VALUING THE BENEFITS OF DESIGNATING A NETWORK OF SCOTTISH MPAs IN TERRITORIAL AND OFFSHORE WATERS

A report to Scottish Environment LINK

Instituto de Recursos Naturales y Ordenación del Territorio
Universidad de Oviedo
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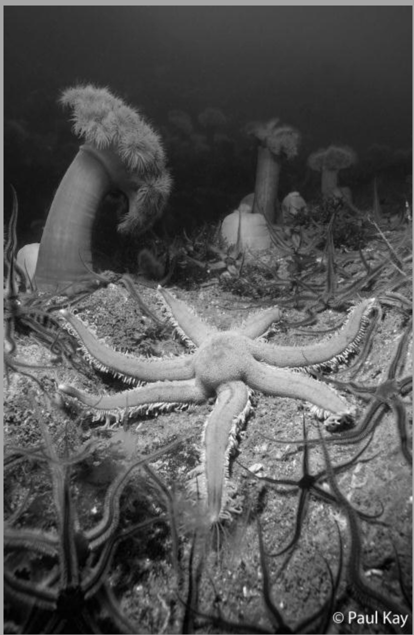
NOVEMBER 2012



Scottish reef with seven-armed starfish (*Luidia ciliaris*), plumose anemones (*Metridium senile*) and black brittlestars (*Ophiocomina nigra*)

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Scottish Environment LINK is the forum for Scotland's voluntary environment community, with over 30 member bodies representing a broad spectrum of environmental interests with the common goal of contributing to a more environmentally sustainable society.

Scottish Environment LINK's Marine Taskforce comprises the following organisations:

Hebridean Whale and Dolphin Trust
Marine Conservation Society
National Trust for Scotland
RSPB Scotland
Scottish Ornithologists Club
Scottish Wildlife Trust
WWF Scotland
Whale and Dolphin Conservation

For more information please see www.savescottishseas.org or www.scotlink.org

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[1] Formally of the Scottish Agricultural College prior to the merger to become SRUC in 2012

FOREWORD

Scotland's wealth and our individual wellbeing are dependent on the marine environment and the resources, also known as goods and services, it provides. Sometimes the economic value of these resources is obvious – the provision of food, energy or protection from storms, to name just three. Sometimes it's less so – the crucial role our seas play in regulating climate and the value we place on their existence for future generations, for instance. But regardless of whether these values are obvious or not, collectively we have failed to fully appreciate and protect our seas, whilst taking many of their services for granted. This has left virtually every marine habitat type and many marine species, as shown by Scotland's Marine Atlas[2], in a declining state or of concern.

£6.3 billion - £10 billion - the estimated benefits of a network of Marine Protected Areas in Scottish waters over 20 years.

But there is time to change. In fact, we have to change. As our population grows, and with it our demands for everything from food to energy, we will become even more dependent on the goods and services our marine environment provides. We will need more food. We will need more renewable energy. We will need more protection from extreme weather events. And in this increasingly busy world, we will need more of the benefits to our wellbeing that the seas provide.

In order to change, and make the best, most sustainable decisions, it is vital that we better understand the value of our seas – in economic as well as environmental and social terms, recognising, of course, that the environment is important for its own sake. However, economics is a language that private and public sectors alike understand. There has already been major research outlining the value of natural services in the shape of the UK's 'National Ecosystem Assessment'[3] and the United Nations-led 'The Economics of Ecosystems and Biodiversity'[4] studies. Whilst valuing goods and services is still a developing area of work, both studies identified that failing to recognise the economic values derived from natural assets leads to their overexploitation and inept decision-making for their management.

Fortunately, we are making progress. The Scottish Government is currently identifying a network of Marine Protected Areas (MPAs) – comprising both existing sites and new nature conservation MPAs. Alongside other measures such as marine planning, these MPAs have the potential to help protect *and recover* Scotland's seas.

Commissioned by Scottish Environment LINK's Marine Taskforce, this report attempts, for the first time, to estimate the benefits provided by designating a

[2] http://www.scotland.gov.uk/Publications/2011/03/16182005/0

[3] http://uknea.unep-wcmc.org/

[4] http://www.teebweb.org/InformationMaterial/TEEBReports/tabid/1278/Default.aspx

network of Marine Protected Areas for nature conservation in Scottish waters. Why? Because, by understanding the economic benefits provided by the goods and services that a network of MPAs can help support, decision-making can be improved.

Of course, like many similar studies these values are limited by the data available, which means that many of the figures are almost certainly underestimates. It is not possible, for example, to put a current value on the contribution a network of MPAs makes to removing pollutants. Nor has this report been able to calculate the possible off-site economic benefits a network of MPAs could bring, such as the increased fish and shellfish populations spilling-over into surrounding waters documented in ecological studies. Nevertheless, the results are eye-opening.

The study estimates that in just 20 years the overall benefit of a network of MPAs in Scottish offshore and territorial waters is somewhere between £6.3 billion and £10 billion. There is real potential here to help create a flourishing Scotland[5] - the decisions to designate and properly manage these MPAs are therefore critical.

While the benefits here are estimated for a range of theoretical MPA networks[6], the findings identify elements that may help maximise the benefits of any MPA network. Notably, the greatest benefits arise in those networks which protect a high proportion of threatened and declining habitats and species. The findings also indicate that significant benefits arise from halting those activities currently having detrimental impacts on some areas of the marine environment and their dependent species, such as bottom-towed fishing gear. Furthermore, protecting spawning and nursery grounds within the network also appear to help maximise benefits. Additional analysis should further explore these and other influential factors to make sure the findings are used to strengthen Scotland's MPA network.

This report illustrates what economic benefits we can hope to see in Scotland should a network of MPAs be used in tandem with other measures to protect and recover our seas. But these benefits will only flow if this network is well-designed and well-managed[7]. Whilst we will never be able to fully quantify the total worth of our seas, one thing is now clear: the economic value derived from designating an ecologically-coherent Scottish MPA network, to help secure healthy and productive seas, is potentially so great that it makes plain economic and social, as well as environmental sense, to do so.

Scottish Environment LINK's Marine Taskforce

[5] www.scotlink.org/files/policy/PositionPapers/LINKHelpingScotlandFlourish.pdf

[6] At the time of writing Scotland's proposed network was not complete

[7] Further information on how a network should be designed and managed can be found on the Scottish Environment LINK and SaveScottishSeas websites.

EXECUTIVE SUMMARY

i. The marine environment provides us with many goods and services upon which we rely, such as food production, climate regulation, recreational enjoyment and storm protection. Furthermore, Scotland's seas are a hugely important natural resource upon which many jobs and industries depend. The provision of these goods and services depend on a healthy and well-functioning marine ecosystem. However, there is growing evidence that many marine ecosystems have been degraded. During recent years there has been a policy shift towards a holistic ecosystem approach to manage marine environments with an objective of reversing the degradation of the marine ecosystems, as well as recognising the relevance of such marine ecosystem services for society.

ii. In this sense, the Marine (Scotland) Act 2010 provides a great opportunity to improve the state of our seas and adapt to current international conventions regarding integrated marine management. Notably, amongst other tools such as marine planning, it requires Scottish Ministers to designate new Nature Conservation Marine Protected Areas (MPAs) to create an ecologically coherent network of well-managed sites that contribute to the conservation or improvement of the Scottish marine area.

iii. However, the move to integrated management, and in particular the implementation of regulatory tools such as MPAs, requires the collaboration and support of a broad range of stakeholders. Economic valuation provides an important tool to help with the successful implementation of MPAs by providing a common unit to measure the socio-economic benefits for the different stakeholder groups. A full understanding of social and economic benefits of establishing a MPA network should help to ensure support and compliance from all sea users and the general public.

iv. In this context, INDUROT was commissioned by Scottish Environment LINK to determine a monetary valuation of the benefits of designating a network of MPAs in Scottish territorial and offshore waters. These benefits range from the potential to reverse the decline of fishing populations and productivity to the enhancement of marine tourism and broadening of local economic options. Moreover, it would offer opportunities for education, training, heritage and culture. The conservation of biodiversity and marine ecosystems will also contribute to the maintenance of important services such as climate regulation, or prevention and alleviation of environmental disturbances.

v. The specific objectives of the present study are summarised are as follows:

- Clearly state the socio-economic benefits an ecologically coherent network of well managed marine protected areas would bring to Scotland's industries and local communities.
- Provide an economic valuation in monetised terms of the likely range of benefits Scotland should expect to see from designating a network of MPAs.
- Identify, where possible, the key factors which are critical for the benefits to be realised.

vi. The adopted methodological approach has been based on a previous study from the Scottish Agricultural College (SAC) and the University of Liverpool (Moran *et al.*, 2007 – CRO 380 report), although some changes have been introduced in order to update estimated economic values and to improve the representativeness of the data for the particular case of Scotland. Furthermore, an economic estimation for non-use values has been considered in this study.

vii. This study estimated the economic value arising from the designation of three theoretical networks of MPAs in Scottish territorial and offshore waters. These three networks (A, G and I) were selected from the output of a previous Defra analysis (Richardson *et a*l., 2006). Two different types of management regimes/levels of restriction were applied to MPA sites within each network scenario, i.e. 'Highly Restrictive' (HR-MPA) and 'Maintenance of Conservation Status' (MCS-MPA). Further, to illustrate the range of likely benefits, the valuation exercise assumed that three given combinations of designation would apply, with the split between HR-MPA and MCS-MPA being as follows: 10%/90%; 20%/80%; 30%/70%.

