– these costs would fall on Government and regulators.		
SUMMARY		
Potential costs to business – No additional costs **Potential costs to government** – There might be small monitoring costs of £86k-861k over 10 years. **Total potential costs** – Low. There might be small monitoring costs £75k-750k over 10 years.		
KEY RISKS AND ASSUMPTIONS		
It has been assumed that any additional measures needed to reduce eutrophication in order to		

[151] Further work required as indicator has not been tested in operation

meet these targets would be taken under existing legislation (e.g. the WFD and the Urban Waste Water Treatment Directive) and therefore the costs would not be additional to MSFD.

Descriptor 7 – Permanent alteration of hydrographical conditions

Background

180. The MSFD requires that any permanent alteration of prevailing hydrographical conditions resulting from human activities does not have an adverse effect on coastal and marine ecosystems. This Descriptor is intended to manage the potential hydrographical impacts (including cumulative and in-combination environmental effects) arising from large scale projects such as renewable energy installations, and other significant marine infrastructures.

181. Development in the coastal and marine zone can be broadly categorised into urban (e.g. housing), infrastructure (e.g. ports, harbours, navigation channels, windfarms), tourism and leisure (e.g. marinas), and resources (e.g. oil, gas, and aggregate extraction). Developments in these areas can, if poorly managed, alter hydrographical conditions, resulting in significant local scale impacts on both the coastal and marine environments. Some projects, such as large scale tidal barrages, have the potential to have broader scale impacts on hydrographical conditions.

182. Although there is the potential for developments to cause impacts due to changes in hydrographical conditions, impacts arising from marine and coastal development are currently managed through the marine licensing and consents process. All significant developments are assessed, and their potential impacts monitored, in line with the requirements of the Environmental Impact Assessment Directive, the WFD, and the Habitats Directive. In addition, Marine Plans, when in place, will provide the framework for the licensing and consents process and will be subject to the Strategic Environmental Assessment Directive.

183. The UK characteristics of GES for this Descriptor are as follows:

- The nature and scale of any permanent changes to the prevailing hydrographical conditions (including but not limited to salinity, temperature, pH and hydrodynamics) resulting from anthropogenic activities (individual and cumulative), having taken into account climatic or long-term cyclical processes in the marine environment, do not lead to significant long term impacts on those biological components considered under Descriptors 1, 4 and 6.

Option 0 – Baseline Scenario

184. The existing marine licensing and consents process, in conjunction with the requirements of the Water Framework Directive (in relation to hydromorphological conditions), the EIA Directive, the SEA Directive, and the Habitats Directive (in relation to hydrographical conditions), is likely to be sufficient to ensure that GES for this Descriptor will be achieved. Marine planning will ensure that monitoring for cumulative effects of new activities is interpreted and feeds into future licensing decisions and reviews of marine plans.

Option 1 – Target proposals

185. The target reflects the fact that we expect to achieve GES under the baseline scenario. The target requires all new developments to continue to comply with the existing regulatory regime. Guidance should be followed to ensure that regulatory assessments are undertaken in a way that ensures the appropriate consideration of any potential cumulative and in-combination environmental effects at the most appropriate spatial scales so that GES is not compromised.

186. There is a need to review the operation of the existing marine licensing regime to ensure it adequately reflects the most up to date understanding of the potential for developments to cause changes to hydrographical conditions, and guidance for developers and licensing authorities may need to be updated to reflect this. The cost of such a review is likely to be small, in the region of £20k for England. Similar assessments will be needed for the licensing regimes and relevant guidance in Scotland, Wales and Northern Ireland.

187. As the target is based on application of the existing regulatory regime there will be no additional costs to industry assuming there is currently compliance with the EIA Directive and other relevant legislation. Discussions with other Member States lead us to believe that there is a mixed approach to this Descriptor across OSPAR countries. A number of countries, such as the Netherlands, are proposing a similarly pragmatic approach to the UK, whilst others, such as Belgium, are proposing targets which would involve extensive monitoring of hydrographical conditions on a scale which would not be feasible in the UK.

Table 12 – Targets for hydrographical processes (Descriptor 7)	
TARGETS	
Targets – Spatial Characteristics of Permanent Alterations	All developments must comply with the existing regulatory regime and guidance should be followed to ensure that regulatory assessments are undertaken in a way that ensures the full consideration of any potential impacts, including cumulative effects at the most appropriate spatial scales to ensure that GES is not compromised.
Targets – Impact of Permanent Hydrographical Changes	
ASSESSMENT OF COSTS	
There will be small additional costs to regulators associated with reviewing the existing licensing regime and updating guidance to developers if necessary. Costs (in England) are likely not to exceed £20K unless significant revisions are needed. **Monitoring costs** There could be additional costs for Government and regulators in the form of monitoring in order to provide a more comprehensive understanding of prevailing environmental conditions and through the development of management and assessment tools to improve our confidence in our GES assessment i.e. the NERC shelf sea model[152].	
SUMMARY	
Costs to business – none (assuming full compliance with the EIA Directive and other relevant legislation) **Costs to government** - there will be some small additional costs for government and regulators in terms of updating the guidance (around £20K for England), and possibly additional monitoring costs to provide comprehensive understanding of prevailing environmental conditions and the further development of assessment tools. **Total potential costs** –The costs are likely to be low. A partial estimate of the costs of updating the guidance is £17.4K (discounted). There could be additional monitoring costs which have not been quantified.	
KEY RISKS AND ASSUMPTIONS	
It has been assumed that the existing licensing system will be sufficient to achieve the targets	

[152] Part of the NERC Shelf Sea Biogeochemistry Research Programme which funds further developments in modelling, observational and analytical techniques relating to Ocean Shelf-Edge Physical Exchange. Further developments of such models should help increase our ability to assess cumulative impacts.

proposed for this Descriptor.

Descriptor 8 – Concentrations of contaminants

Background

188. This Descriptor is intended to ensure the presence of contaminants in the marine environment and their biological effects are kept within acceptable limits so as to ensure that there are no significant impacts on, or risk to, the marine environment. These contaminants include synthetic compounds (e.g. pesticides, antifoulants, pharmaceuticals etc), non-synthetic compounds (e.g. heavy metals, hydrocarbons etc), and other substances considered pollutants, whether solid, liquid or gas.

189. Hazardous substances can enter the marine environment through natural sources and as a result of anthropogenic activities, either as direct inputs or via rivers, estuaries and the atmosphere. Pollution itself is considered to be the introduction of substances which have, or are likely to have, deleterious effects on the marine environment and its uses. This includes effects that result in loss of biodiversity, are hazardous to human health, impair water quality, and reduce our ability to use the sea.

190. This Descriptor is supported in the UK by a robust legislative framework from international through to national level, and appropriate consenting and monitoring programmes. There is good knowledge of contaminant levels in the marine environment, particularly in coastal and inshore areas, as a result of OSPAR and the WFD which require the monitoring of specific contaminants and compliance with specific concentration limits to prevent pollution. However, it should be noted that the WFD and the Environmental Quality Standards Directive are currently under revision, and it will be necessary to take account of the new requirements that are adopted.

191. The UK characteristics of GES for this Descriptor are as follows:

- Concentrations of contaminants in water, sediment, or biota are kept within agreed[153] levels and these concentrations are not increasing; and
- The effects of contaminants on selected biological processes and taxonomic groups, where a cause/effect relationship has been established, are kept within agreed levels.

Option 0 – Baseline scenario

192. The BAU report concludes that the effective implementation of the Urban Waste Water Treatment Directive, the WFD, the IPPC Directive, the Existing Substances Regulation and REACH are likely to ensure progress towards Good Chemical Status[154] (for priority and priority hazardous substances) and contribute to Good Ecological Status[155] (for other pollutants) for some problem areas up to 2020, with further improvements likely up to 2030 (due to provision for time limited derogations from WFD targets up to 2027)[156]. It is concluded on this basis that the UK will broadly achieve GES for this Descriptor under the baseline scenario. However, there are likely to be some areas where the measures taken to control inputs of contaminants under the above Directives will not achieve GES by 2020 due to the presence of very

[153] Agreed at a national/EU/International level e.g. within domestic legislation, Regional Seas Conventions etc.

[154] Achievement of Good Chemical Status is a requirement of the Water Framework Directive.

[155] Achievement of Good Ecological Status is a requirement of the Water Framework Directive.

[156] BAU Report 2012, ABPmer, Introduction(iii)

persistent legacy contaminants in sediments where it will not be practical or cost effective to take remedial measures and where it will be necessary to invoke the exceptions/derogations provided in the Directives.

Option 1 – GES Targets

193. The targets for contaminants reflect the fact that we expect to broadly achieve GES under the baseline scenario and they are based on existing OSPAR or Water Framework Directive targets[157] [158]. There is a high-level of regional coordination on the approach to assessment of contaminants and the coordination work undertaken within OSPAR has shown that EU Member States in the North East Atlantic will follow a similar approach to setting targets. As a result of this coordination work a new target for indicator 8.2.2 (significant pollution events) has been developed which is likely to adopted by a number of OSPAR countries.

194. Any measures which would be required to meet the GES targets for this Descriptor would already be taken under the legislation mentioned above. The only exception to this is in relation to the presence in a few areas of persistent, legacy contaminants in sediments which will not be dealt with under existing legislation. As mentioned above, measures to remove these contaminated sediments would not be practical and would be highly costly. The UK does not propose implementing these measures on the grounds that they would be disproportionately costly. Therefore, our assessment is that there will be no additional cost implications from measures associated with these targets.

195. The UK will utilise existing monitoring programmes under the WFD and OSPAR to meet monitoring requirements for MSFD. Therefore we are confident there will be negligible additional costs in terms of monitoring, although additional monitoring could be required in the future if new substances are added to priority substances lists.

Table 13 – Targets for contaminants (Descriptor 8)	
TARGETS	
Targets – Concentration of Contaminants	Concentrations of substances identified within relevant legislation and international obligations are below the concentrations at which adverse effects are likely to occur (e.g. are less than Environmental Quality Standards applied within WFD, and Environmental Assessment Criteria applied within OSPAR).
Targets – Effects of Contaminants	Biological effects - The intensity of those biological or ecological effects due to contaminants agreed by OSPAR as appropriate for MSFD purposes are below the toxicologically-based standards. Oil/chemical spills - Occurrence and extent of significant acute pollution events (e.g. slicks resulting from spills of oil and oil products or spills of chemicals) and their impact on biota affected by this pollution should be minimised through appropriate risk based approaches.
ASSESSMENT OF COSTS	

[157] For further information on the proposed approach to targets see Cefas CBA Report 2012, Section 2.5

[158] The Water Framework Directive and the Environmental Quality Standards Directive are currently under revision, and it will be necessary to take account of the new requirements that are adopted

No additional measures are anticipated. **Monitoring costs** No additional costs are anticipated at the current time, although there could be some additional monitoring costs in future if new substances are added to the list of WFD or OSPAR contaminants.
SUMMARY
No additional costs
KEY RISKS AND ASSUMPTIONS
It has been assumed that any additional measures needed to reduce contaminants in order to meet these targets would be taken under existing legislation (e.g. the WFD). The only exception to this is in relation to legacy contaminants which would not be dealt with under the baseline scenario. However, the UK would not take measures to remove contaminated sediments on the grounds that they would be impractical and disproportionately costly. For this reason it has been assumed that no additional management measures will be needed in relation to these targets.

Descriptor 9 – Contaminants in fish and other seafood

Background

196. This Descriptor is intended to ensure contaminants, specifically organic chemicals and trace metals found in fish and shellfish destined for human consumption do not exceed thresholds laid out in Community legislation or other agreements. Biotoxins[159] and microbiological contamination are not expressly included under this Descriptor, nor elsewhere in the assessment of GES[160].

197. Contaminants present in fish and other seafood destined for human consumption may arise for a number of reasons, from both anthropogenic sources (e.g. industry, sewage discharges, agriculture, aquaculture, etc) and natural sources (e.g. natural geological factors including geothermal activity).

198. The UK characteristics of GES for this Descriptor are as follows:
- Concentrations of contaminants in fish and other seafood caught or harvested for human consumption in UK seas do not exceed the relevant maximum levels listed in EU Regulation 1881/2006 (as amended)or other relevant standards and are not increasing[161].