viii. The benefits resulting from the application of either HR-MPA or MCS-MPA to a particular network scenario stand up because they avoid future damages arising. These benefits can be broadly classified as on-site (occurring within the sites designated as MPAs) and off-site (occurring outside designated sites). This study focused on on-site benefits in the form of changes in the provision of ecosystem goods and services as compared with *status quo* (i.e. no MPA network designation) scenario. Such on-site benefits pertain to the delivery of ecosystem goods and services like food provision, nutrient recycling, gas/climate regulation and non-use values.

ix. Firstly, the study carried out an aggregate valuation of marine ecosystem services provided by the entire UK marine environment. Taking into account that conducting new (primary) valuation studies is highly costly and time-consuming, a Benefits Transfer (BT) methodology has been adopted. This approach consists of transferring valuation estimates from previous primary studies elsewhere to the policy study site.

x. The concrete benefits of designating a Scottish network of MPAs were derived by apportioning these total value estimates to the biophysical changes associated with the implementation of a particular network scenario (A, G and I) and management regime (MCS-MPA or HR-MPA). These benefits arise through time (a 20 year period has been considered) and their value was expressed both in present value terms (using a discount rate of 3.5%) and in terms of undiscounted mean annual benefits.

xi. The overall on-site benefits of designating a Scottish network of MPAs range between £6.3 billion and £10 billion depending on the assessed network scenario and management regime combination (present values: 3.5% discount rate over a 20 years period). The undiscounted mean annual benefits range from £566 million to £758 million.

xii. The highest values are provided by Scenario G although it covers approximately the same area as Scenario I. This is a consequence of the additional criteria for each scenario, since Scenario G focuses on protecting nursery and spawning areas essential to life history stages.

xiii. It is also interesting to highlight the fact that the benefits hardly increase when a higher proportion of the more restricted management regime (HR) is applied. This might indicate that the expected benefits of designating a Scottish MPA network does not depend substantially on the HR/MCS split. This is probably related to the fact that both management regimes prevent the development of activities that currently have negative impacts across the marine environment (e.g. both HR and MCS management regimes restrict bottom fishing gears). Nonetheless, given the degree of uncertainty associated with the assessment of the positive impacts arising from both HR-MPA and MCS-MPA designation, and following a precautionary approach, it is difficult to be conclusive about this particular issue.

xiv. The estimated benefits include both use (direct and indirect) and non-use values. The non-use values accounts for around 12%-14% of the overall on-site benefits, depending on the network scenario and the applied management regime; while use values (direct and indirect) sum up the remaining 86%-88% (ranging between £5.5 billion and £8.9 billion, 3.5% discount rate over a 20 years period).

xv. A sensitivity analysis has been carried out considering two elements of the analysis: the aggregate value estimates for the ecosystem service categories and the positive impact of MPA designation upon the delivery of marine ecosystem goods and services (estimated by the CRO 380 report through expert assessment). Following a precautionary approach, the sensitivity analysis has considered the low end of the range for certain aggregate economic values and the percentage of improvement derived from MPA designation.

xvi. The present value estimates resulting from the sensitivity analysis vary depending on the assessed network scenario and management regime combination (present values: 3.5% discount rate over a 20 years period). These results represent an average drop of 30% (£4.3 billion-£7.2 billion) for what can be considered as 'worst case scenario' compared to what is considered as the 'best estimate' (£6.3 billion-£10 billion). Consequently, if the sensitivity results are taken into consideration the expected benefits would range between £4.3 billion and £10billion.

xvii. There are several caveats that should be highlighted in relation to the estimates derived from this study. Firstly, the precision of Benefits Transfer (BT) depends on the availability of studies corresponding to the relevant benefit categories identified. Existing data on marine goods and services valuation is scarce, and thus, it did not allow a comparison of a large number of studies (meta-analysis) to increase estimations reliability.

xviii. The final results presented pertain to ecosystem goods and services categories for which an aggregate value was estimated. There are several categories for which such estimation was not possible due to a lack of data/pertinent studies, i.e. bioremediation of waste, biologically mediated habitats, resistance and resilience, cultural heritage and identity, and option use values. These values are likely to be substantive but they could not be included in the monetary analysis. Therefore, the estimated values should be taken as a minimum benefit, taking into consideration that a complete estimation of the Total Economic Value (TEV) could not be undertaken.

xix. Off-site benefits derived from the designation of a MPA network have been ruled out of the analysis. Although there are different studies showing good evidence of increasing abundance and catch sizes in both protected and surrounding areas, there are not robust and reliable valuation studies to allow the translation of these positive impacts into monetary estimates. If further research is carried out, the off-site economic benefits should be added to the on-site benefits estimated in the present report.

xx. The potential positive systemic network effects (positive synergies derived of the fact of designating an ecologically coherent network) have not been considered due to the lack of literature on the valuation of this systemic effect. Taken together, these caveats provide a note of caution to the estimates derived. However, they do not invalidate the approach adopted in this study.

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1.
INTRODUCTION

1.1. BACKGROUND AND JUSTIFICATION OF THE PROJECT

Scotland has a rich and diverse marine environment that covers a surface area that is over 6 times our terrestrial land mass and our coastline and hosts a wide variety of marine species and habitats. Current estimates suggest there are around 6,500 species of animals and plants (excluding the microbial flora) in Scotland's seas spread along diverse distinctive and unique natural habitats (Marine Scotland, 2011a). These habitats and the resources they support provide society with a valuable and diverse set of goods and services, including seafood, recreational enjoyment, carbon sequestration, storm protection, climate regulation and opportunities for pharmaceutical discoveries. Furthermore, Scotland's seas are a hugely important natural resource upon which many jobs and industries depend, for example those related with commercial and recreational fisheries and tourism and recreational activities. All of these goods and services and dependent industries rest on a healthy and well-functioning marine ecosystem.

Nonetheless, there is growing scientific evidence that many marine ecosystems, both in Scotland and all around the world, have been degraded due, mainly, to anthropogenic factors such as overfishing and other threats like siltation, sedimentation from run off, pollution and increasing population and tourism activities (Frid *et al.*, 2003; Sanchirico *et al.*, 2002; The Scottish Government, 2011). Traditionally, marine resources have been managed on a sectoral basis that has not been able to reverse the degradation of our seas. As a response, over recent years there has been a growing policy shift towards a more integrated management approach with the main objective of recognising the multiple interdependencies that compete for ocean space and the relevance of marine ecosystem services for society.

Several international conventions have highlighted the aforementioned necessity of adopting an integrated management approach for the marine environment and its resources. The 2002 Johannesburg World Summit on Sustainable Development, the OSPAR Convention for the Protection of the marine environment of the North-East Atlantic and the European Habitats Directive and Marine Strategy Framework Directive specifically require the development of MPA networks to protect marine biodiversity.

In this sense, the Marine (Scotland) Act 2010 and the Marine and Coastal Access Act 2009 provide a great opportunity to improve the state of our seas and adapt to current international conventions regarding integrated marine management. Notably, amongst other tools such as marine planning aiming to achieve a clean, healthy, safe, productive and biologically diverse marine and coastal environment, they require Scottish Ministers to designate new Nature Conservation Marine Protected Areas (MPAs) to create an ecologically coherent network of well-managed sites that contribute to the conservation or, where appropriate, improvement of the Scottish marine area.

MPAs are defined as *"…areas of sea specially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means."* (IUCN, 1994). MPAs management schemes can be either extremely protective against various forms of human exploitation and activities or can be designed as multiple-use areas that are often zoned to provide different levels of protection, and permit various activities and resource usage (Baker, 2000).

The designation and implementation of a well-managed and ecologically coherent MPA network will contribute to halting and reversing the degradation of the marine environment and, thus, would make a positive impact on the delivery of the vast array of goods and services that a healthy marine environment provides. Different studies have already highlighted the socio-economic and environmental benefits for industries, local communities and the marine environment that can be gained in establishing a MPA network (Becker and Chores, 2006; Kenchington *et al.*, 2003; Sanchirico *et al.*, 2002). These benefits range from the potential reversal of declining fishing populations and productivity by protecting critical breeding, nursery and feeding habitats to the enhancement of the area's profile for marine tourism and the broadening of local economic options. Moreover, it would offer opportunities for education, training, heritage and culture. The conservation of marine ecosystems will also conserve and improve the delivery of important services such as climate regulation, removal of pollutants or prevention and alleviation of environmental disturbances (e.g. flooding episodes).

The shift towards integrated management, and in particular the implementation of regulatory tools such as MPAs, requires collaboration and support of a broad range of stakeholders, sea-users and the general public. In this sense, economic valuation provides an important tool to help with the successful implementation of MPAs by providing a common unit to measure the previously stated socio-economic benefits. It is expected that an economic estimation of the benefits of establishing a MPA network should help to ensure support and compliance from all stakeholders and sea users.

With the objective of carrying out such economic valuation, the present study has applied a methodological approach previously developed by the Scottish Agricultural College[8] (SAC) and the University of Liverpool (Moran *et al.*, 2007 – CRO 380 report[9]). These two institutions were commissioned by Defra to determine a monetary estimate of the benefits of designating a network of Marine Conservation Zones[10] (MCZs) in English territorial waters and UK offshore waters as proposed in the UK Marine Bill, which has subsequently been enshrined in UK law as the Marine and Coastal Access Act (2009). This study estimated the value arising from the application of three theoretical networks of MCZs and two different levels of management regimes.

The benefits resulting from the application of these management regimes to each network scenario occur because they avoid environmental damages, allowing the maintenance or improvement of the delivery of a range of ecosystem goods and services. These benefits are normally classified as on-site (occurring within the sites designated as MPAs) and off-site (accruing outside the designated sites) benefits. The CRO 380 report focused on on-site benefits[11]. In economic terms, ecosystem services can also be classed into three broad value categories: direct use, indirect use and non-use values[12]. The CRO 380 report only estimated monetary values for direct and indirect use values. However, for the present study estimations for non-use values have also been included.

The present study has adopted this methodological approach in order to calculate the range of economic benefits derived from the designation of a network of MPAs in Scotland's territorial and offshore waters (Scotland's seas), although some minor modifications have been introduced in order to allow for economic estimation updates.

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[8] SAC has recently become part of Scotland's Rural College (SRUC).

[9] For ease of exposition this report will be cited as CRO 348 report through the rest of the document.

[10] 'Marine conservation zones' is the term applied under the Marine Bill for Marine Protected Areas.

[11] Although the study also considered off-site benefits through a production function model, the scientific evidence of these estimations was considered weak.

[12] A further explanation of these value categories is presented in section 2.3 economic valuation estimates

1.2. PROJECT AIMS AND OBJECTIVES

The main aim of the present project is therefore to assess the social and economic benefits to Scotland of designating an ecologically-coherent network of well-managed MPAs. This broad objective includes the following specific objectives:

- Clearly state the socio-economic benefits an ecologically coherent network of well managed marine protected areas would bring to Scotland's industries and local communities, whilst also highlighting the intrinsic value of marine biodiversity that such a network would protect and, where appropriate, enhance.
- Provide an economic valuation in monetised terms of the likely range of benefits Scotland should expect to see from designating a network of MPAs (taking into account different combinations of network scenarios and management regimes).
- Identify, where possible, the key factors which are critical for the benefits to be realised.

1.3. PROJECT SCOPE

The geographical scope of this study is restricted to Scottish territorial waters (out to the 12 nautical mile limit) and offshore waters adjacent to Scotland as defined in the Marine and Coastal Access Act 2009 (limit of the UK Continental Shelf designated area for the seabed and UK Exclusive Fisheries Zone for the water column). Consequently, this study does not cover the marine areas adjacent to England, Wales or Northern Ireland or areas outwith UK jurisdiction adjacent to Scotland (See Figure 1).

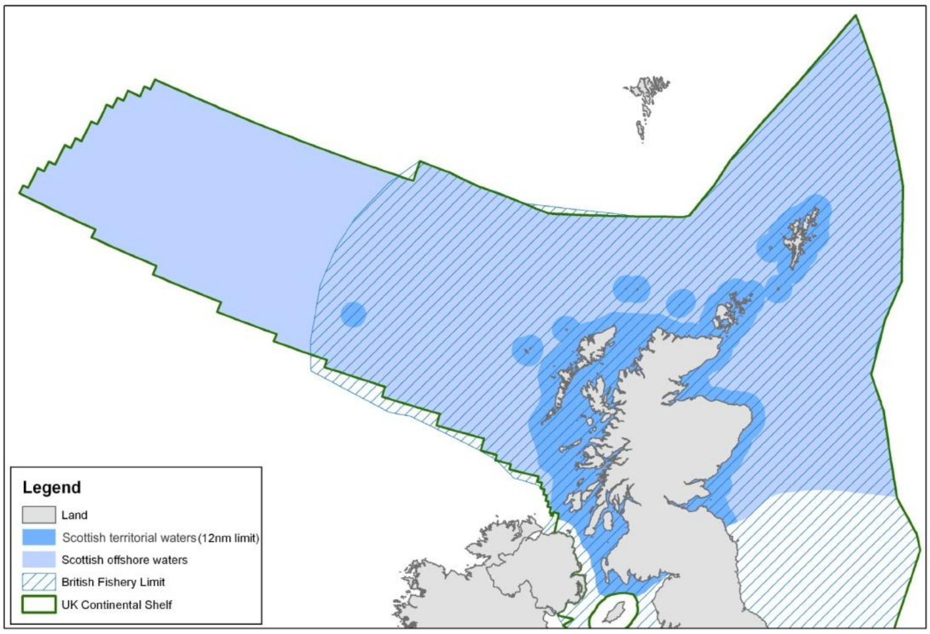

Figure 1. Scottish territorial and offshore waters
(Adopted from Marine Scotland, 2011b - p. 10)

2.
ECONOMIC VALUATION OF ON-SITE BENEFITS

2.1 ADOPTED APPROACH AND METHODOLOGY

As has been stated in the introductory chapter, the present study has adopted the same methodological approach as the CRO 380 report to value on-site benefits of designating a network of MPAs in Scotland's territorial and off-shore waters. This methodology can be summarised as follows:

a) Selection of three MPA network scenarios from the work carried out by Richardson *et al.* (2006) and the specification of two different management regimes for such networks;

b) Identification of the types and extent of the different marine habitats contained in each of the selected MPA scenarios;

c) Reviewing the literature to find estimates for the total aggregated value of the different goods and services provided by UK marine ecosystems and habitats;

d) Splitting these total aggregated values across the different marine habitats;

e) Application of expert judgement analysis and literature review to determine what is known about the current status of each of the marine habitats and what would happen to them if there were no MPA designation - *status quo* scenario (as assessed by the CRO 380 report);

f) Consideration of the effects of the two management regimes on each of the habitats types by category of goods and services in comparison with the *status quo* scenario (as assessed by the CRO 380 report);

g) Economic valuation of the effects of the proposed protection measures (management regimes) by habitat type and goods and services category;

h) Aggregation of these values and application of sensitivity analysis.

2.2 DEFINITION OF THE NETWORK SCENARIOS AND THE MANAGEMENT REGIMES

2.2.1. Defining the network scenarios and the extent of the associated marine habitats

In order to inform the preparation of the partial Regulatory Impact Assessment (RIA), Richardson *et al*. (2006) were commissioned by Defra to develop a number of MPA network scenarios based on varying OSPAR criteria and other additional criteria used in the site selection. In total 12 possible MPA network scenarios were developed based on available information on the distribution of OSPAR Threatened and Declining Habitats (TDH) and UK Marine Landscapes. The three network scenarios (A, G, and I) selected by the CRO 380 report from Richardson *et al.* (2006) were used for the purposes of the present study (See Table 1 and Figures 2-4[13]). Figures in Appendix A present the three network configurations.

[13] These Figures can be seen with a higher level of detail in Appendix A.

Table 1. Synopsis of the extent and protection criteria for Network Scenarios A, G and I.

Scenario	% of OSPAR Species and Habitats included	% of Marine Landscapes included	Network size for the UK (1000 km^2)	Network size within Scotland's seas (1000 km^2)	Additional criteria
A	20%	10%	125.7	76.9	None
G	60%	10%	156	102.4	Commercial fishery species spawning and nursery areas preferred to protect areas essential to life history stages
I	60%	10%	147.2	96.1	Locked out sites licensed for aggregate extraction, dredging and dredge disposal activities

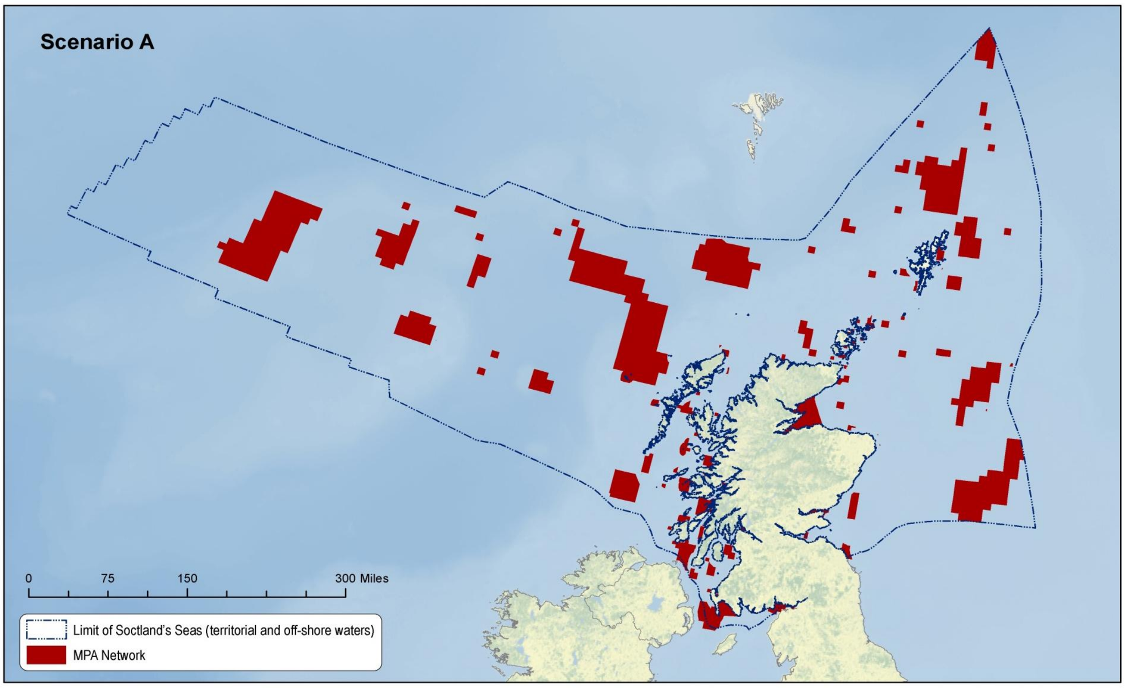

Figure 2. Illustration of MPA sites – Scenario A.