Option 0 – Baseline scenario

199. The projected baseline set out in the BAU report concludes that effective implementation of existing directives such as the WFD, the Urban Waste Water Treatment Directive, the Shellfish Waters Directive, the revised Bathing Waters Directive, the IPPC Directive and REACH will

[159] Paralytic, Diarrhetic and Amnesiac Shellfish Poisoning toxins

[160] The ICES Task Group 9 report says “the term "**contaminants**" is interpreted as "hazardous substances present in fish as a result of environmental contamination for which regulatory levels have been set for human consumption or for which the presence in fish is relevant". In this interpretation, hazardous substances are substances (i.e. chemical elements and compounds) or groups of substances that are toxic, persistent and liable to bio-accumulate, and other substances or groups of substances which give rise to an equivalent level of concern. It also says: Although regulatory levels have been set for marine biotoxins, they are not considered as contaminants. Their presence in fish and seafood is not always linked to human activities. Harmful algal bloom events are often due to climatic and hydrographical circumstances although human induced eutrophication from domestic, industrial and agricultural wastes can stimulate harmful algae blooms. Therefore, there is not always a consistent link between the levels of marine biotoxins in fish and seafood and the environmental status of the marine environment. In addition, the threat from marine biotoxins is managed in a different manner to other regulatory levels in seafood, prompting controls on harvesting.

[161] With the exception of fish liver, for which a high rate of non-compliance is expected.

continue to manage this pressure to achieve improvements in environmental state by 2020[162]. On this basis it is concluded that the UK will achieve GES for this Descriptor under the baseline scenario.

Option 1 – GES Targets

200. The target for contaminants in fish and seafood reflects the fact that we expect to achieve GES under the baseline scenario and it is based on existing thresholds for contaminants set out in existing EU legislation or other internationally and nationally agreed standards. Since the target reflects existing agreed standards, we have high confidence, confirmed by coordination with other OSPAR countries, that other Member States will take a similar approach.

201. It is unlikely that additional measures will be needed beyond those already being put in place to meet existing legislative requirements. Some additional monitoring in commercial fishing grounds in the relevant MSFD sub-regions (Greater North Sea and Celtic Seas) is likely to be necessary because current Food Standards Agency monitoring schemes are generally not able to identify the source of the samples being tested in their current monitoring programmes. Current estimates of additional monitoring costs are in the region of £40-80k per annum for England and Wales[163] and some smaller additional monitoring costs for Scotland are also anticipated.

Table 14 – Targets for contaminants in seafood (Descriptor 9)	
TARGETS	
Targets – Criteria 9.1: Levels, numbers and frequency of contaminants	For contaminants where regulatory levels have been set, there should be a high rate of compliance based on relevant surveys and including samples originating from commercial fishing grounds in the Greater North Sea and the Celtic Seas.
ASSESSMENT OF COSTS	
No additional measures. **Monitoring Costs** Current estimates of additional monitoring costs are in the region of £344k-£689k over 10 years for England and Wales for additional samples of commercially exploited species collected on existing surveys, and/or sampling from fish markets and monitoring on sub-samples of shellfish tissue through current biotoxin monitoring programme.	
SUMMARY	
Potential costs to business – No additional costs **Potential costs to government** – There are likely to be additional monitoring costs for England and Wales of between £344k-£689k over 10 years, and smaller additional monitoring costs for Scotland. **Total potential costs** – The costs are likely to low - £344K-£689K over 10 years.	
KEY ASSUMPTIONS AND RISKS	
It has been assumed that any additional measures needed to reduce contamination in order to meet these targets would be taken under existing legislation (e.g. the WFD, Urban Waste Water Treatment Directive, revised Bathing Waters Directive) and therefore the costs would not be additional to MSFD.	

[162] BAU Report 2012, ABPmer, Introduction(iii)

[163] Cefas CBA Report 2012, p.246

Descriptor 10 – Marine litter

Background

202. Significant amounts of litter[164] appear in our seas and on our beaches. It is unsightly and can cause harm to marine wildlife through entanglement and ingestion, and through smothering of the seabed. Litter also has economic effects through clean up costs to local communities and lost tourism, and costs to fishermen through lost catch and snagged nets. It can also pose a hazard to seafarers through fouling of ship propellers. Plastics are the main type of litter found both on beaches and offshore, including increasing quantities of microscopic pieces of plastics resulting from degradation of larger plastic products in the sea. These may act as a vector for transferring toxic chemicals to the food chain. There is, therefore, widespread recognition that current and future measures to reduce marine and coastal litter will bring ecological, economic and social benefits.

203. A lack of data and understanding with respect to the properties, quantities, sources and impacts of marine litter means making a robust assessment of status either regionally or over time is not possible. A robust baseline and sufficient data to detect trends through time is needed, however acknowledging the need for cost-effective data collection is essential. Whilst our understanding of the quantities and types of beach and seafloor litter is steadily improving, the current programme of monitoring needs further development.

204. The UK characteristics of GES for the Descriptor are as follows:

- The amount of litter, and its degradation products[165], on coastlines and in the marine environment is reducing over time and levels do not pose a significant risk to the coastal or marine environment, either as a result of direct mortality such as through entanglement, or by way of indirect impacts such as reduced fecundity or bioaccumulation of contaminants within food chains.

Option 0- Baseline Scenario

205. The BAU report concluded that, under the current regulatory regime, litter will continue to be a problem, accumulating in coastal areas and in the water column[166]. Charting Progress 2 found that there continues to be "significant amounts of litter in our seas and on our beaches".[167] The monitoring data are too sparse to allow a meaningful assessment of changes in quantities of litter either regionally or over time.

206. Land-based sources are estimated to make up around 80% of the litter reaching the marine environment[168]. Measures to reduce land-based sources of litter are already being taken forward as part of the UK Government's Waste Review[169] and Devolved Administrations waste policy. These include measures to increase recycling, improved product design and measures to reduce littering through initiative such as the Love Where You Live campaign. A range of measures are also in place to prevent litter from marine sources, particularly shipping. MARPOL Annex V (Garbage) has just been reviewed by the IMO resulting in a general

[164] "Marine litter (marine debris) is any persistent, manufactured or processed solid material discarded, disposed of, abandoned or lost in the marine and coastal environment" Marine Litter – An analytical overview, Regional Seas Programme, UNEP.

[165] Degradation products of litter include small plastic particles and micro plastic particles

[166] BAU Report 2012, ABPmer, Introduction(iii)

[167] Charting Progress 2, Chapter 4, Page 77

[168] Faris and Hart, 1994

[169] Government Review of Waste Policy in England 2011 - http://www.defra.gov.uk/publications/files/pb13540-waste-policy-review110614.pdf

prohibition being applied with a limited amount of exceptions for discharge of litter into the sea. These changes will take effect internationally from 1st January 2013 and will be enforced by the MCA. All these measures are included as part of the baseline.

Option 1- GES Targets

207. Due to the high level of uncertainty surrounding the effects of litter on the marine environment it has not been possible to develop specific targets with thresholds equating to GES. Instead, a trend-based target for litter on coastlines has been developed which requires an absolute reduction in visible litter items on coastlines within specific categories (e.g. plastics, sanitary items, fishing litter). This target will lead to a reduction in the levels of litter on our beaches and coastlines. It is likely that other countries within the North East Atlantic will all implement a very similar target for litter on coastlines.

208. For the other aspects of litter included in the Commission Decision it is not considered possible to set specific targets at this time both due to uncertainties surrounding impacts and a current lack of data to set suitable baselines. However, two additional indicators will be put forward covering trends in litter on the seafloor and trends in the amount of litter ingested by Northern Fulmars. Both of these indicators are designed to give an indication of the amounts of litter present in the wider marine environment and how this is varying over time. However, due to the persistent nature of most types of litter, these indicators are only likely to change very slowly in response to management measures. Both indicators will be monitored in order to develop a robust baseline and targets may be developed in the future if this is considered necessary.

209. For the remaining two aspects of litter included in the Commission Decision, microparticles and the impacts of litter on marine life, there are not considered to be suitable indicators at this time, however, further work will be carried out to see how these aspects of litter could be monitored and assessed in the future.

210. In order to meet the target for litter on coastlines action will be needed both to address terrestrial sources of litter (this is considered to be the main source) and marine sources (e.g. litter from the fishing industry. Since the consultation it has become clear that existing policy on terrestrial litter, including the 'Love Where you Live' campaign[170], will play a large part in achieving this target. Current litter policies involve a strong focus on action being taken across society (e.g. by communities and businesses) rather than centralised action by Government, and could include measures such as public campaigns to raise awareness and promote changed behaviour on littering and encouraging and facilitating community clean-up activity. As the need for additional action on terrestrial litter has already been acknowledged by Government, the costs associated with it are considered to be part of the baseline, rather than additional costs driven by this Directive. There is also a need to address marine sources of litter, for example through the extension of voluntary codes of practice with the fishing industry. The costs associated with this kind of action are considered additional under MSFD and are discussed further in table 15 below.

211. There will also be some additional monitoring and information costs for government and regulators associated with the target proposed under this option. A broad initial estimate is that these would amount to somewhere between £55,000 and £125,000 pa for England and Wales.[171]

[170] *Love Where You Live* is a new campaign designed to inspire everyone to take action to reduce litter. The campaign is led by Keep Britain Tidy, with support from Defra. The campaign is about everyone taking responsibility for litter, and to change the way people think and act about littering. We all love something about where we live and this campaign is about everyone working together to make change happen.

[171] Cefas CBA Report 2012, p246

Table 15 – Targets for marine litter (Descriptor 10)	
TARGETS	
Targets – Characteristics of Litter in the Marine Environment	Overall reduction in the number of visible litter items within specific categories/types on coastlines from 2010 levels by 2020 Surveillance indicator to monitor the quantities of litter on the seafloor (preferred option). Surveillance indicator to monitor the amounts of plastic found in the contents of fulmars stomachs (in line with the OSPAR Ecological Quality Objective) (preferred option).
ASSESSMENT OF COSTS	
As described above, further action to reduce terrestrial sources of litter will be taken under the baseline as part of the Government's existing policies on reduction of terrestrial litter. Some additional measures are likely to be needed to reduce marine sources of litter. **Extension of fishing industry code of practice** Seafish has developed a voluntary code of practice for the fishing industry which includes a module on sustainable waste practices. This includes measures such as ensuring that any waste produce on board the vessel is taken back to shore and disposed of responsibly, and that any litter collected in nets is collected and taken ashore rather than being returned to the water. Currently around 400 vessels have signed up to the code of practice, but with additional promotion by Seafish this could be significantly extended. This would involve additional costs to Seafish of promoting the scheme more proactively. Costs to fishers of applying the code of practice are thought to be relatively minimal and relate mainly to the cost of disposing of additional waste. **Fishing For Litter** Fishing for litter schemes involve actively supporting the fishing industry to improve their practices for the waste they accidentally catch by providing things like bags, skip rental etc. Pilot schemes are already in operation, funded by Governemnt and local authorities. However, further assessment is needed of their impact and effectiveness before any decisions are taken about extending these schemes. **Monitoring costs** An initial estimate suggests that these could be between £55,000 and £125,000pa for England and Wales[172]. Thus the total monitoring costs over 10 years are estimated to be £412.5K - £938m.	
SUMMARY	

[172] Cefas CBA Report 2012, p.246

Potential costs to business – Cost to business will depend on which measures are ultimately taken forward and how they are implemented. Costs of extending the current Seafish code of practice for the fishing industry are thought to be relatively minimal, relating mainly to the cost of disposing of additional waste.**Potential costs to government** – Costs to Government will depend on which measures are ultimately taken forward and how they are implemented. The total quantified costs to government from the additional monitoring mentioned above are estimated at £412.5k - £938k over the appraisal period. **Total potential costs** – Costs are likely to be low, but will depend on which measures are ultimately taken forward. We have not been able to quantify the costs to businesses. It estimated that the costs to government of additional monitoring could be £412.5k-£938k over the appraisal period.
KEY ASSUMPTIONS AND RISKS
It has been assumed that measures taken under the baseline to reduce terrestrial litter will play a key role in achieving the target for litter on coastlines.

Descriptor 11 – Introduction of energy, including underwater noise

Background

212. According to the Commission Decision 2010[173], at this stage this Descriptor is intended to address the impacts of noise on the marine environment and does not currently cover the impacts of any other forms of energy.

213. Anthropogenic inputs of sound can potentially affect marine organisms in a variety of ways. Continuous noise may degrade the sound habitat, masking biologically relevant signals such as echolocation clicks, making it harder or impossible to find a mate, locate food or detect predators. Impulsive sounds can lead to a variety of behavioural reactions such as avoidance of feeding or breeding areas, or may result in physiological effects such as temporary or permanent damage to hearing organs, and at very high levels, even death.