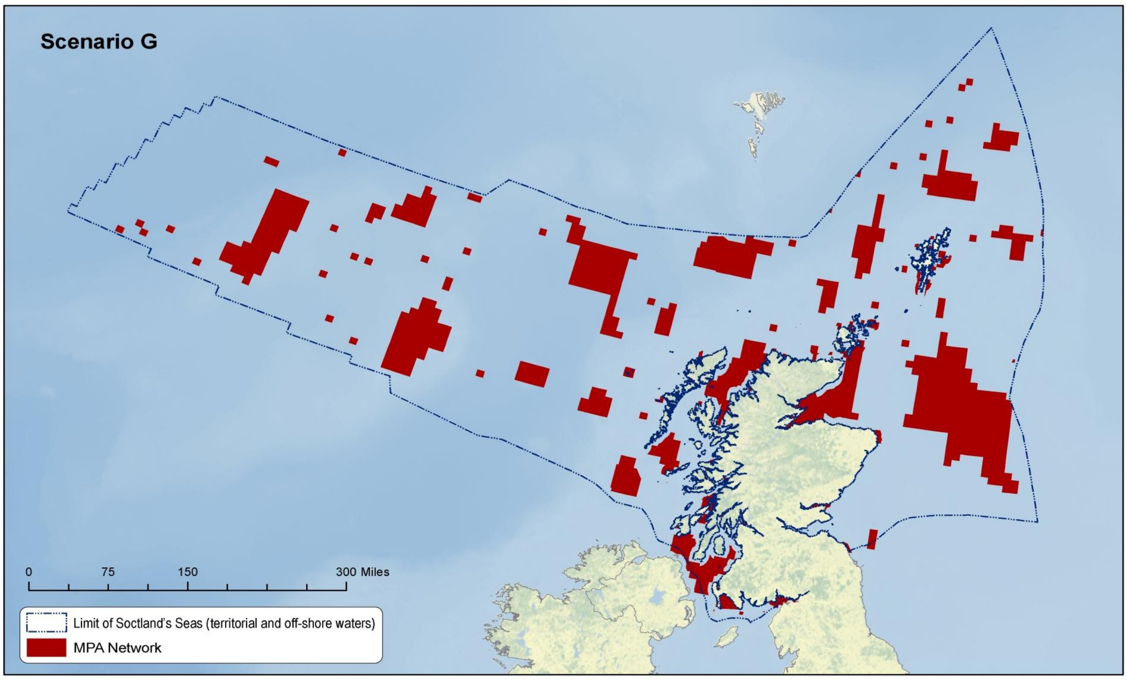

Figure 3. Illustration of MPA sites – Scenario G.

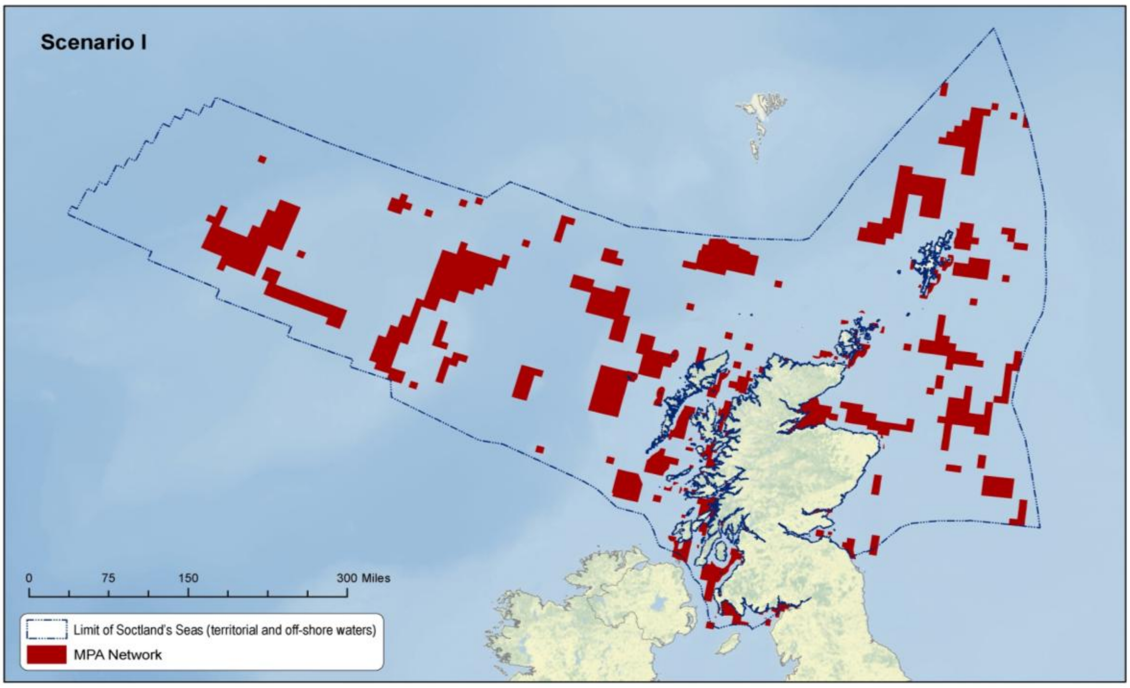

Figure 4. Illustration of MPA sites – Scenario I.

These three MPA networks were mapped using GIS software (ArcMap version 10.1) and the different categories of TDH habitats and marine landscapes were overlaid. As a result, it was possible to identify habitats associated with each MPA within each network using 9 OSPAR TDH habitat categories and the 26 JNCC marine landscapes types[14]. The proportion of each of the 35 habitat/landscape types protected under the three scenarios in Scotland's seas related to the total extent of these habitats in UK marine waters could then be assessed:

[14] Although there are 12 OSPAR TDH habitats categories the Defra CRO 380 report only focused on 9 of these habitats (refer to Table 2 and Table 3 for a complete listing). On the other hand, the original list of 26 JNCC landscape types was used in this analysis.

Table 2. Extent of TDH habitats protected under Scenarios A, G and I (compared with the total extent of the habitat found in UK waters)

Threatened and declining habitats (TDH)		**Scenario A**	**Scenario G**	**Scenario I**
Code	**Description**	**% Protected**	**% Protected**	**% Protected**
TDH1	Carbonate mounds	10.73%	11.16%	10.73%
TDH2	*Lophelia pertusa* reefs	3.18%	5.07%	5.12%
TDH3	Maerl beds	28.29%	48.46%	49.02%
TDH4	*Modiolus modiolus* beds	25.91%	26.82%	30.45%
TDH5	*Ostrea edulis* beds	28.57%	28.57%	28.57%
TDH6	*Sebellaria spinulosa* reefs	0.95%	0.95%	0.95%
TDH7	Sea mounts	3.28%	4.92%	4.92%
TDH8	Sea-pen and burrowing megafauna communities	19.34%	55.97%	56.29%
TDH9	*Zostera* beds	9.86%	10.85%	11.18%

Source: data extracted from GIS data arising from Richardson *et al.*, 2006.

Table 3. Extent of marine landscapes protected under Scenarios A, G and I (compared with the total extent of the landscape found in UK waters)

Marine landscapes (JNCC)		**Scenario A**	**Scenario G**	**Scenario I**
Code	**Description**	**% Protected**	**% Protected**	**% Protected**
L1	Aphotic reef	15.21%	9.64%	21.15%
L2	Oceanic cold water coarse sediment	19.28%	32.02%	28.34%
L3	Oceanic cold water mixed sediment	11.93%	15.10%	14.86%
L4	Oceanic cold water mud	10.04%	10.74%	10.29%
L5	Oceanic cold water sand	11.60%	12.47%	13.44%
L6	Oceanic warm water coarse sediment	34.37%	33.30%	33.31%
L7	Oceanic warm water mixed sediment	10.47%	16.69%	22.27%
L8	Oceanic warm water mud	10.44%	10.56%	10.64%
L9	Oceanic warm water sand	19.81%	12.75%	22.18%
L10	Photic reef	8.03%	9.67%	12.82%
L11	Shallow strong tide stress coarse sediment	2.09%	2.02%	2.99%
L12	Shallow moderate tide stress coarse sediment	1.77%	2.63%	1.99%
L13	Shallow weak tide stress coarse sediment	4.33%	6.81%	5.29%
L14	Shallow strong tide stress mixed sediment	0.51%	0.51%	6.27%
L15	Shallow moderate tide stress mixed sediment	0.64%	0.87%	0.71%
L16	Shallow weak tide stress mixed sediment	4.90%	7.13%	7.51%
L17	Shallow mud	10.27%	13.43%	20.16%
L18	Shallow sand	4.22%	5.12%	4.55%
L19	Shelf strong tide stress coarse sediment	6.24%	9.13%	8.80%
L20	Shelf moderate tide stress coarse sediment	2.62%	4.63%	2.53%
L21	Shelf weak tide stress coarse sediment	6.03%	6.93%	6.11%
L22	Shelf strong tide stress mixed sediment	20.55%	17.47%	7.30%
L23	Shelf moderate tide stress mixed sediment	1.23%	1.73%	1.18%
L24	Shelf weak tide stress mixed sediment	8.62%	34.59%	13.05%
L25	Shelf mud	10.21%	39.22%	22.35%
L26	Shelf sand	6.51%	8.80%	7.34%

Source: data extracted from GIS data arising from Richardson *et al.*, 2006.

2.2.2 Definition of the different management regimes

There are two broad types of protection that can be applied to individual MPA sites within a given MPA network. These two management regimes (also applied in the CRO 380 report) are termed Highly Restricted (HR-MPA) and, with a lower level of protection, Maintenance of Conservation Status (MCS-MPA). It is important to note that the 'maintenance' of ecosystem goods and services does not necessarily mean that current management regimes would not change. Some management may be required in order to prevent decline. However, this would be considered on a site by site basis. Table 4 presents a summary with the different restrictions and management measures that apply under both management regimes.

Table 4. Restrictions and management measures applied to each management regime.

	Level of protection	
	Highly Restricted	**Maintenance of Conservation Status**
Management regime restrictions	• General presumption against fishing of all kinds, all constructive, destructive and disturbing activities. • Recovery measures appropriate to the local situation (enhanced restoration/aftercare measures on expiry of operating licenses).	• New development activities permitted where in the public interest (on social or economic grounds) • Existing activities to continue if do not cause site condition to deteriorate. • Restriction of bottom fishing gears either spatially or temporally and technical conservation measures implemented. • Recovery measures appropriate to the local situation (enhanced restoration/aftercare measures on expiry of operating licenses).

It is important to note that the finally implemented MPA network will likely combine these or other types of management regimes depending on the particular characteristics of each MPA site. However, the previously defined scenarios only define the locations of sites that could constitute a potential or theoretical MPA network. Thus, in the CRO 380 report different levels of protection for each scenario were combined to provide different managerial options, i.e. some MPA sites protected under HR-MPA and others under MCS-MPA. Three management scenarios combining different levels of protection were subsequently assessed in the CRO 380 report and applied in this study: 10% HR-MPA/90%MCS-MPA; 20%HR-MPA/80%MCS-MPA; and 30%HR-MPA/70% MCS-MPA. This provided for a range of economic benefits from designating a MPA network in Scotland's seas.

2.3 ECONOMIC VALUATION ESTIMATES

2.3.1 Background to the economic valuation of marine ecosystem goods and services

Before detailing the economic valuation of the goods and services provided by marine ecosystems it is important to briefly explain why and how economists value particular aspects or changes of the natural environment. The rationale that underlies the economic valuation of environmental resources is the assumption that these resources impact on the well-being of individuals and society. Moreover, monetary estimates can act, albeit imperfectly, as measures to estimate the extent to which the well-being of individuals is affected. Environmental resources impact human welfare in a wide variety of ways, and it is thus necessary to determine the different types or categories of value that need to be captured by the existing valuation techniques (Edward-Jones *et al.*, 2000).

There are two broad categories of environmental values: *use values* and *non-use values*. Use values are associated with the benefits that arise as a result of direct contact with the natural resource. This may be in the form of direct consumption (e.g. extracting timber from forests or fish from the sea) or for so-called secondary or indirect uses (soil stabilization and water retention from forest or climate regulation by marine environment). Direct use values are also known as primary or marketed goods and services (things that can be directly paid for), whereas indirect values are correspondingly non-marketed goods and services - they do not have a direct market price (Pearce and Turner, 1990). In addition to these, another use value is known as option value, which is the value placed on environmental resources by people who may want to use it on the future. Finally, non-use values correspond to those benefits which do not imply contact between the individual and the good or service (e.g. value placed on simply knowing that a natural resource is there). A synopsis of the most relevant value categories is provided below:

Table 5. Different value categories within the Total Economic Value

	Value category	**Description**
Use Values	Direct Use	Arise from the direct exploitation of the environment; either consumptive goods (e.g. fisheries), or non-consumptive use (e.g. wildlife viewing).
	Indirect-Use Value	Benefits that are derived from ecosystem functions that give rise to a 'socially relevant endpoint', e.g. climate regulation from carbon sequestration in plants.
	Option Use Value	Is the value associated with an individual's willingness to pay to safeguard the option to use a natural resource in the future.
Non-Use Values	Bequest Value	Is the value an individual places on ensuring the availability of a natural resource to future generations.
	Existence Value	Is the value placed on simply knowing that a natural resource is there.

Adopted from Beaumont *et al.* (2006).

Most of the environmental benefits arising from the potential MPA network designation are non-market in nature. While market price information may be used to approximate the value of some goods and services that are transacted in markets (e.g. fish or raw materials extraction); other goods and services have no corresponding market valuation. This means that non-market valuation methods must be used to quantify the monetary value of these benefits. Non market valuation methods have advanced significantly over the last two decades and have been widely used in a large number of studies. However, conducting new studies can be costly and time consuming.

As a result, the CRO 380 report used a technique denominated Benefits Transfer (BT) to approximate environmental benefits of marine ecosystems' goods and services. BT is the process of transferring existing valuation estimates derived in previous representative studies to be applied to a new study. A significant drawback of BT is that it relies on the existence of a body of relevant valuation studies and this is not the case for marine resource valuation. Indeed the majority of valuation studies relate to terrestrial biological resources and they are not relevant to marine valuations. The most directly relevant study is provided by Beaumont *et al.* (2006) that attempted to approximate the total economic value of UK marine resources. Thus, this study was mostly used in both the CRO 380 and the present study to derive the total economic value of various goods and services provided by the UK marine environment.

2.3.2 Economic valuation estimates for the entire UK marine environment

As stated above, estimates for the total economic value of various ecosystem goods and services provided by the UK marine environment have been derived mostly from Beaumont *et al*. (2006). The different ecosystem goods and services benefits categories were set out as indicated by the standard economic framework of 'total economic value' established by the IUCN (1998). The CRO 380 report modified some of the Beaumont *et al.* (2006) figures through reconsidering the original basis of these valuations and through a literature review search for other pertinent studies providing a higher reliability. For the purposes of this study, aggregate values arising from the CRO 380 report have been adjusted to 2011 prices and, where possible, updated using 2011 data. Moreover, a new literature review process searching for updated information has allowed the inclusion of non-use values not considered in the CRO 380 report (the estimation of non-use values is further explained in the following section).

Final estimates for the annual benefit that the entirety of UK marine ecosystems provides with respect to each of these benefit categories[15] are presented in Table 6[16]. Nonetheless, and despite the estimation of non-use values, there were several categories of goods and services for which no reliable economic estimation could be found, although it is known and recognised that they are important services with a significant positive impact on society. These goods and services are: bioremediation of waste; resilience and resistance; biologically mediated habitat; and cultural heritage and identity. Consequently, it is likely that the real benefits of UK marine ecosystems and, thus, the economic benefits of designating a Scottish MPA network are higher than the results presented in this study.

It is also important to note that the process of Benefits Transfer (BT), outlined previously, was hindered by the limited number of relevant studies on marine ecosystem valuation. For the majority of ecosystem good/service categories only one estimate/methodological approach was found to be used to derive an estimate. Therefore, the development of a meta-analysis was not possible. This may limit the reliability of the estimates that were derived. The final column of Table 6 contains a subjective evaluation of the reliability of the values generated, along with a brief comment as to the reasoning for the evaluation attributed.

Finally, it is necessary to highlight that these economic values refer to the annual benefit that the whole UK marine ecosystem provides. The incremental benefit for Scottish society derived from implementing a particular MPA network with a particular management regime was not considered at this stage and it will be estimated through the following sections.

Economic valuation of non-use values

The monetary estimation of non-use values (NUV) comes from a subsequent report also carried out by the Scottish Agricultural College for Defra (McVittie and Moran, 2008 – CRO 383 report). This study aimed to determine a primary economic estimate of benefits derived from the implementation of Marine Conservation Zones (MCZs) in the draft Marine Bill, with a specific emphasis on quantifying non-use values which were not captured in the Defra CRO 380 report. They used two survey-based stated preference methods (Contingent Valuation and Choice Experiment) to derive the willingness to pay (WTP) of UK population for a proposed MCZs designation (taken from Richardson *et al.*, 2006 hypothetical network scenarios). The Choice Experiment (CE) approach attempted to disaggregate the overall MCZ scenario positive impacts into selected relevant benefits or MCZs attributes. As a consequence, CE is considered more useful for indicating the value of changes in levels of attributes that could be viewed as more specifically non-use in nature, i.e. the biodiversity attribute used in the survey.

The "halt loss of biodiversity" attribute from the CE approach was then considered as the most appropriate measure of NUV arising from McVittie and Moran (2008) study, although it is not free from some limitations.. Firstly, the complex nature of stated preference surveys may lead interviewees to include some use (direct or indirect) related motives into respondents' revealed preferences. In this case, the addition of non-use and use values might lead to an element of double counting. However, the attributes related to "biodiversity" as used in the CRO 383 study are considered to have a largely non-

[15] These values pertain to the on-site economic benefits.

[16] A further explanation of the estimation of these values can be found in Appendix B.

use value. Secondly, the extent to which the designation of an MPA network achieves the particular objective set out in CRO383 of "halt biodiversity loss" is questionable. However, its utilisation to derive the NUV of designating a network of Scottish MPAs is defensible taking into account that the duties in the Marine (Scotland) Act 2010 and the Scottish Government's vision are intended to create a network of MPAs to protect and, where appropriate, recover the marine environment.

Thus, the median value of the "halt loss of biodiversity" level from McVittie and Moran (2008) study, ranging from £20 to £128 per household and year, was appropriately adjusted to 2011 prices and used in the present study. Table 6 presents the aggregate figure of the non-use benefit category for the whole UK in 2011 prices. The NUV estimate in the current report aggregates households' median willingness-to-pay to 'halt biodiversity loss' across all *UK* households. This is defensible in that the non-use values for marine biodiversity protection are likely to apply across all UK households as opposed to simply across the sub-set of Scottish households. This aggregate figure was subsequently apportioned to consider the proportion of habitats and landscapes protected under the three network scenarios in Scotland's seas.

Table 6. Economic benefits provided by UK marine ecosystems through the delivery of various goods and services.