214. There is no evidence at present to suggest that current levels of impulsive or ambient sound in UK waters are having an impact at the population level on cetaceans or other marine animals. There remains, however, significant gaps in our understanding of the current levels of noise in the marine environment, the actual impacts of marine noise on species and populations, and the thresholds at which noise is considered to be having a 'significant' impact on organisms. In addition, underwater noise is not currently monitored or recorded systematically in the UK.

215. The UK characteristics of GES for this Descriptor are as follows:

- Loud, low and mid frequency impulsive sounds and continuous low frequency sounds introduced into the marine environment through human activities do not have adverse effects on marine ecosystems:
    - Human activities potentially introducing loud, low and mid frequency impulsive sounds into the marine environment are managed to the extent that no significant long term adverse effects are incurred at the population level or specifically to vulnerable/threatened species and key functional groups.
    - Continuous low frequency sound inputs do not pose a significant risk to marine life at the population level, or specifically to vulnerable/threatened species and key

[173] Commission Decision of 1 September 2010 on criteria and methodological standards on good environmental status of marine waters (2010/477/EU)

functional groups e.g. through the masking of biologically significant sounds and behavioural reactions.

216. Due to the high level of uncertainty about the effects of noise on the marine environment it has not been possible for experts to propose specific targets for impulsive sound and ambient sound which they believe to be equivalent to GES. An operational target has been developed for impulsive sounds and a surveillance indicator developed for ambient sounds – these are summarised below[174] and are designed to enable us to better monitor, understand and manage the impacts of noise.

217. There is still considerable uncertainty over the approach that other Member States will be taking to setting targets for both impulsive and ambient sounds. However, the UK co-chairs the EU Technical Sub-Group on Noise[175], established by the Commission to assist in developing a coordinated approach to this Descriptor, so is well-placed to promote the approaches to target setting proposed in this impact assessment.

Impulsive sounds (Commission Criteria 11.1)

218. The majority of impulsive sounds will come from seismic surveys (e.g. for oil and gas) and pile driving (e.g. for renewable energy installations). The potential physical effects of such sounds on marine life i.e. hearing loss, death etc occur close to these sources and are recognised and managed in the existing licensing regime; for example, through the use of mammal observers, temporal restrictions on when activities can take place, and "soft starts[176]".

219. For this reason this Descriptor and the associated Commission indicator aim to address the cumulative impacts of noise generating activities on the behaviour of noise sensitive populations i.e. marine mammals, fish etc, through consideration of noise levels, and their distribution in space and time.

220. Whilst a good scientific understanding exists with regard to the level of noise which can cause physical harm to certain species, there is far less certainty about the levels of noise which are likely to cause negative behavioural impacts and can have an effect at a population level. The difficulty in setting thresholds for behavioural impacts is further compounded by the fact that behavioural change is very context specific. A sound that might have an effect in one context may not have an effect in another context.

221.

Option 0- Baseline Scenario

222. In order to overcome these uncertainties experts in Cefas and JNCC have made an assessment of current and planned noise levels in UK waters. The major current source of impulsive underwater sound arises from seismic surveys, and this will likely continue to be the case up to 2020 and most likely beyond. The relative proportion of noise from offshore renewable energy construction is likely to increase by 2020, and possibly beyond. Experts have predicted the future distribution of impulsive sound events and although the number of noise generating events is likely to increase (largely as a result of renewable energy expansion), it is not expected that this will be significant at the temporal and spatial scales relevant to this Descriptor. Therefore our current understanding indicates that it is unlikely that

[174] Cefas CBA Report 2012, Section 2.8

[175] This is a group of experts established by, and reporting to, the EU Commission. They have been tasked with discussing and providing advice on marine noise, including approaches to target setting and monitoring methodologies.

[176] A soft start involves slowly building up the strength/intensity of a noise generating activity thus allowing noise sensitive species the opportunity to leave the area prior to physical harm occurring.

there would be any significant adverse effects on marine animal populations up to 2020 and beyond, provided appropriate measures continue to be taken through the current licensing regime to manage the potential physical impacts near to individual noise generating activities[177].

223. However, there is currently no means of recording, assessing or managing the distribution or timing of impulsive noise, increasing the risk that the pattern of activity might pose a threat to the achievement of GES in the future. Not setting any target could also imply that cumulative effects of projects do not need to be considered.

Option 1- GES Targets

224. Setting a specific target representing GES is difficult, given current uncertainties. Based on the conclusions above, the aim of the GES target for impulsive sounds is to take a proportionate, precautionary approach, allowing continued management, collection and evaluation of better evidence relating to behavioural impacts of noise at a population level.

225. The target establishes a requirement to establish and maintain a 'noise registry' which would record in space and time activities generating noise in order that they can be analysed to determine whether they may potentially compromise the achievement of GES. Such a registry would likely be managed by regulators and require a degree of coordination from regulating authorities around the UK. It would enable a better understanding of potential cumulative and in-combination effects, and allow for some adjustment in the scheduling of activities if it appeared significant adverse impacts may arise. However, any adjustments to the scheduling of activities would need to be very carefully managed and made well in advance given the high potential for significant costs to be incurred by developers e.g. as a result of increased project timescales, missed grid connections etc.

226. It is estimated that the administrative and financial burden of establishing a noise registry will be relatively small for both the regulator and industry (a small additional cost may be incurred by industry where applications are required to provide more detailed information in advance with respect to when and where an activity will take place).

227. In relation to monitoring, beyond the costs associated with the possible creation and administration of a noise registry, there will be no additional monitoring implications

Table 16 – Targets for Impulsive Sounds (Descriptor 11)	
TARGETS	
Targets – Distribution in time and place of loud, low and mid frequency sounds	To establish an actively managed 'noise registry' to record, assess, and manage the distribution and timing of anthropogenic sound sources measured over the frequency band 10 Hz to 10 kHz, exceeding the energy source level 183 dB re 1 μPa² m² s; or the zero to peak source level of 224 dB re 1 μPa² m² over the entire UK hydrocarbon licence block area.
ASSESSMENT OF COSTS	
Implementing and managing a noise registry There will be small additional costs to regulators arising from the administrative burden	

[177] This assessment is based on work which was done after the BAU Report 2011 was completed. For this reason the BAU Report conclusions on Descriptor 11 are not considered to be the most up-to-date analysis.

associated with the establishment and management of such a registry of £22k in 2012/13 and around £42k per annum after that[178]. A small additional cost may be incurred by industry arising from the need to submit additional information relating to proposed noise generating activities during the license application process. There may also be a small benefit to industry from utilising the noise registry to plan activities with other developers, thus potentially cutting deployment costs, however this depends on the nature and commercial sensitivity of the information contained in the noise registry.

Monitoring costs
No new monitoring costs beyond the implementation of the noise registry mentioned above.

SUMMARY

Potential costs to business – Costs to business from managing impulsive sounds will likely be small, arising from the need to submit some additional information during the licensing process.
Potential costs to government and regulators - These costs are likely to be £297k over the appraisal period, arising from the need to create and administer the noise registry.
Total potential costs – Costs will be low. Total monetised costs are £297k over 10 years.

Ambient noise (Commission criterion 11.2)

228. The main source of anthropogenic ambient noise in the marine environment is from shipping activity. As with impulsive sound, what constitutes GES is uncertain given current levels of knowledge but in contrast to impulsive sounds, a management regime for preventing physical harm does not exist and far less is known about current noise levels. The effects of ambient noise on marine life are also largely unknown so again in contrast to impulsive sounds, where it has been possible to use thresholds for physical harm, there are no specific exposure thresholds that can be proposed which can be used as part of a framework to define GES[179].

Option 0 – Baseline scenario

229. Ambient noise levels are likely to increase if the volume of shipping in UK waters increases, and no measures are taken to reduce noise levels from ships. However, there is insufficient monitoring data at this time to support any assessment of current ambient noise levels or their impact on marine animal populations.

230. Action already being taken through the IMO to improve efficiency standards in newly built ships will also make them less noisy (more hydrodynamic ships are more efficient and also tend to create less noise). In July 2011 the IMO adopted, by means of an amendment to the MARPOL Convention, an Energy Efficiency Design Index (EEDI) which will establish a mandatory efficiency standard for the design of new ships, with a tightening stringency over time. The EEDI provisions come into force on 1 January 2013, and the first efficiency improvements must be made from 1 January 2015. It is currently unclear how far these measures will reduce noise levels from shipping.

Option 1 - GES Targets

231. Given uncertainties with respect to current levels and impacts of ambient noise a specific target will not be established and instead a surveillance indicator has been put forward with the UK determination of GES for noise being used as a generic, qualitative target. This approach

[178] These are the costs which will be incurred by the JNCC in developing and managing the registry.

[179] Tasker et al. 2010

will ensure appropriate monitoring is put in place in order that a more specific target can be established at a later date when sufficient evidence has been collected.

232. Additional monitoring will be necessary in order to establish the surveillance indicator and improve our understanding of ambient noise levels. Cefas are currently developing a proposal for a cost effective monitoring programme for ambient sounds based on in situ observations (utilising existing platforms) and modelling. A broad initial estimate of the costs for this is between £100-150k per annum[180].

Table 17 – Targets for Ambient Sound (Descriptor 11)	
TARGETS	
Targets – Criteria 11.2: Continuous low frequency sound	Surveillance indicator to monitor 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.
ASSESSMENT OF COSTS	
No new measures would be required under this option. **Monitoring costs** The adaptation of existing monitoring stations would provide a cost effective means of achieving this with the costs expected to be between £100-150k per annum[181] for government and regulators.	
SUMMARY	
Potential costs to business – No additional costs. **Potential costs to government and regulators** – Additional monitoring will be in the region of £750k-£1.1m over the appraisal period. **Total potential costs** – Costs will be low.	

[180] Cefas CBA Report 2012, p.246

[181] Cefas CBA Report 2012, p.246

Section E: Benefits

Benefits of achieving the GES targets

233. The marine environment provides ecosystem goods and services which benefit society. The Millennium Ecosystem Assessment set out a typology of ecosystem services under four broad headings: provisioning, regulating, cultural and supporting services. The diagram below provides examples of some ecosystem services provided by the marine environment.

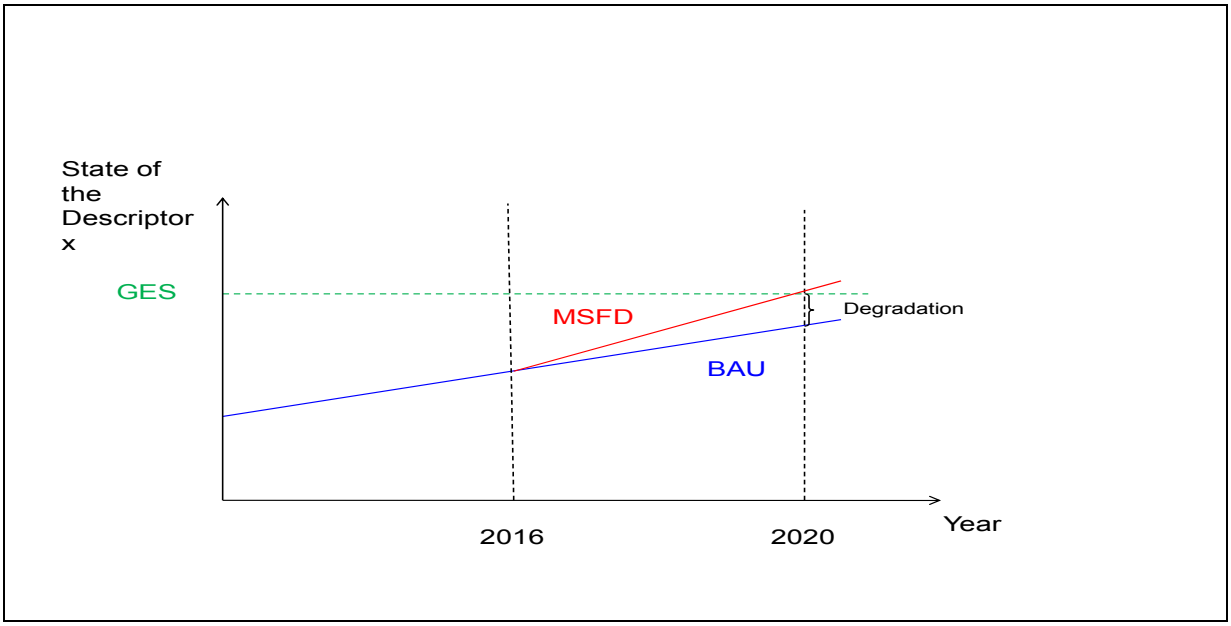
Categories		Relevant Categories		Example of Product or Service
Provisioning services	→	Food	→	Fish for human consumption
				Fish used in animal feeds
		Fibre		Aggregates
		Biochemicals, pharmaceuticals and natural medicines		Fish oil
Regulating services	→	Gas and climate	→	Carbon sequestration
		Bioremediation of waste		Waste remediation, water purification
		Natural hazard		Protection from natural hazard
Cultural services	→	Knowledge and education	→	Scientific knowledge of ecosystem functions, genetic information, and potential for chemical/therapeutics discovery
		Recreation		Recreational sea angling Nature-based recreation Scuba Diving
		Recreation Spiritual and religious		Recreational sea angling Nature-based recreation Scuba Diving Artistic work based on the marine environment
		Cultural and social		Protection of iconic sites or archaeological features
		Aesthetic and inspiration		Protection of iconic sites or archaeological features
		Non-use and option values		Altruistic/Bequest/Existence/Option/Quasi-option values
Supporting services	→	Primary production	→	(Not directly analysed to avoid double counting[182])
		Nutrient cycling		
		Biologically-mediated habitat		

[182] Supporting services are those that are necessary for the production of all other ecosystem services and include habitat provision and nutrient cycling. The important point to emphasise is that they differ from provisioning, regulating, and cultural services in that their impacts on people are indirect and will therefore not be valued directly but by taking account of the impact on these other ecosystem services that are directly 'consumed'.

	Resilience and resistance	

234. The benefits of implementing the MSFD are assessed by valuing the level of improvement in the marine environment brought about by achieving GES before or by 2020 or, described in another way, by valuing the avoided costs arising from degradation in the marine environment if GES is not achieved within the timeframe. In other words, the benefits of achieving the GES targets can be assessed by valuing the difference in societal welfare when we compare the expected state of the marine environment under the Business As Usual scenario with the expected state when GES targets are achieved before or by 2020. However, in addition, there will also be earlier benefits that arise from the transition to GES before 2020 where this diverges from the BAU scenario.

Figure 6. Illustration of the cost of degradation



235. The blue line shows projected improvements in the state of the marine environment under the Business As Usual scenario. The green line shows the expected environmental state when the GES targets are achieved. The red line shows the trajectory towards achieving GES under MSFD measures. The gap between GES and BAU describes the degradation in the marine environment that will occur in the absence of a situation where GES is achieved through MSFD. The value of this gap, in terms of change in welfare, describes the benefit of achieving the GES targets. The diagram represents the underlying theoretical model behind the assessment of benefits in this impact assessment, however, due to lack of trend data it has not been possible to fully apply this model and only certain elements have been assessed below. Further work will be carried out in future impact assessments to further develop this approach. It is also important to note that for some Descriptors BAU and GES are likely to converge over time (as shown in the diagram). This reflects an optimistic BAU scenario where the existing legislative drivers are assumed to deliver improvement in the state of component and pressures in the future. However, for other Descriptor BAU and GES are likely to diverge over time, reflecting a scenario where the state of the marine environment worsens from under business as usual.

236. In order to value the change in societal welfare (the gap in Fig.6) the ecosystem services framework was used. This framework enables an assessment of the changes in services to society caused by changes in the state of ecosystem components and pressures in the marine environment.

237. There are a wide range of pressures and components covered by the 11 GES Descriptors, and measuring the change in state across all these elements would be a challenging task. However, for the purposes of valuation the ecosystem services framework requires assessments to be based only on final ecosystem services[183] – those that directly contribute to human welfare - in order to remove the risk of double counting the benefits. This does not mean that intermediate ecosystem services are less important, but that their value in supporting the final services should be captured through the changes in value of the latter. For example, the intermediate ecosystem service of primary production by phytoplankton and macro-algae (ecosystem component) supports the final ecosystem service of food provision in the form of fish and shellfish (ecosystem component) higher up the food chain. This means that the value of food provision also reflects the value of primary production, because without primary production, food will not be available.

238. Similarly, increased levels of litter (pressure) could cause negative impacts on marine mammals (ecosystem component) and could therefore indirectly affect the provision of the aesthetic and cultural services provided by them. At the same time increased levels of litter directly reduce the value of the aesthetic and cultural services received from going to the beach. For the purposes of valuation, only the direct effects of litter have been considered. The indirect effects should be reflected when measuring the value of aesthetic and cultural services from sightings of marine mammals[184].

239. To identify the changes in the provision of the ecosystem services between the BAU scenario and the achievement of GES targets, the following steps were taken:

- Identification of the ecosystem components that provide these final ecosystem services and the key pressures that impact on them;
- Assessment of whether there is any degradation in the ecosystem components, or significant changes in the impact of the pressures, when comparing the BAU scenario with the achievement of GES.
- These assessments were made based on discussions with economists and policy experts in Defra (step i) and with experts from JNCC and CEFAS (step ii) who have worked on developing the targets and indicators for the descriptors[185]. The Table 18 below shows the components and pressures which are considered to relate to final ecosystem services.

[183] Final ecosystem services include provisioning services, cultural and recreational services, regulating services. Please refer to the following link for more information on ecosystem services.
Hhttp://uknea.unep-wcmc.org/LinkClick.aspx?fileticket=KSXkgw7AKSY%3d&tabid=82

[184] Similarly invasive species are likely to indirectly impact health of final ecosystem components such as fish stocks and cause loss of native biodiversity. Such indirect impacts are captured through degradation of these components and hence are not valued to avoid double counting. However, this does not include the risk of new species of NIS having severe detrimental impacts on biodiversity, which are hard to quantify.

[185] The assessment made by setting up meetings (in August and September) with policy experts within Defra and experts within JNCC and CEFAS

Table 18: Final ecosystem services and related ecosystem components and pressures

Final ecosystem service	Relevant ecosystem components or pressures	Further explanation
Provisioning services	Fish and Cephalopods (D1 and D4) Intertidal rocky habitats (D1 and D6) Intertidal sediment habitats (D1 and D6)	Fish and Cephalopods provide food for consumption. Intertidal rocky habitats provide provisioning services such as food, medicine and fertilizer from seaweed. Intertidal sediment habitats also provide e.g. different types of fish, mussels and cockles.
Cultural and Recreational Services	Marine Mammals (D1 and D4) Fish (D1 and D4) Seabirds (D1 and D4) Intertidal sediment habitat (D1 and D6) Intertidal rocky habitat (D1 and D6) Subtidal benthic habitats (D1 and D6) Litter (D10) Organic enrichment (D8) Contamination (D8)	Marine mammals, fish and seabirds provide aesthetic pleasure to divers, tourists, nature lovers and sea anglers. Intertidal rock, intertidal sediment and subtidal benthic habitats also provide aesthetic pleasure to divers. Litter in the sea and beaches is likely to have negative impact on the cultural services that visitors benefit from when they visit these places. Similarly, increase in organic enrichment and contaminants could reduce the aesthetic value of marine waters.
Regulating services	Intertidal sediment habitats (D1 and D6) Intertidal rocky habitats (D1 and D6) Subtidal benthic habitats (D1 and D6) Pelagic habitats (D1 and D6)	These habitats provide key regulating services such as natural hazard protection, climate regulation and detoxification and purification (regulation of water quality and air quality). They also provide key supporting services such as nutrient cycling, ecological interactions. A large part of nutrient cycling is carried out by pelagic habitats and plankton is the foundation of the marine food web. They also play an important role in gas exchange, including regulating the amount of carbon in the atmosphere, and releasing oxygen as a product of photosynthesis.

240. On comparing the state of these ecosystem components under the BAU scenario and the achievement of GES it was found that not all the components were likely to face degradation in the absence of MSFD. Similarly, on comparing the impacts of the pressures under BAU and GES it was found that some pressures are already likely to be managed at levels equivalent to GES under the BAU scenario. For example, for contaminants and organic enrichment GES targets are achieved under the BAU scenario, therefore there is no degradation as a result of these pressures. Further details of the assessment of degradation across the different components and pressures is provided in Annex B[186]. Based on this assessment the final list of components and pressures relevant for valuation of benefits was reduced to the following:

- Fish
- Litter

[186] It should be noted that there is a significant level of uncertainty in this assessment. It is based on expert judgement, but for some ecosystem components e.g. marine mammals there is insufficient evidence to make an assessment of degradation.

- Seabed Habitats
- Birds

241. The section below provides an assessment of the benefits associated with improvements in the state of these components due to achievement of GES targets, as well as benefits associated with reductions in litter levels. The benefits have been assessed both quantitatively and qualitatively (where there was a lack of substantial evidence).

Benefits – Increase in abundance of fish under GES

242. The previous analysis in the consultation IA looked at a very simplified model of increase in landings from fish stocks reaching maximum sustainable yield (MSY). During consultation, the analysis was refined to reflect a number of more robust scenarios and assumptions about fisheries management and stock dynamics.

243. The key scenarios, assumptions and economic approach taken to arrive at these net benefits are summarised below. Please see Annex D for further detail on the scenarios and economic approach used to arrive at net benefit figures):

Fisheries Model Scenarios

A baseline scenario, which reflects a continuation of the most recent trend in the realised fishing mortality rates (Fsq) as derived from the 2011 ICES assessment (under current management plans, where these are in place) and a number of other plausible target MSY scenarios have been considered in this analysis. These MSY scenarios are linked with different levels of fishing mortality capable of producing MSY (Fmsy) and have been presented in detail in the individual stock assessment paper provided in Annex D. For each stock, a particular fishing mortality scenario (Fmsy) has been modelled to reflect the existing view in the scientific community on the appropriate fishing mortality threshold which corresponds to fishing at Maximum Sustainable Yield (MSY)[187].

Targetting lower level of fishing mortality (corresponding to Fmsy) would imply decreasing in fishing effort in the initial years. This is will result in costs to the fishing industry from lower levels of landings realised. However as the stocks improve benefits these losses are converted into benefits in the longer term. However, there are other factors that also impact on the trajectory of future stock such as recruitment into the stock (i.e. the number of fish surviving to enter the fishery), interactions between different fish stocks and effectiveness of policy on discards.

- For Sole and Cod stocks for the North Sea and Irish Sea, the linkage between recruitment and the adult spawning stock biomass (the proportion or size of the stock which is at sexual maturity) is a major factor in determining the trajectory of future stock biomass and yield. An optimistic, high recruitment model assumes that recruitment will recover to historic levels (for example in case of North Sea Cod, to the historic levels recorded in the 1970's and 80's[188]). A pessimistic, low recruitment model assumes that recruitment will remain at the

[187] For North Sea Cod on the other hand, the thresholds that correspond to fishing at MSY lie within a range. ICES advice states that Fmsy for the North Sea Cod is expected to lie in the range 0.16 to 0.42. ICES has suggested a target of 0.19 at the lower end of the scale, but the current agreed EU-Norway plan uses 0.4 as its target for long term exploitation. Note that both of these lie within the Fmsy range for North Sea Cod, which mean that both targets will achieve Fmsy in the long term.

[188] Some observers have commented that the high abundance of cod during the 1970s and 1980s was due to conditions prevalent at that time that resulted in a gadoid (cod, whiting and haddock) outburst which supported uncharacteristically high populations.

lower levels seen in more recent years. For these stocks, both high and low recruitment scenarios have been considered in this analysis in order to reflect the current uncertainty as to the future dynamics of the stock.

- North Sea Cod, Haddock and Whiting are a part of mixed fisheries, and are caught together. This is also the case for Western Channel Plaice and Sole. Due to the different biological characteristics (e.g. growth rates, natural mortality) of each of these stocks, it is not possible for each stock to achieve Fmsy individually under current exploitation patterns. So in the case of North Sea Cod, Haddock and Whiting, yield of Haddock and Whiting would have to be reduced below MSY in order to exploit Cod at MSY. Further detail on this are provided in Annex E.

- For species where discarding is included in the model, it is assumed in the baseline that discarding policies are not put in place and that fish considered as discards are thrown overboard and not sold. In the target MSY scenario, it is assumed that a discard ban becomes operational in 2018 and is 100% effective. This means that fish which would have been discarded are landed and sold from 2018 onwards.

Economic Modelling Assumptions

- Price per tonnage for small (discards) and large fish is assumed to be constant over the time period[189]. In reality an increase in supply could result in a fall in price. Sensitivity analysis considering a 20% and 50% fall in price is provided.

- At present, the market for undersized or discarded fish is in its infancy. Consequently, limited evidence is available as to what the market price is for undersized fish, or fish that would otherwise be discarded. For the purposes of this IA, it has been assumed that undersized fish that would previously have been discarded are sold in the market at 1/3 of the price of larger, more valuable fish.