Goods & -Services categories (codes)	MEA (2005) categories	Valuation method	Definition	Monetary value[1] (Defra 380 report)	Monetary value[2] (present study)	Explanation of variance
Food provision (E4)	Provisioning	Market data	Plants and animals taken from the marine environment for human consumption	£884.9 million	£1,200.9 million	Statistics about value of food fish landed by UK vessels in UK and abroad have been updated to 2011 figures
Raw materials (E5)		Market data	The extraction of marine organisms for all purposes, except human consumption	£116.5 million	£152.8 million	The value from the CRO 380 report has been adjusted for changes in prices in 2011 using the appropriate Consumer Price Index (CPI)
Leisure and recreation (E9)		Market data	The refreshment and stimulation of the human body and mind through the perusal and engagement with living marine organisms in their natural environment	£1.4 - £3.4billion	£1.8 - 4.4 billion	The value from the CRO 380 report has been adjusted for changes in prices in 2011 using the appropriate Retail Price Index (RPI)
Nutrient recycling (E1)	Supporting	Market, WTP	The storage, recycling and maintenance of availability of nutrients mediated by living marine organisms	£1.3 billion	£1.8 billion	Figures from Costanza *et al* (1997) study (expressed in US dollars) were adjusted to $2011 prices and converted through an average 2011 $/£ exchange rate
Bioremediation of waste (E2)		Valuation data not available	Removal of pollutants through storage, dilution, transformation and burial	Valuation data not available	Valuation data not available	N/A
Gas and climate regulation (E3)	Regulating	Avoidance cost approach	The balance and maintenance of the chemical composition of the atmosphere and oceans by marine living organisms	£8.2 billion	£7.1 billion	The present study updated the Defra figures for the shadow price of carbon to 2011 prices using the latest Defra report. These figures are lower than those used in the CRO 380 report
Resilience and resistance (E7)		Valuation data not available	The extent to which ecosystems can absorb recurrent natural and human perturbations and continue to regenerate without slowly degrading	Valuation data not available	Valuation data not available	N/A
Biologically mediated habitat (E6)		Valuation data not available	Habitat which is provided by living marine organisms	Valuation data not available	Valuation data not available	N/A
Disturbance prevention (E8)		Avoidance cost approach	The dampening of environmental disturbances by biogenic structures	£0.44 billion*	£0.54 billion	The value from the CRO 380 report has been adjusted for changes in prices in 2011 using the appropriate CPI
Cultural heritage and identity (E10)	Cultural	Valuation data not available	The cultural value associated with the marine environment e.g. for religion, folklore, painting, cultural and spiritual traditions	Valuation data not available	Valuation data not available	N/A
Cognitive values (E13)		Market data	Cognitive development, including education and research, resulting from marine organisms	£453.3 million	£491.1 million	The value from the CRO 380 report has been adjusted for changes in prices in 2011 using the appropriate CPI
Non-use/bequest values (E11)		WTP	Value which we derive from marine organisms without using them	N/A	£0.6 - 3.9 billion	Not included in the CRO 380 report

* In addition to £17 - £32 billion capital costs.

1. Undiscounted monetary value per annum (2006 figures)
2. Undiscounted monetary value per annum (2011 figures)

2.4 SPLITTING AGGREGRATE BENEFIT VALUES ACROSS HABITAT/LANDSCAPE CATEGORIES

2.4.1 Splitting aggregate benefit values

As explained in the previous section, the valuation estimates presented above were aggregate annual values (undiscounted) for the respective ecosystem goods and services categories. The CRO 380 report already pointed out that, despite an extensive literature review, no specific values by habitat/landscape and goods and services category were identified. Consequently, for each economic good/service category the total value of UK marine ecosystems was split between the 35 identified habitat and landscape types. This first step is necessary in order to pro-rate the total value of a given ecosystem service for the whole UK to the marginal benefit of protection across a particular MPA network scenario and management regime combination.

This first stage entailed designating how important one particular landscape/habitat was in comparison to the other landscapes/habitats. This was done through an analysis of *relative* importance. Once this was determined, weighting was applied to each landscape/habitat. This allowed the following type of question to be answered: what contribution does the totality of aphotic reef in the UK make to the totality of nutrient cycling provision across all UK marine ecosystems? Similar questions were then asked about other marine landscapes/habitats. The rationale and the discussion of the application of the apportioning approach are set out in Appendix C.

Table 7. Example of final proportions of total benefits from each good/service category (1-13) by landscape/habitat type (to be applied to all UK marine environment, including Scottish waters)

Goods&Services /L&TDH	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13
	%TV	%TV	%TV	%TV	%TV	%TV	%TV	%TV	%TV	%TV	%TV	%TV	%TV
L1	0.72	0.72	0.72	1.60	4.37	1.80	1.80	1.80	2.86	2.86	2.86	2.86	2.86
L2	0.05	0.05	0.05	0.06	0.05	0.06	0.06	0.06	2.86	2.86	2.86	2.86	2.86
L3	0.64	0.64	0.64	0.71	0.65	0.80	0.80	0.80	2.86	2.86	2.86	2.86	2.86
L4	3.07	3.07	3.07	3.43	3.12	3.86	3.86	3.85	2.86	2.86	2.86	2.86	2.86
L5	0.73	0.73	0.73	0.82	0.74	0.92	0.92	0.92	2.86	2.86	2.86	2.86	2.86
L6	0.49	0.49	0.49	0.55	0.50	0.62	0.62	0.62	2.86	2.86	2.86	2.86	2.86
…													

Adopted from CRO 380 report

2.4.2 Incorporating Scottish MPA network scenarios data

Both total annual benefits and the proportion of these benefits by habitat and landscape refer to the whole UK marine environment. However, as already stated in section 2.2 definition of the network scenarios and the management regimes, Scottish MPA scenarios will only protect a proportion of these habitats and landscapes found in UK marine waters. Therefore, values presented in Table 7 have to be cross-referred with the percentage of each habitat and landscape protected under the three scenarios in Scotland's seas (Table 2 and Table 3). The results will provide proportions of the total benefit that the UK marine environment delivers for a given good or service that is attributable to a particular habitat/landscape given how much of that habitat is contained under a specific network scenario. Table 8 presents an example of some of the results obtained for the Scenario A[17]:

[17] Appendix D presents the results for all good/services category, habitat type and network scenario.

Table 8. Example of the percentage of the total aggregate value for goods and services categories apportioned to the extent of habitats and landscapes protected under Scenario A in Scottish waters.

L/TDH	% protected	E1/A	E2/A	E3/A	E4/A	E5/A	E6/A	E7/A	…
L1	15.21%	0.11	0.11	0.11	0.24	0.66	0.27	0.27	
L2	19.28%	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
L3	11.93%	0.08	0.08	0.08	0.08	0.08	0.10	0.10	
L4	10.04%	0.31	0.31	0.31	0.34	0.31	0.39	0.39	
L5	11.60%	0.08	0.08	0.08	0.10	0.09	0.11	0.11	
L6	34.37%	0.17	0.17	0.17	0.19	0.17	0.21	0.21	
…									

For example, the contribution of the aphotic reefs landscape (L1) to nutrient recycling (E1) is 0.72% of the total value of E1 (see Table 7). Under Scenario A, 15.21% of the total UK area of aphotic reef is being conserved. Thus, the percentage value to be inputted for this cell in Table 8 is 0.11% (0.72*0.15). What this figure means is that if the UK marine ecosystems provide some annual benefit in terms of nutrient recycling, 0.11% of this benefit can be attributed to the aphotic reefs protected by the sites under Scenario A in Scotland's seas. It should be mentioned that this approach assumes that the 15.21% of aphotic reef protected under Scenario A is as valuable (on a per hectare basis) as the remaining 84.79% that is not. This may not be the case, but without any further data no other adjustment can be made.

2.5 ESTIMATING THE MARGINAL POSITIVE IMPACTS OF MPA DESIGNATION

Results arising from the previous section allowed an estimation of the aggregate annual benefit (in terms of delivery of different goods and services) provided by the different habitats comprising each network scenario. The next step was to estimate in economic terms the marginal effects of the designation of a MPA network. This means, what are the benefits arising from the designation of a MPA network compared to the current situation, i.e. *status quo* or 'do nothing' scenario? The methodology applied to carry out this estimation has been replicated from the CRO 380 report and is summarised in the following sections.

2.5.1 Survey of extent of scientific knowledge

Firstly, the CRO 380 report analysed the existing scientific knowledge at the time in terms of the links between the delivery of ecological functions and the sensitivity of the associated biological system to human activities for each habitat considered. This analysis was carried out using expert knowledge and an extensive literature review. Each cell in the habitats/goods and services matrix was assigned with a score referring to the status on scientific knowledge for that particular link. The scores assigned were: 'High' (H); 'Medium' (M); and 'Low' (L). Available information directly relevant to the UK situation was graded 'high'. Where knowledge was only partial, accounts were contradictory, or, where extrapolations had to be made from outside the bio-geographic region the extent of knowledge was deemed 'medium'. Where information was fragmentary or lacking for a habitat this was scored as 'low'. In circumstances where information was not available, expert scientific judgement was used to extrapolate and characterise the impact–response relationship (Moran *et al.*, 2007, p. 29).

It is important to note that since the publication of the CRO 380 report further scientific research has been carried out in relation to sensitivities of MPA/MCZ search features in both Scotland and the UK (see for example Chaniotis *et al.*, 2011 and Tillin *et al.*, 2010). However, this new information could not be considered for the present study due to time and resource limitations. As a consequence, the initial information provided by the CRO 380 report was used for both assessing the marginal effects of MPA designation and the sensitivity analysis. The complete matrices are presented in Appendix E[18].