- The net benefits have been assessed over 13 and 18 years (presented in table 19 below). CFP reform is likely to be implemented from 2013 onwards implying that the costs and benefits related to this descriptor will accrue earlier compared to other measures where the start date is 2016. As the appraisal period is 2013-2025 the 13 year benefit estimates were used to inform the overall impacts of the policy. For some stocks higher landings are realized over a much longer timeframe (over 18 years) but we have not been able to model these due to scientific uncertainty.

- Following the advice of the Green Book, a discount rate of 3.5% is applied to these values to calculate the present value of landings over a 13 (2013 -2025) and an 18 year period (2013 -2030).

- For most stocks, the transition to reach MSY will be delivered through the reformed CFP. However, MSFD will be a key influence on the shape and content of the reformed CFP, and provides part of the impetus behind the policy to deliver to deliver Fmsy. This implies that some of the benefits and costs of achieving lower FMSY would be attributable to MSFD. However, as CFP is considered to be the major driver for changes in fisheries management a 75% share of the benefits and costs achieved by reaching MSY are attributed to the CFP reform. The remaining 25% of the benefits and costs of achieving Fmsy are attributed to MSFD.

[189] The values of these landings of the UK fleet are found by multiplying the amount of annual landings to the selling price of the species, using data from the MMO Monthly Statistics (MMO, March 2012) http://www.marinemanagement.org.uk/fisheries/statistics/monthly.htm

Economic Modelling approach used

- The change in landings between the baseline (status quo) and the target MSY scenario is estimated. The change in landings are then multiplied by the price[190] and then by UK relative stability[191] to determine the proportion of value of landings attributable to the UK fishing fleet. As per the assumptions mentioned above, the value of discards (quantity of discards multiplied by price) is added to the value of revenues from landings.

- Revenues from landings are not an accurate measure of net economic benefits from additional fish landings (please refer to second bullet under fisheries model scenario). This is because the UK fleet would incur costs to catch and land these additional fish, which would not be incurred otherwise[192]. To calculate the net benefits it is necessary to deduct the value of the additional costs incurred from the revenues generated by additional landings to obtain values for the net benefits associated with increases in landings.

- Identifying the appropriate value of costs to deduct is not straightforward. In particular, the potential presence of unemployment or underemployment in fishing communities may mean that the opportunity cost of labour may be less than the value of the wages or crew share received by fishermen, as their next best employment opportunity may be a lower-paying one. If this is the case, viewing additional crew share/ wages as a cost may exclude an element of the benefits of catching and landing additional fish. However, it is empirically difficult to estimate the extent to which crew share should be included as a benefit at this point in time. In light of this uncertainty, this IA presents benefits from additional fish landings as a range of values. The lower end of the range is taken to be the value of operating profits, which is defined as total income minus operating costs. The upper end of the range is taken to be the value of Gross Value Added (GVA), which is defined as operating profits plus wages / crew share[193]. If a particular fish stock has recruitment scenarios available, the lower end of the range is taken to be the value of operating profits at low recruitment, while the upper end of the range is taken to be the value of GVA at high recruitment. This was done to reflect the uncertainty of the size of the fish stock and its impacts on the net benefits that are actually realised. For purposes of determining a 'best estimate', the midpoint in this range is used. Annex C provides further detail on the methodology employed to calculate operating profit and GVA.

- The operating profit and GVA estimates are then scaled down to 25% to arrive at net benefits attributable to MSFD alone.

[190] The values of these landings of the UK fleet are found by multiplying the amount of annual landings to the selling price of the species, using data from the MMO Monthly Statistics (MMO, March 2012) http://www.marinemanagement.org.uk/fisheries/statistics/monthly.htm.

[191] Scientists estimate how much of a stock may be caught and landed and the relative stability indicates the percentage of that catch attributable to each Member State.

[192] Fishing vessels incur a range of operating costs which are often split into two groups: **fishing costs and vessel costs**. **Fishing costs** include fuel and oil, boxes, ice, food and stores, sales commission, harbour dues, subscriptions and levies, shore labour, travel costs, quota leasing, days at sea purchase and crew share (wages). Fishing costs vary depending on the amount of vessel activity and the value and volume of landings. **Vessel costs** comprise gear and vessel repairs, insurance, administration, and the purchase, hire and maintenance of electronic equipment. Many vessel costs are fixed, costs are fixed, regardless of level of vessel activity during the year.

[193] Information on crew share, operating profits and total income of the UK fishing fleet was taken from Seafish's Economic Survey of the UK Fishing Fleet 2006 to 2009 surveys. This information was then categorised according to broad gear types since different species are caught by different gear types.

- The table below applies the low and high recruitment scenarios (if recruitment scenarios are available), assumptions and methodology described above to arrive at the expected range of benefits of harvesting at Fmsy.

- **Table 19: Net Benefits of fishing at Fmsy[a]**

Fish Stock	Fishing Mortality[b]	UK Relative Stability[c]	Price per tonne [d]	Range of present value of net benefits (and range of potential landings tonnage, including discards)[e]	
				13 Years	18 years
North Sea Cod (ICES area IV)	Baseline: Fsq = 0.68 Target: Fmsy= 0.4	0.32 [a]	Landings £1,800; Discards£600	£817.4K to £37.1m	£1.7m to £49.3m (426.4K to 2.1m tonnes)
North Sea Haddock (ICES area IV)	Baseline: Fsq = 0.23 Target: 10% annual reduction in fishing mortality until Fmsy for Cod is reached	0.565	Landings: £1063; Discards: £354	251.1K to 1.5m tonnes)	
North Sea Whiting (ICES area IV)	Baseline: Fsq= 0.27 Target: 10% annual reduction in fishing mortality until Fmsy for Cod is reached	0.34	Landings: £1042; Discards: £347		
Irish Sea Cod (ICES area VIIa)	Baseline: Fsq= 0.61 Target: 25% reduction in fishing mortality until Fmsy=0.4 is achieved	0.43	Landings: £1800	£27.5K to £3m 1.8K to 56.1K tonnes)	£47.8K to £4.8m (3.2K to 95.3K tonnes)
Irish Sea Sole (ICES area VIIa	Baseline: Fsq= 0.31 Target: 10% annual reduction in fishing mortality until Fmsy (0.16) is achieved	0.22	Landings: £8980	-£11K to -£27.6K (-33.8 to -152 tonnes)	-£3K[f] to £84K (49 to 930 tonnes)
Western Channel Plaice (ICES area VIIe)	Baseline: Fsq= 0.45 Target: 10% annual reduction in fishing mortality until Fmsy (0.19) is achieved	0.29	Landings: £1007	-£163.4Kto -£470K (-3.7K tonnes)	-£169K to -£486K[f] (-3.5K tonnes)
Western Channel Sole (ICES area VIIe)	Baseline: Fsq= 0.247 Target: 10% annual reduction in fishing mortality until Fmsy for Plaice is achieved	0.59	Landings: £8980		
North Sea Sole (ICES area IV)	Baseline: Fsq= 0.34 Target: 10% annual reduction in fishing mortality until Fmsy (0.22) is achieved	0.04 [a]	Landings: £8980	-£57K to -£290K (-3.3K to -7K tonnes)	-£23K to -£78K[f] (3.1K to 9.8K tonnes)
West of Scotland Haddock (ICES area VIa)	According to experts this stock is effective at its target in the baseline. However discards are landed under the policy scenario due to the ban	0.78 [a]	Discards: £354	£148K to £493K (25.5K tonnes)	£208K to £696K (38.5K tonnes)
TOTAL[g]				£761.2K to £39.9m (271.3K to 1.5m	£1.7m to £54.4m (474.3K to 2.3m

Fish Stock	Fishing Mortality[b]	UK Relative Stability[c]	Price per tonne [d]	Range of present value of net benefits (and range of potential landings tonnage, including discards)[e]	
				13 Years	18 years
				tonnes)	tonnes)

Notes:
[a] The estimated wide range of net benefits for each stock is explained by the wide recruitment scenarios for certain stocks. In addition the low estimate represents economic benefits in terms of operating profit while the higher estimate expresses them in terms of GVA.
[b] Fishing mortality is the level of stock mortality generated by fishing activity.
[c] These are based on 2011 shares. The relative stability relating to north sea cod, haddock and whiting are not the overall UK share of all of the Cod TACs, but UK share of IV as a proportion of the overall stock yields.
[d] Fixed price is assumed over the whole time period for analysis. For landings, price is taken from MMO, 2012, Monthly Return of Sea Fisheries Statistics for England, Wales, Scotland and Northern Ireland, March; Table 1a. For discards, it is assumed that price is 1/3 of the value of the price for full-sized fish landings since discards are smaller, less valuable fish. This information is taken as anecdotal evidence from a Cefas fisheries liaison officer (based on experience of working at fish auction markets).
[e] The figures presented as a range are only applicable to species that have recruitment scenarios. [f] The negative values reflect that while there is a long term benefits from increase in landings in the future, these are outweighed by the losses in the initial period (due to restriction in fishing efforts). This is mainly because the benefits in the future are discounted (i.e. the value of £1 a few years from now is less than the value of £1 today).
[g] Total values may not match due to rounding errors.

244. From the Table 19 above we see that the 13 and 18 year total net benefits of pursuing the targets for these stocks are £761.2K to £39.9m and £1.7m to £54.4m respectively. However, these are conservative estimates and are likely to be higher if all relevant fish stocks were included in the analysis. Also on comparing the 18 years and 13 years estimates we see that most of the benefits accrue in the future. Due to scientific uncertainty stock projections we have not modelled benefits beyond 18 years for the purpose of this analysis.

245. For some stocks such as Irish Sea Sole, the mixed fishery for Western Channel Plaice and Sole, and North Sea Sole, the net benefits are negative. For these 4 fish stocks, the marginal change starts out negative because of the decrease in fishing mortality (i.e. we are catching less fish in the policy scenario than we would have been in the baseline scenario); but in the long run, landings become positive. However, this marginal increase in landings is not large enough to compensate for the decrease in landings in the previous years if we consider a timeframe of 10 and 18 years, possibly due to the natural dynamics of the stock. It likely that over a longer timeframe the net benefits are likely to become positive.

Sensitivity analysis

Change in prices

246. Some sensitivity analysis was carried out for North Sea Cod based on the assumptions outlined under economic modelling. This considered a scenario of a 20% and a 50% fall in price of landings (following a rise in fish stocks) and assessed the impact this would have on net benefits. This analysis was applied to North Sea Cod only since achieving the target fishing mortality under the central scenario (Fmsy= 0.4) results in a significant increase of landings, and this increase may be large enough to drive down the price of North Sea Cod[194]. It is assumed that the decrease in the price of landings starts in 2017 since this is the year where the most significant increase in landings starts. To simplify the analysis, it is also assumed that this new price stays constant afterwards.

[194] For North Sea Cod, the increase in landings is in the magnitude of tens of thousands of tonnes, while for the other stocks, the magnitude of increase is only tens or hundreds of tonnes

Table 20: Sensitivity analysis under different apportionment scenarios

Fishing mortality scenario for North Sea Cod	Price (per tonne) scenario	Range of net present value benefits for Cod	
		13 years	18 years
Baseline: Fsq= 0.68 Target: Fmsy= 0.4	Original price: Landings: £1800 Discards: £600	£1.9m to £41m	£2.9m to £53.5 m
	20% decrease from original price: Landings: £1440 Discards: £480	£1.5m to £32.8m	£2.3m to £43m
	50% decrease from original price: Landings: £900 Discards: £300	£989.1K to £20.5m	£1.5m to £26.8m
Total net present value benefit of all landings			
		13 years	18 years
20% decrease in price of North Sea Cod		£365.5K to £31.7m	£1.15m to £43.6m
50% decrease in price of North Sea Cod		-£228K to £19.3m	£268.5K to £27.6m

247. A 20% reduction in price would imply overall net benefits of £365.5K to £31.7m over 13 years, while a 50% reduction in price would imply benefits of -£228K to £19.3m over 13 years. These figures show that a decline in prices (due to increased supply of fish) can possibly result in negative net benefits. However, the best estimate of net benefits are still positive even if we account for a fall in price.

248. Further sensitivity using alternative Fmsy scenarios (considered less plausible compared to the central scenario presented in Table 20) are presented in Annex E.

Benefits – Reduction in litter under GES

249. Marine litter directly and indirectly affects ecosystem services and the benefits we enjoy from the marine environment. As discussed in section D, litter can cause impacts to marine animals through entanglement or ingestion, smothering of the seabed, damage to propellers of boats, and can be an eyesore for tourists visiting beaches or taking boat trips. This in turn could result in economic costs and losses to coastal communities (tax payers), individuals, fishermen, farmers, ports and mariners and others.

250. The GES target for marine litter requires an overall reduction in litter on coastlines by 2020, with additional indicators for litter on the seafloor and litter on the water column. Action to reduce terrestrial sources of litter (estimated to make up 80% of litter on coastlines) are already being taken forward under the baseline scenario, but the MSFD target is likely to drive additional measures to reduce litter from marine sources, meaning that a proportion of the benefits from reducing litter levels should be attributed to MSFD.

251. As mentioned in the introduction, for the purposes of this analysis, only the direct benefits of reducing litter are considered to avoid double counting. These include:

- Benefits from reducing litter levels in coastal areas - This would lead to an increase in the aesthetic, recreational and cultural services experienced by people visiting coastal areas.

- Benefits from reducing the numbers of litter items floating in the marine waters - The BAU scenario states that there is likely to be a continuing problem with litter in the water column. This could result in negative impacts on boats and other vessels through damage to propellers, and to various other marine activities (such as aquaculture).

Benefits from reduction in litter items on beaches

252. Litter on beaches can negatively affect people's experiences through reduced recreational opportunities, loss of aesthetic value and loss of non-use values. There are two types of benefit arising from cleaner beaches – use benefits and non-use benefits. Use benefits are benefits that are directly enjoyed by beach users e.g. relaxation, walking. Non use benefits are benefits enjoyed by people who don't directly use beaches but are keen on maintaining their value so that they can be used by others (altruistic), future generations (bequest), or simply the benefit derived from knowing clean beaches exist (existence value). As many of the benefits associated with cleaner beaches are not traded in the market alternative valuation techniques have to be used which take into account both use and non-use values e.g. Willingness to Pay techniques[195].

253. A Willingness to Pay study by Susana Mourato et al[196] estimated £2.3bn in benefits to Wales and England from avoidance of dog mess and litter on beaches over 25 years. The study used choice experiment methods to evaluate how much individuals are willing to pay for absence of litter (compared to current levels). Using the average 2002 WTP estimate of £6 (per year per household) these benefits are estimated to be £1.72 billion over the appraisal period[197] for the whole of UK.

254. Given that the estimates above relate to what people were willing to pay for complete removal of litter from the beaches this is a significant over-estimate of the benefits of achieving the proposed GES targets for litter, which aim to achieve an overall reduction in litter. It should also be noted that the additional benefits from MSFD arise from reduction in *marine* sources of litter (around 20% of litter on beaches is from this source) because reductions in terrestrial sources are already included in the baseline scenario. Nevertheless, this indicates that achieving the MSFD target for litter is likely to lead to additional benefits to society through reductions in beach litter.

Reduction in impacts from litter on fishing vessels

255. Commercial fisheries could also be affected by marine litter and in some cases the damage caused could be significant enough to affect overall profitability of a vessel. For instance, fishing gear damaged or lost due to marine litter will need to be repaired or replaced, which in turn could result in costs due to loss of time at sea and costs of replacing gear. Reduction in levels of litter from marine sources driven by the MSFD target would reduce the cost of these impacts, leading to economic benefits through the damage costs avoided to the industry.

256. This analysis investigates direct costs associated with marine litter across the all UK sea fisheries. KIMO International has developed a questionnaire to investigate how marine litter affects fishing vessels in Scotland. Fishermen were asked to provide values based on the

[195] In economics, the willingness to pay (WTP) is the maximum amount a person would be willing to pay, sacrifice or exchange in order to receive a good or to avoid something undesired, such as pollution.

[196] CSERGE Working Paper ECM 03-12, Bathing water directive revisions, what are the benefits to England and Wales (a stated preference study), Susana Mourato, Stavros Georgiou,Ece Ozdemiroglu3, Jodi Newcombe and Alexandra Howarth3

[197] The WTP has been converted to 2010 prices using the GDP deflator and multiplied by the number of households in UK http://www.communities.gov.uk/housing/housingresearch/housingstatistics/housingstatisticsby/householdestimates/livetables-households/

direct economic impacts of marine litter on their vessels including the value of dumped catch, the costs of repairs to fishing gear, the cost of fouling incidents and lost earnings as a result of reduced fishing time[198]. For the purposes of this analysis it has been assumed that the average costs of marine litter identified in this report apply to the whole UK fishing fleet, rather than just Scottish vessels[199].

257. The total costs of marine litter related incidents for UK fisheries are estimated using the average costs of marine litter per vessel in the Scottish fleet[200]. Costs to the UK fishing fleet associated with litter incidents that involve dumping catch, repairing fishing gear and lost earnings as a result of reduced fishing time due to clearing litter from the nets are estimated at between £29.75m to £33.14m per annum. Costs to the UK fishing fleet associated with litter incidents that involve fouling (e.g. of propellers) are estimated at between £763,111 and £770,282 per annum. These estimates should be treated with caution[201].

258. The estimated total costs to the UK fishing industry of the impacts of marine litter in the water column and on the seabed is between £30.5 million to £33.9 million per annum. This is equivalent to 5% reduction (approximately) in the total revenues that are generated by the UK fleet in comparison to 2009 UK vessels landed value. If the damage costs are assumed to remain the same over the future years[202] and GES targets are assumed to reduce the severity of damage caused by reducing damage costs by 2-5% (from the baseline), then this would result in benefits (in terms of damage costs avoided) to the fishing industry of £4.3m to £10.7m over the appraisal period[203].

259. The analysis above indicates that measures to reduce marine sources of litter will bring benefits to the fishing industry and other marine users in terms of reducing the severity of damage to vessels caused by litter. The benefits to the fishing industry of reducing marine litter related incidents have been estimated at £4.3m to £10.7m over 10 years.

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[198] Fishermen were asked to provide the costs of marine litter per year. 22 vessels have responded and out of which only 4 vessels reported that they had not experienced incidents with marine debris in the last year. The 18 vessels have experienced incidents with marine litter and, therefore they were able to provide their cost associated with marine litter. The KIMO report also states that on average each vessel participating in the project experienced just less than one incident per year involving marine litter.

[199] This is because there are no other studies that can be used to elicit information about the costs of marine litter incurred by other parts of the UK fleet.

[200] KIMO estimates are converted using the following exchange rate Euro1 = 0.8685 GBD

[201] Average costs of litter related incidents have been disaggregated into two categories is due to the different economic costs of marine litter impacts associated with different fishing methods:

- Incidents due to dumped catch, repairs to fishing gears and reduced fishing time due to clearing nets are mainly applicable to those fisheries that have contact with the seabed. The total cost of these kind of incidents has been estimated based on the average costs per vessel for this category of incident and the number of active UK vessels that use seafloor fishing gear. It is assumed that each vessel in the affected category has one litter 'incident' of this sort each year. This simplifying assumption is made as a result of a lack of robust data as to the frequency and prevalence of incidents of this sort.

- Incidents due to fouling are more likely to be due to litter in the water column and can therefore affect any type of vessel. The total costs to the UK fleet of these kind of incidents has been estimated based on the average cost per vessel for this category of incident and the number of active UK fishing vessels. It is assumed that each vessel in the affected category has one litter 'incident' of this sort each year. This simplifying assumption is made as a result of a lack of robust data as to the frequency and prevalence of incidents of this sort.

[202] We assume increase in litter causes a proportional increase in damage costs to vessels (i.e. a 5% increase in litter results in a 5% increase in damage costs). There is not information on litter trends of marine litter floating in the sea so we used a proxy of litter trends on beaches. The 5% increase was arrived at looking at the average beach litter trends over the last 5 years (Marine Conservation Society Beachwatch report 2010).

[203] These estimates need to be interpreted cautiously due to lack of representation of original sample data and the probability of incidence with marine litter across the UK fleet. At this stage, these estimates are based on best available evidence and some broad assumptions (that have been highlighted above).

Benefits - Improvements to seafloor habitats under GES

260. Seafloor habitats provide key regulating services (such as environmental resilience, regulation of pollution, climate regulation and natural hazard protection), provisioning services (such as fish, fertilizers and wild harvesting) and recreational services (such as nature watching, tourism and sports).

261. The MSFD targets for seafloor habitats will protect a wide range of broadscale sediment habitats which are not currently protected under existing legislation. The baseline scenario indicates that for a number of these habitats (particularly sub-tidal sediment habitats) there is likely to be degradation in the absence of MSFD. It is extremely hard quantify what impact degradation of these habitats would have in terms of changes to the provision of regulating, provisioning and recreational services, other than to conclude that it would reduce the capacity of those habitats to provide those services. This implies that there will be benefits from improving the state of these habitats by implementing the MSFD targets for sediment habitats. Given the fact that these habitat types make up a significant percentage of the UK's overall seafloor habitats, the benefits are likely to be significant.

262. Defra is in the process of commissioning an 18 month project that will look at changes in ecosystem services from marginal changes in the state of seafloor habitats. The work will help inform any future cost benefit analysis of measure for seafloor habitats.

263. Table 21 below lists the specific ecosystem processes and services provided by those seafloor habitats which are likely to improve in status as a direct result of the GES targets (note that other habitats are also likely to improve, but these improvements are attributed to other drivers such as the Habitats Directive, the Water Framework Directive etc):

Type of sediment habitat	Ecosystem Process	Ecosystem Service
Shallow/ Shelf sublittoral coarse sediment	The beneficial ecosystem processes identified were primary and secondary production, larval/gamete supply, food web dynamics, formation of species habitat, species diversification, erosion control and biogeochemical cycling.	The beneficial ecosystem services identified were fisheries, environmental resilience, and regulation of pollution
Shallow/ Shelf sublittoral sand		
Shallow/ Shelf sublittoral mud		
Shallow/ Shelf sublittoral mixed sediments		

Benefits – Improvements in the state of birds under GES

264. Seabirds provide direct cultural and aesthetic services to tourists, as well as providing key supporting services to help maintain vital marine ecosystems. A comparison of the BAU scenario with the achievement of GES targets suggests that there is some degradation in relation to seabirds if BAU is followed. In particular, it is considered that the GES targets proposed for birds would result in greater mitigation of climate change impacts on bird populations than would be the case under the BAU scenario.

265. An RSPB study[204] estimates that in 2009, there were more than 142,000 visitors to the four RSPB sites that have the most significant populations of seabirds[205].

266. While evidence exists around expenditure related to seabirds[206], there is limited evidence around the value society places on conserving bird colonies for future generations, or the value people derive from knowing that healthy bird populations exist. Consequently, it has not been possible to assess the improvements in cultural and aesthetic services that would result from the implementation of the proposed GES targets for birds, but the estimates above show the significant benefits that are associated with healthy bird colonies.

Benefits – Summary

267. The total quantified benefits are estimated to be £5m to £50.6m. These however represent a small portion of the benefits and it has not be possible to quantify benefits such as

- Cultural and recreational benefits from improvement in fish stock (e.g. potential benefits to sea anglers and divers), reduction in litter (e.g. potential benefits to beach walkers), improvement in seafloor habitats (e.g. potential benefits to divers) and improvement in abundance of sea birds (e.g.to bird watchers).
- Improvement in education and knowledge of the public, industry and government administration (regarding various marine species and habitats) from various awareness raising campaigns, monitoring programmes and research projects.
- Increased satisfaction from knowing that rare, threatened and representative marine species, habitats and features of geological or geomorphological interest are being protected (non-use value). These benefits include the benefit to themselves (existence value), as well as the benefit that they gain from knowing that species and habitats are being conserved for others in the current generation (altruistic value) or future generations (bequest value)
- In addition while this impact assessment measures impacts of targets on human welfare biodiversity has an intrinsic value that is worth protecting regardless of its value to humans.

268. In terms of linking the benefits to the targets and illustrative measures we can say that provisioning and recreational benefits from improvements in fish stocks can be can be attributed to the D3 targets (although the D1,4,6 targets will also play a role in supporting this), the recreational benefits from reduction of litter and the reduction in damage costs caused by litter can be attributed to D10 targets, the benefits from improvement in abundance of birds can be attributed to D1 and D4 targets, and the benefits from improvement of seafloor habitats can be attributed to D1 and D6 targets.