2.5.2 Calculating the marginal effects of MPA designation

Following the CRO 380 report methodology, an assessment was made to allow the calculation of the *marginal* changes that arise from MPA designation. The three different regimes assessed were: *status quo*; MCS-MPA; HR-MPA. The *status quo* assessment is important as a benchmarking exercise but was not used in the valuation estimation *per se*. It provided a prediction of what would happen to the status of the landscapes/habitats (with regards their delivery of ecosystem goods and services) with no MPA designations. These 'bottom' line scenarios were then used to assess the marginal positive impact of applying MCS-MPA and HR-MPA designation. There are two main questions that need to be answered to value this marginal impact:

i. How significant would the change be for the protection scenario as compared with the no-designation counterfactual?
ii. When would this change arise?

These questions were addressed through the application of coding with three different elements. The first element of the code is a letter code (VH; H; M; L; VL). This letter code is a subjective assessment ('very high'; 'high'; 'medium'; 'low'; 'very low') that categorised a percentage range of the extent of positive impacts relative to the *status quo* (see Table 9). A mid-point value was applied for the 'best estimate' of positive impact, with a low point identified for sensitivity analysis purposes.

Table 9. Interpretation of the impact coding for the extent of the impact

Coding	Percentage range	Mid-point	High value	Low value
VH (very high)	90-100%	95%	100%	90%
H (high)	50-89%	70%	89%	50%
M (medium)	10-49%	30%	49%	10%
L (low)	1-9%	5%	9%	1%
VL (very low)	<1%	0.5%	1%	0%

If the score is (say) VH for a particular economic benefit/landscape-habitat combination for HR-MPA it would be anticipated that there would be a 90-100% (mid-point or 'best estimate' 95%) improvement in the provision of the service by the landscape-habitat *as compared with the current provision of that service* were HR-MPA not to be applied. Therefore, a figure of 95% of the annualised value for that economic/landscape-habitat is inputted in the relevant cell of the matrix. If the score is (say) M for the same cell but for MCS-MPA then only a 10-49% range, with a mid-point of 30%, would apply by comparison.

The second element is a number (0/20; 5/20; 6/20; 8/20; 10/20; 15/20; 20/20). This second element is the first of two accounts for the timing (temporal dimension) of the positive impact. It was assumed that all benefits would start at the inception of the MPA designation but that there would be a certain amount of time (measured in years) before a maximum (annual) benefit level would arise. For instance, '5/20' means that the maximum benefit is achieved after five years, and this maximum benefit level persists until the end of the evaluation period of 20 years. The third element is a letter term (S/L/E). This term indicates the trajectory of benefit values before the maximum benefit is arrived at. Most of the benefits might arise near the start (S), near the end (E) or in a linear fashion (L). The matrices containing the codes applied to each of the cells are presented in Appendix F.

[18] Further details about the designation of these codes and their transformation into scalar coefficients can be found in the CRO 380 report (Moran *et al.*, 2007).

These codes are transferred into *scalar coefficients* which transform the three element code into a single number that can be used for estimation purposes. There are scalar coefficients for undiscounted mean values and for discounted[19] present values. These scalars[20], summarising information regarding the marginal effect of implementing a determined management regime in a MPA network, can be cross-referenced with the matrices that summarise the proportion of the total aggregate values of the different goods and services apportioned by the extent of habitat/landscape types of each network scenario (see Table 8 in section 2.4.2 Incorporating Scottish MPA network scenarios data). The resulting tables[21] show the marginal contribution that is made by the designation of HR-MPA or MCS-MPA for each of the defined network scenarios. This is briefly explained below.

Consider Table 10. This table contains an example of the final impact factors to be applied to estimate the present value of Scenario A designation under the MCS-MPA management regime. For ease of exposition

Table 11, which shows an example of the present value scalar coefficients for MCS-MPA (complete tables in Appendix F), is also presented below. The figures in the cells in Table 10 arise when these scalars are cross-referenced with the appropriate percentage values for Scenario A given in Table 7. For instance, the E1/L1 cell (aphotic reef/nutrient recycling) present value scalar is 6.06 (

Table 11) and the percentage value is 0.11 (Table 8). Thus, the entry in Table 10 for the E1/L1 cell is 0.664, i.e. the multiple of these two values. What this figure (0.664) means is that the MCS-MPA protection of aphotic reef under Scenario A in Scotland's' seas provides an economic benefit (measured in present value) equal to 0.664% of the total aggregate value of nutrient recycling across all UK marine ecosystems.

Table 10. Example of the final summary table with the Net Present Value Impact Factors (NPV-IF) for Scenario A and MCS-MPA management regime (discount rate 3.5%)

NPV-IF A MCS-MPA	E1	E2	E3	E4	E5	E6	E7	…
L1	0.664	0.664	0.664	0.665	0.007	1.660	1.660	
L2	0.043	0.043	0.043	0.000	0.000	0.052	0.052	
L3	0.342	0.342	0.342	0.001	0.001	0.428	0.428	
L4	1.380	1.380	1.380	0.003	0.003	1.735	1.735	
L5	0.379	0.379	0.379	0.001	0.001	0.478	0.478	
L6	1.021	1.021	1.021	0.002	0.002	1.291	1.291	
…								

Table 11. Present value scalar coefficients for MCS-MPA

MCS-MPA NPV Scalars	E1	E2	E3	E4	E5	E6	E7	…
L1	6.06	6.06	6.06	2.73	0.01	6.06	6.06	
L2	4.48	4.48	4.48	0.01	0.01	4.48	4.48	
L3	4.48	4.48	4.48	0.01	0.01	4.48	4.48	
L4	4.48	4.48	4.48	0.01	0.01	4.48	4.48	
L5	4.48	4.48	4.48	0.01	0.01	4.48	4.48	

[19] Discounting is an economic technique used to transform a monetary flow along several years into its present value. This is further explained in Section 2.6..

[20] Appendix G presents all the scalar coefficients matrices (for both discounted and undiscounted values), as well as further information of how converting impact codes into scalar coefficients

[21] Appendix H presents all the final Impact Factor matrices (for both discounted and undiscounted values)

L6 …	6.06	6.06	6.06	0.01	0.01	6.06	6.06

2.6 AGGREGATION OF BENEFITS ACROSS NETWORKS AND MANAGEMENT COMBINATIONS: FINAL RESULTS

The final step to estimate the economic benefits of designating a theoretical MPA network in Scottish territorial and off-shore waters was to cross-reference the impact factors presented above with the aggregate annual benefit provided by UK marine ecosystems' goods and services. Those benefit categories for which benefit values have not been found were omitted from this final analysis: biologically mediated habitat; resilience and resistance; disturbance prevention and alleviation; cultural heritage and identity; and option use value. As a consequence, it is likely that the real economic benefits of designating a MPA network in Scotland's seas are higher than those presented below.

The benefits arising from each habitat and landscape type[22] and the considered ecosystem's goods and services categories have been aggregated in order to provide the final estimations. These estimations, presented in Table 12 , refer to total present value (across a 20 year period) for the three network scenarios (A, G and I) and the three combinations of management regimes[23]. Before presenting these figures it is important to briefly explain what present value means. The present value can be defined as the current worth of a flow of benefits that are expected to arise over the future (20 years in this case). The estimation of the net present value (through the application of a discount rate) is a standard economic method for using the time value of money to appraise long-term projects. Although the application of relatively high discount rates to environmental valuations is somewhat controversial since it attributes a greater importance to benefits realised in the present (Stern, 2007), a discount rate of 3.5% has been applied in this study as set out in the UK IA Guidance and applied in the CRO 380 report. The same figures but measured in terms of undiscounted mean annual benefits are presented in

Table 13.

Table 12. Overall present values (£) of designating a Scottish MPA network for the three network scenarios and three combinations of management regimes (3.5% discount rate across a 20 year period)

	10% HR/90% MSC	20% HR/80% MSC	30% HR/70% MSC
Scenario A	6,332,206,000	6,345,314,000	6,358,422,000
Scenario G	10,012,870,000	10,031,360,000	10,049,850,000
Scenario I	8,476,021,000	8,493,900,000	8,511,779,000

Table 13. Undiscounted mean annual benefits (£) for the three network scenarios and three combinations of management regimes

	10% HR/90% MSC	20% HR/80% MSC	30% HR/70% MSC
Scenario A	565,956,000	566,910,000	567,863,000
Scenario G	880,001,000	881,350,000	882,699,000
Scenario I	755,120,000	756,450,000	757,780,000

As it can be observed in Table 12, the benefits arising from designating a network of Scottish MPAs over a 20 years period range between £6.3 billion and £10 billion. Scenario A has values that are clearly lower than the other two scenarios, ranging from £6.3 billion to £6.4 billion, which is reasonable taking into account that it is the least conservationist Scenario. On the other hand, although both

[22] The benefits by habitat and landscape type (expressed as net present values, discount rate 3.5%) for the three network scenarios and two management regimes are presented in Appendix J, where these results are also compared with the figures arising from the CRO 380 report.

[23] The benefits arising from the protection of the entire networks under each of the management regimes by ecosystem good and services categories is presented in Appendix I.

Scenario G and Scenario I aim to protect 60% of OSPAR TDH habitats and 10% of JNCC marine landscapes, the higher benefits arise from implementing Scenario G (ranging between £10 billion and £10.1 billion). This highlights the importance in both ecological and economic terms of protecting spawning and nursery grounds, which is the only different criterion applied to Scenario G in comparison with Scenario I (which focuses on sites locked-out for licensed extraction, dredging and disposal activities).