[204] RSPB, (2010), The Local Value of Seabirds: Estimating spending by visitors to RSPB coastal reserves and associated local economic impact attributable to seabirds, The RSPB, Sandy, UK, accessed online <http://www.rspb.org.uk/Images/seabirds_tcm9-262584.pdf> on 23 June 2011

[205] Estimate was made using the information on the number of visitors in the RSPB Reserves of - Bempton Cliffs, South Stack Cliffs, Mull of Galloway and Rathlin Island. The total expenditure for such visits was estimated to be £5m- £10m. This would imply benefits (in terms of expenditure on the 4 bird reserves) in the range of £51m - £102m over 10 years, assuming expenditure remains constant over the period.

[206] RSPB, (2010), The Local Value of Seabirds: Estimating spending by visitors to RSPB coastal reserves and associated local economic impact attributable to seabirds, The RSPB, Sandy, UK, accessed online <http://www.rspb.org.uk/Images/seabirds_tcm9-262584.pdf> on 23 June 2011

Section F: Conclusion

269. This impact assessment considers the impact of setting UK targets and indicators of GES (Option 1), compared to a baseline scenario where the MSFD is not implemented (Option 0).

270. Given the lack of data it has only been possible to quantify part of the costs and benefits of achieving the proposed GES targets. On comparing these quantified costs and the benefits across the GES Descriptors, we arrive at a net present value of -£1.7m-£23.2m (over the appraisal period, 2013 -2025). The benefits quantified are underestimate of overall benefits as it has not been possible to quantify benefits relating to recreational and cultural benefits from increased in abundance of fish stock, seabirds, reduction in litter and improvement in seafloor habitats. There are also likely to be high non-use values and educational and research benefits from improving the state of the species and habitats. There are also some illustrative measures (when assessing costs) that has not been possible to quantify – these have been described qualitatively. In particular there are likely to be high unquantified benefits such as

271. Also it will be important to note that the estimates provided in the IA are based on illustrative measures rather than actual measures. All decisions on which measures are taken will be subject to a separate impact assessment which will fully assess the effectiveness of those measures in achieving GES as well as their socioeconomic implications.

272. The net present value figures have reduced compared to the Consultation IA for a number of reasons:

- At the time of producing the Consultation IA there was significant uncertainty about the direction of a number of existing policies, making decisions about what to include in the baseline difficult. Based on improved information about the likely outcomes of a number of existing policies the baseline assumptions have been updated, and a number of costs have been removed because these are now considered as part of the baseline. This is particularly the case for: CFP reform, where the direction of the reform process is now much clearer; international shipping, where the direction of internationally managed measures to reduce introduction and spread of non-indigenous species is now clearer; Marine Conservation Zones, where there is now more information about the site designation process; and litter, where it has become clearer that existing policies on terrestrial litter will play a significant role in supporting the proposed GES targets for litter (reducing both the costs and benefits of litter).

- The costs associated with a number of measures and monitoring needs have been removed compared to the Consultation IA because the consultation process indicated that the figures used were insufficiently robust to be included. Instead the impact of these measures has been described qualitatively. These include measures for reducing seabird by-catch, and monitoring costs for sediment habitats.

- The analysis of benefits from increased fish stocks has been significantly improved compared to the Consultation IA, based on much more sophisticated assumptions and scenarios of changes in fish stock dynamics. The new scenarios considered looks at both an optimistic and pessimistic scenario of improvement in fish stocks and hence provides a range for the benefits. In addition the benefits are ‘net benefits’ to the fishing industry as it also takes account costs implications of reducing fishing in the initial years to get benefits of higher stocks in the future. This has led to reduction in these benefits compared to the Consultation IA, which took a very simplistic approach to valuing these benefits.

ANNEX A: Detailed Indicators for Descriptors 1, 4 and 6

See separate document

ANNEX B: Assessment of degradation across the different ecosystem components and pressures

See separate document

ANNEX C: Methodology for presenting benefits as GVA and operating profit

Gross Value Added

- Gross value added is the measure of the contribution of a producer, industry or sector to the economy; in this case, the contribution of the UK fishing fleet to the UK economy. For the Impact Assessment, the income approach to calculating GVA is used, where:

  GVA = sum of remuneration of labour (crew share) + operating profits

- The total income of a fishing fleet consists of fishing income and non-fishing income. Fishing income comes from the value of the landings made by a fishing fleet in a year (i.e. revenue). From this, it is assumed that GVA as a proportion of total income is the same proportion as GVA relative to the value of landings. The proportion of GVA that constitutes total income is found by:

  GVA as percentage of total income = [(crew share +operating profits)/ total income] * 100

- GVA from the estimated value of landings is found by:

  GVA from the value of landings = value of landings of each stock * GVA as percentage of total income

  It is assumed that GVA as a proportion of the value of landings stay constant over the whole analysis period.

Operating profits

- Operating profits from the estimated value of landings were also calculated as a lower bound estimate of the benefits of fishing at MSY. Again, information on total income and operating profits of the UK fishing fleet from Seafish's Economic Survey of the UK Fishing Fleet 2006 to 2009 surveys were used, and were categorised according to the broad gear types.

- Operating profits as a proportion of estimated value of landings is calculated by:

  Operating profits as proportion of value of landings = estimated value of landings * (operating profits/total income)

  It is assumed that operating profits as a proportion of landings stays constant over the whole period of analysis.

Table 1. GVA and Operating Profits as percentage of Total Income, according to gear type and region

Broad gear type (region)	**GVA percentage of total income**	**Operating profits percentage of total income**
Dredges (North Sea)	42%	17%
Dredges (South West, South East, Irish Sea)	47%	21%

Bottom trawls (North Sea)	37%	11%
Bottom Trawls (South West, South East)	42%	15%
Bottom Trawls (Irish Sea)	40%	13%
Mid-water trawls (all regions)	56%	43%
Pots (all regions)	48%	21%
Nets (all regions)	44%	16%
Hooks and Lines (all regions)	59%	33%
Collection by hand (all regions)	46%	21%

- For the analysis, it is assumed that a species in a particular ICES area is targeted by particular fishing fleets belonging to a broad gear type category (see Table 2 below). The fishing fleets in Seafish's Economic Survey of the UK Fishing Fleet have been categorised according (but not limited) to the areas fished[207]; therefore it is reasonable to assume that a stock of species found in a particular ICES area is harvested by a particular fleet as categorised in the Seafish survey.

- Seafish Economic Surveys data are the best available evidence that can be used to calculate the Gross Value Added and operating profits of vessels that target the stocks under consideration. Limitations to these data are:
    - The specification of the fleet segments is not consistent for every year.
    - The data is only available for the years 2006 to 2009 and therefore do not fully reflect the annual variability in the economic performance of fleet segments.
    - In the surveys, total income includes both fishing and non-fishing income. However, in calculating the benefits of fishing at Fmsy, only value of landings (fishing income) is taken into consideration. This means that applying values that are derived from data that include non-fishing income (GVA and operating profit percentages relative to total income) onto values that represent fishing income may result in underestimates or overestimates of the benefits.

Table 2. Fishing gear used to harvest species

Fish species and area	**Gear typically used to harvest the species[a]**	**Broad gear type assumed to be used to harvest the species**
North Sea (IV) Cod	Otter trawls and gillnets	Bottom trawls (North Sea)
North Sea (IV) Whiting	Trawls	Bottom trawls (North Sea)
North Sea (IV) Haddock	Demersal trawlers (single, twin and pair) and (to a lesser extent) by seiners	Bottom trawls (North Sea)
Irish Sea (VIIa) Cod	Otter trawls	Bottom trawls (Irish Sea)
Irish Sea (VIIa) Sole	Beam trawls	Bottom trawls (Irish Sea)
West Channel (VIIe) Plaice	Beam trawls (taken as by-catch) and otter trawls	Bottom trawls (South West and South East)

[207] Other categories include physical characteristics of vessels, activity level, the gear used and species targeted

West Channel (VIIe) Sole	Beam trawls, otter trawls, gill nets	Bottom trawls (South West and South East)
North Sea (IV) Sole	Beam trawls and otter trawlers and gillnets (as by-catch)	Bottom trawls (North Sea)
West of Scotland (VIa) Haddock	Bottom trawls	Bottom trawls (North Sea)
[a] Source: ICES 2012 advice, http://www.ices.dk/advice/icesadvice.asp		

ANNEX D: MSY Fishery Simulations

This annex outlines the simulated stock projections used as the basis for the fisheries benefits calculations. It sets out the simulated stock projections used to evaluate the potential outcome in terms of the future development of catches (landings and discards) and spawning stock biomass, during management scenarios in which the fishing mortality rate is adjusted to the level that will achieve maximum sustainable yield over the long term. For stocks in which there is uncertainty about future levels of the recruitment of young fish to the stock (recruits) additional simulations were conducted to evaluate impact on the potential yields.

Fishing mortality

For each fish stock a series of potential scenarios for the expected development of fishing mortality rate towards F_{MSY} were examined:

1. A continuation of the most recent trend in realised fishing mortality rates as derived from the 2011 ICES assessment. These scenarios represent the likely continuation of the current management; for instance a 1.5% reduction per year for North Sea cod, despite the current management plan attempting to achieve a higher rate of reduction.
2. Where the fishing mortality is currently at the ICES assumed value of F_{MSY} or at the level of the agreed management target then the fishing is maintained at that rate.
3. Where the fishing mortality exceeds the target F_{MSY} a series of transitions towards the target were evaluated
    a. For stocks for which there is an agreed management plan for transition to F_{MSY} this was used as the basis for the projected reduction in mortality rate.
    b. Where there is no agreed plan two scenarios are presented
        i. a reduction to F_{MSY} in one year
        ii. a staged reduction of 10% per year as has been agreed for flatfish stocks in the North Sea
4. For species which are caught together in mixed fisheries if one stock requires a more substantial reduction in mortality rate than the other species then the changes in relative mortality rate and the time period over which that change is required, are applied to the other stocks within the fishery; for instance reductions in North Sea cod mortality currently prevent the achievement of the haddock mortality targets.

In each stock section a base case and a most likely future scenario under MSFD are described. Where there are no agreed plan for transition to F_{MSY} and current fishing mortality exceeds F_{MSY}, a staged reduction of fishing mortality at a rate of 10% per year has been taken as the most likely scenario to achieve MSY targets.

Realised fishing mortality may differ from the management target as a result of constraints on the annual change in TAC, unforeseen changes in discarding patterns and also noise in the biological and management processes. The noise in the system has been modelled but stock specific TAC constraints have not, in the long run the constraints will not affect the level of yield achieved they generally only impact on year to year variation.

Stock and recruitment

Along with the future fishing mortality strategy, the major factor determining the trajectory of future biomass and yield is the linkage between the adult spawning biomass and the recruitment that it produces. For several stocks historic recruitment levels have been higher than in recent years due to reductions in stock size and also potential changes in survivorship and productivity.

An example is presented in Figures x.1 and x.2 for North Sea cod. Figure x.1 illustrates the time series of recruitment, during the 1970's and 80's recruitment and spawning biomass were both high, during the 1990's and 2000's over-exploitation reduced spawning biomass and recruitment levels declined with it. In recent years, despite a reduction in fishing mortality rate recruitment levels have remained low since 2000 which may result from the low stock abundance or alternatively the poorer environmental conditions in recent years.

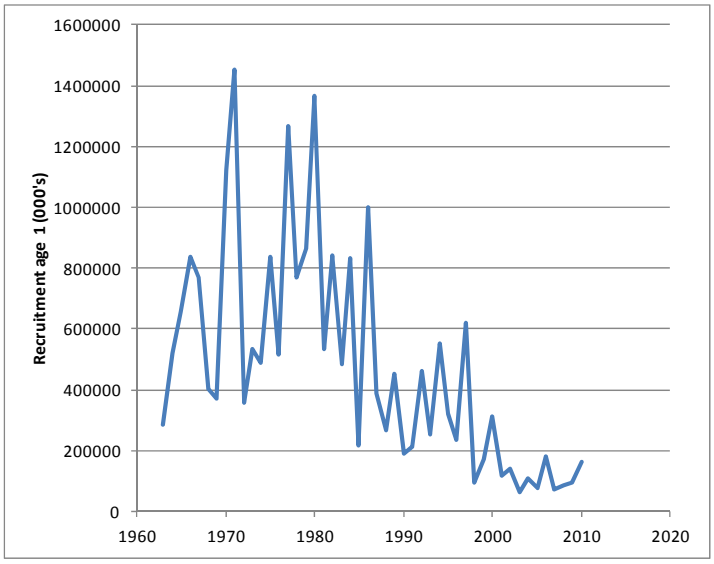

Figure x.1. The time series of North Sea cod recruitment at age 1, illustrating the lower level of recruitment recorded since 2000 which may result from the low stock abundance or alternatively the poorer environmental conditions in recent years.

Figure x.2 presents the fit of two alternative models for the future response of North Sea cod recruitment to the increased spawning biomass resulting from a reduction in fishing pressure. An "optimistic" model represents recovery of young fish recruitment to the historic levels recorded in the 1970's and 80's. A "pessimistic" model assumes that recruitment does not recover at high biomass abundance but remains at its current low level.

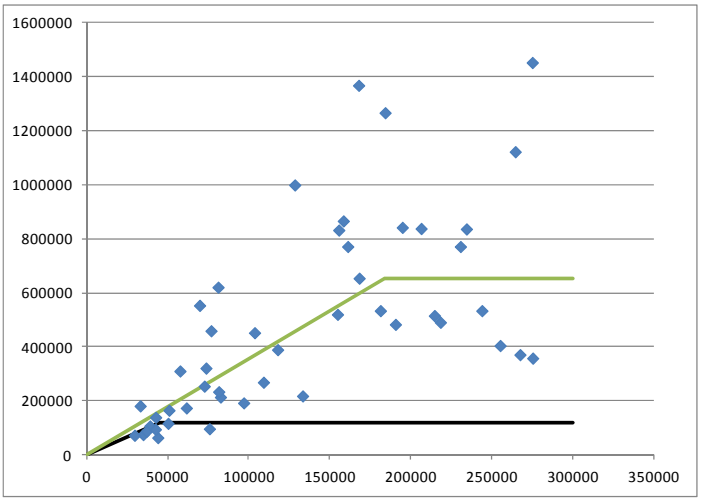

Figure x.2. The fit of a model that assumes constant recruitment after spawning biomass exceeds a set threshold for a pessimistic model that assumes recruitment does not recover at higher biomass abundance (black) and a second more optimistic model that allows for recover of recruitment abundance to the historic levels.

The two scenarios simulate the potential impact of future changes in the North Sea environment on recruitment to the cod stock and reflect current scientific uncertainty about the dynamics of the cod stock to environmental factors resulting from warming of the North Sea. There is currently a scientific debate as to whether the environment is becoming less favourable for survivorship young cod. Despite a rebuilding of the North Sea cod adult biomass in recent years there has been no resulting increase in the abundance of young fish produced by the stock; the productivity of the North Sea for young cod may have changed. Additionally, some observers have commented that the high abundance of cod during the 1970's and 1980's was an artefact of environmental conditions prevalent at that time that resulted in a gadoid (cod whiting and haddock) outburst which supported uncharacteristically high populations. The two models reflect the current uncertainty as to the future dynamics of the North Sea cod and are used to evaluate management plans.

The high recruitment model is considered optimistic, but does capture the dynamics of the historic data and is therefore considered one of the likely future scenarios with increasing recruitment levels following increased adult biomass. The pessimistic model is a "worst case" scenario in which future recruitment remains independent of the increased biomass of adults. It is likely that with warming of the North Sea over time and the simulation results therefore bracket the range of future recruitment, biomass and consequent catch that would be achieved by fishing at $F_{MSY.}$

Discarding scenarios

Currently there is substantial discarding within some European fisheries which reduces potential yield by either wasting marketable fish or killing fish at a young age before they have had a chance to grow. The discarded fish are assumed dead in the model, which is reasonable for the fisheries and stocks evaluated.

A discard ban is being discussed within the revised CFP consequently once imposed it is assumed that undersized fish caught in a mixed fishery will be landed. Assuming that the industry does not change its selectivity to avoid discarding small fish, due to the potential loss of value resulting from landing small fish, two potential scenarios could be envisaged:

1) Business as usual; discarding continues unchanged the CFP reforms are ineffective

2) A total discard ban is effective and yields are increased by landing the small fish that would have been discarded. To simulate this the model output of discards weight can be added to landings over the required time period.

In the target MSY scenario, it is assumed that a discard ban becomes operational in 2018 and is 100% effective.

Simulation approach

The information required for the stock projections is taken from the ICES 2011 assessments. The simulation approach uses the basic ICES forecast procedure, extending the year range and adding a linkage between the recruitment, fish entering the stock at the youngest age, and the adult spawning stock biomass as well as stochastic random variation simulating environmental and measurement noise. Populations at each age are carried forward in time and subject to natural mortality and a specified fishing mortality regime. Yield from the stock (landings and discards) is calculated each year. The projections are repeated 1000 times for each evaluation following the addition of random noise in the starting values.

The simulations assume that compliance with the regulations is 100%. They are not considered to represent all of the future uncertainty, which is uncertain, but a subset of it. The model is a first order approximation which allows some of the variation in yield and future stock dynamics to be explored. Short-term dynamics would be expected to be characterised better than the medium to long-term because, as stock abundance increases, a number of changes would be expected to occur in a stock's biology and environment for which there is currently no data. For example:

- Density dependent changes in growth and maturation;
- Changes in natural mortality through increased levels of predation and cannibalism;
- Environmentally-driven changes in recruitment variation.

More specific information on the stock simulations for each of the 7 stocks which were analysed is provided in attached documents.

ANNEX E: Using other fishing mortality scenarios

Alternative Fmsy target scenarios were also modelled to see the impacts of these scenarios on landings and benefits. These are described in Table 1 below, and they are based on either 1) a more optimistic ambition for the reduction in fishing mortality, or 2) on the pace at which fishing mortality for the stock is reduced. The table below provides the benefits from these other Fmsy target scenarios for the different fish stocks, where these scenarios were provided[208].

Table 1. Present value of benefits under different Fmsy targets

Fish Stock	Fishing mortality scenario	UK Relative Stability	Price (£ per tonne)	Benefits under a different Fmsy target	
				13 years	18 years
North Sea Cod (ICES area IV)	Baseline: Fsq = 0.68Target: 10% annual reduction until F=0.19 under high recruitment conditions	0.32	Landings: £1,800 Discards: £600	-£2.1m to £10m	-£1.8m to £20.5m
North Sea Haddock (ICES area IV)	Baseline: Fsq = 0.23 Target: Haddock mortality dependent on Cod mortality; 10% annual reduction until fishing mortality for Cod reaches F=0.19	0.7761	Landings: £1063 Discards: £354		
North Sea Whiting (ICES area IV)	Baseline: Fsq= 0.27 Target: Whiting mortality dependent on Cod mortality; 10% annual reduction until fishing mortality for Cod reaches F=0.19	0.5274	Landings: £1042 Discards: £347		
Irish Sea Sole (ICES area VIIa	Baseline: Fsq= 0.31 Target: Immediate decrease in fishing mortality to the current ICES target mortality of Fmsy=0.16 under low and high recruitment conditions	0.2219	Landings: £8980	-£10.6K to £7.8K	£137 to £134K
Western Channel Plaice (ICES area VIIe)	Baseline: Fsq= 0.45 Target: Immediate decrease in fishing mortality to the current ICES Fmsy framework target mortality of Fmsy=0.19	0.2908	Landings: £1007	-£19K to -£55K	-£17K to -£49.5K
North Sea Sole (ICES area IV)	Baseline: Fsq= 0.34 Target: Immediate decrease in fishing mortality to the current ICES Fmsy framework target mortality of Fmsy=0.22 under low and high recruitment conditions	0.0428	Landings: £8980	-£66K to -£319K	-£102K to £18K

[208] There was no alternative Fmsy scenario for the West of Scotland Haddock

The values of the difference between the central scenarios and the scenarios with different Fmsy or rate of fishing mortality reduction targets show that there can be a significant difference in the benefits, depending on which scenario occurs. Taking the North Sea mixed fishery as an example; if the fishing mortality for Cod is set at the more ambitious F=0.19 (instead of F=0.4), then the benefits would be lower at both the 13 and 18 year periods. This is because at a fishing mortality of F=0.19, less fish have to be caught in order to achieve this target, which means less landings overall. However, at a longer time scale (e.g. >30 years), the benefits will be higher due to the recovery of the stock, which means that more fish may be caught and landed.

ANNEX F: Mixed fishery considerations for cod, haddock and whiting in the North Sea

Medium term Total Allowable Catch (TAC) forecasts are generally based on single-species considerations which do not take into account species interactions (i.e. predator-prey relationships), or technical interactions (the consequence multiple species being fished simultaneously). Both issues can affect the productivity of fish stocks and yield from fisheries and mean that achieving single species exploitation targets for all species simultaneously (including single-species Fmsy values) may not be possible. Multispecies interactions can affect growth and natural mortality rates for stocks, whilst technical interactions can be a cause of discards if the TACs are not consistent.

In the North Sea, technical interactions are considered an important management issue and ICES Working Group on Mixed Fisheries in the North Sea (WGMIXFISH; ICES, 2011) has developed methods for providing mixed fishery advice for the 7 principal demersal stocks in the North Sea (cod, haddock, whiting, saithe, plaice, sole and *Nephrops*) in order to explicitly linking the actions of fishing one stock on another through a fleet and fishery approach.

WGMIXFISH considers whether – and to what extent – management targets for individual commercial species (fishing mortality levels corresponding to a set level of removals) are likely to be undermined by mixed fisheries interactions. The approach taken in WGMIXFISH assesses the amount of fishing effort (time spent fishing) required to catch the TACs for each of the species based on a number of scenarios. These scenarios include i) the fishery for all species closing when the first TAC is reached; ii) the fishery stays open until the last TAC is reached; iii) the fishery closes when the cod TAC is reached (being the stock currently in the worst condition); iv) where the fishing effort does not change year from year, v) where fishing effort is reduced year on year until the cod management target is reached.

The MIXFISH advice for 2012 concluded that meeting the single species exploitation boundary for cod under current fishing patterns would mean reducing landings of haddock and whiting 45% and 21% below their single species landings TACs respectively (cod scenario; Figure 1); conversely achieving the total cumulative landings of cod, haddock and whiting based on single stock considerations would mean over-exploiting cod and whiting (max scenario, Figure 1). This conclusion is broadly similar to the medium term simulations presented here.

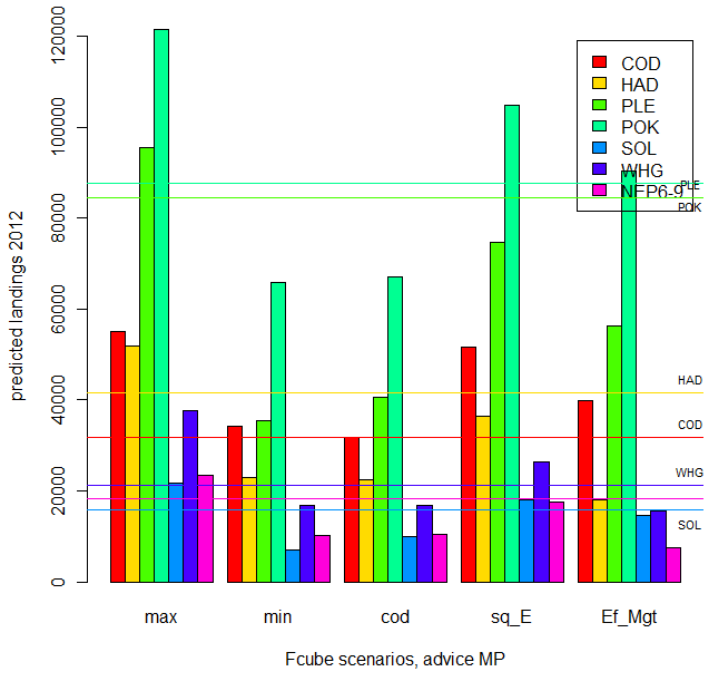

Figure 1. TAC year results (2012). Fcube estimates of potential landings by stock after two successive years of applying the Fcube scenarios. Coloured horizontal lines correspond to the TAC set by the single stock advice (as reproduced by the 'baseline run').

The consequences of mixed fishery interactions mean that in order to stay within single-species Fmsy values total (cumulative) yield must be compromised, some overexploitation above Fmsy levels can be expected or fishery patterns must change to provide consistency between TACs. Several management techniques are currently in place to reduce catches of cod and allow exploitation of healthier stocks, such as juvenile and Real Time Closures (closing areas where juvenile cod are found or areas of high cod abundance) and changes to fishing gear (to allow cod to escape). Such management measures are likely to be increasingly necessary in the future if the yield from fisheries is to achieve the higher range of estimates in these projections.

References

ICES. 2011. Report of the Working Group on Mixed Fisheries Advice for the North Sea (WGMIXFISH), 29 August - 2 September 2011, ICES Headquarters, Copenhagen, Denmark. ICES CM 2011/ACOM:22. 94 pp.