It is also interesting to note that the benefits increase only slightly when a higher proportion of the more restricted management regime (HR) is applied. This might be due to two causes: on the one hand, it might indicate that the expected benefits of designating a Scottish MPA network will not vary when increasing the percentage of MPA sites associated to a higher level of restriction (HR) compared to those associated to the Maintenance of Conservation Status (MCS). This outcome may reflect the fact that the expected benefits arise mostly from halting those activities that currently have negative impacts across the marine environment, i.e. both management regimes restrict bottom towed fishing gear, probably the activity with the most prevalent negative impact. Nonetheless, this conclusion would be contradictory to the findings of Lester and Halpern (2008), which state that while partially protected areas deliver ecological benefits, no-take reserves generally show greater benefits and yield significantly higher densities of organisms.

On the other hand, it may be a consequence of an inaccurate assessment of the positive impacts of implementing an MPA network and, in particular, the extent of the positive effects of the HR-MPA regime compared to the MCS-MPA. In this sense, it may be also possible that the positive impacts of designating a MPA network under the HR-MPA management regime have been somewhat undervalued. This assessment was carried out by the CRO 380 study based on an extensive literature review and expert criteria. Although it is considered a sound and robust assessment, it is not free from certain level of uncertainty.

If the contribution of non-use values to the overall benefits is analysed, they represent approximately 12% to 14% of the total benefits, while the use values (both direct and indirect) comprise the remaining 86%-88% (ranging between £5.5 billion and £8.9 billion). In terms of the expected benefits by category of goods and services, the highest benefits are delivered by climate regulation services (carbon sequestration) ranging from £3.6 billion to £6 billion depending on the network scenario and the management regime. Nonetheless, it is necessary to point out that there is a high level of uncertainty associated with the estimation of the benefits derived from carbon sequestration owing to the assumptions made by Beaumont *et al* (2006), which in turn was used as the evidence base for both the CRO 380 and the present study. Firstly, calculations from Beaumont *et* al (2006) for climate regulation[24] services use a base total value just for the UK territorial waters (out to the 12 nautical mile limit). However, the scope of this project covers both Scotland's territorial and off-shore waters and, therefore, the total UK value to be apportioned should also include off-shore waters. Secondly, it could be argued that the carbon sequestered by primary production (as considered in this study) is returned to the water column in a short period of time through respiration and decay processes.

2.7 SENSITIVITY ANALYSIS

The methodological approach adopted in this study is subject to various uncertainties arising from different methodological stages of the analysis. There are two main sources of uncertainty: the first pertains to the impact scores for timing and extent of impact and the second to the aggregate values or benefits of ecosystem services (Benefits Transfer process).

[24] This also applies to the calculations for nutrient recycling.

With respect to the impact scores for the extent of the marginal positive impacts that HR-MPA and MCS-MPA management regimes would have for the various ecosystem services/landscape and habitat types, the mid-point ('best estimate') point in the scoring range was applied (see Table 9). In order to carry out the sensitivity analysis the more conservative 'low value' of the range in Table 9 has been applied.

The other main element of uncertainty is related to the aggregate benefit estimates set out in Section 2. For both 'Leisure and recreation' and 'Non-use/bequest values' ecosystem services a range of estimated annual values were provided (£1.8-£4.4 billion for 'leisure and recreation' and £0.6-£3.9 billion for 'non-use values'). £4.4 billion and £1.4 billion respectively were considered as the most reliable estimates (see Appendix B for further explanation), but for sensitivity analysis purposes the lower value was used to estimate the final results.

Table 14 presents the present values resulting from the sensitivity analysis integrating these two elements together, i.e. taking the low point for the impact scoring and the low end of the range for 'leisure and recreation' and 'non-use/bequest values'. It has been decided to apply only the low range values for both elements following a precautionary approach. Thus, these values should be treated as the lower bound in the estimates.

Table 14. Sensitivity analysis: present values using low points in benefit coding and lower values for 'leisure and recreation' and 'non-use/bequest values' (3.5% discount rate).

	10% HR/90% MSC	20% HR/80% MSC	30% HR/70% MSC
Scenario A	4,288,044,000	4,305,284,000	4,322,524,000
Scenario G	7,094,591,000	7,126,364,000	7,158,137,000
Scenario I	5,995,014,000	5,997,367,000	5,999,721,000

Although there has been an average drop of 30% in the range of values compared with the considered as 'best estimate', the lower estimate bound ('worst case' scenario) still provides an economic benefit ranging between £4.3 billion to £7.2 billion over a 20 year period.

2.8 MAIN ASSUMPTIONS AND LIMITATIONS OF THE ADOPTED METHODOLOGICAL APPROACH

There are several assumptions that had to be made through the economic assessment. One of the most important is related to the fact that the literature review revealed no studies that provided a value for the provision of a particular ecosystem service by a particular landscape or habitat. Thus, aggregate values for the various ecosystem services for the provision of the given service across all UK marine habitats were used. This may impose two main limitations regarding the reliability of the results:

1. the validity of the aggregate estimates; and
2. the validity of the method of apportioning these aggregate values.

Benefits Transfer (BT) was used to find the correspondent aggregate effects. This process consists of transferring a value from a study site to a policy site. The BT application in most cases relied on one single study for the derivation of value and thus no meta-analysis was possible to validate the results. Further, data limitations meant that the more robust forms of BT (i.e. transfer of the benefit function or transfer of an adjusted mean value) were not feasible. Thus the aggregate values used in this study should be treated with due caution. Nonetheless, most of the estimates are taken from a study focusing on the valuation of UK marine ecosystem services, which is considered an appropriate study from a locational perspective (both focused on UK marine ecosystem services) and facilitated the transfer process between the study and the policy site.

With respect to apportioning benefits across the different habitat and landscape types various assumptions were made. All sites were treated as being 'typical' in the sense that one hectare of (say) aphotic reef was assumed to deliver exactly the same amount of each ecosystem service regardless of its location. This is unlikely to be empirically valid and indeed contravenes the whole concept of a 'network' of MPAs in that units were treated in isolation. This simplifying assumption was applied in part because the literature on the economic valuation of systemic MPA network effects is very limited. Furthermore, information is not available regarding which sites within a given network were to be protected under HR-MPA and which under MCS-MPA; only proportions were assigned.

Moreover, the apportioning of benefits across the landscape and habitat types was carried out by the CRO 380 report through expert assessment. Although the methodological process was somewhat crude, it is defensible in the absence of any previous attempt to apportion the benefits of MPAs by benefit category and habitat types (Moran *et al.*, 2007).

Limitations derived from the apportioning of the non-use benefit category are particular to this study and should also be highlighted. The aggregate value used to apportion the benefits arise from a *stated preference* approach (McVittie and Moran, 2008) based on a UK sample asked about their WTP to achieve the "halt loss of biodiversity" resulting from the designation of a UK MPA network (concretely, Scenario A from Richardson *et al*, 2006). Consequently, apportioning this aggregate value according to the extent of the protected areas in Scotland's seas indirectly assumes that respondents provided a WTP proportional to the size/extent of the presented network, which may be not the case. However, taking into consideration time and resource limitations, no other option was available to estimate non-use values.

On the other hand, the assessment of the positive impacts of designating a MPA network in comparison with the *status quo* scenario has also been carried out through expert assessment. Consequently, it is not free from certain level of uncertainty. However, as occurred with the apportioning of benefits process, it is considered a reasonable approach in the absence of prior studies assessing the effects of MPA implementation by benefit category and habitat type.

Concluding, the present study is not free from some shortfalls, as any environmental valuation study, and it is hoped that available information will continue to be improved upon the future. However, it is considered a sufficiently robust approach at this stage necessary to fully understand and illustrate the potential benefits derived from designating a Scottish MPA network.

3.
CONCLUSIONS

3.1. OVERVIEW AND CONCLUDING REMARKS

The present study has estimated an economic value for the benefits arising from the designation of a theoretical MPA network in Scottish territorial and off-shore waters. To achieve this objective, the methodological approach previously developed by the Scottish Agricultural College (SAC) and the University of Liverpool (Moran *et al.*, 2007 – CRO 380 report) has been applied, although some modifications have been introduced. These two institutions were commissioned by Defra to determine a monetary estimate of the benefits of designating a network of Marine Conservation Zones (MCZs) in English territorial waters and UK offshore waters as proposed in the UK Marine Bill.

Following the aforementioned methodological approach, three hypothetical networks were selected from a previous study (Richardson *et al.*, 2006) to be used in this assessment (Scenarios A, G and I). It is important to note that these are theoretical MPA designation scenarios and, thus, such networks will not exactly replicate the network that will eventually be identified by Marine Scotland. Nonetheless, it is considered that developing a theoretical economic valuation at this stage could serve to illustrate the potential benefits for Scottish industries and local communities of a healthy marine environment as underpinned by a network of well-managed MPAs.

Two different types of management regimes/levels of restriction were applied to MPA sites within each network scenario, i.e. MCS-MPA and HR-MPA. Further, to illustrate the range of likely benefits, the valuation exercise assumed that three given combinations of designation would apply, with the split between HR-MPA and MCS-MPA being as follows: 10%/90%; 20%/80%; 30%/70%.

This study focused on the on-site benefits of the MPA designation, pertaining to the delivery of ecosystem goods and services such as food provision, nutrient recycling, gas/climate regulation, storm protection, non-use values and cognitive values. The inclusion of non-use values constitutes one of the main innovations applied in this study in comparison with the CRO 380 report, which highlighted the importance of these values but did not provide an economic estimation.

Although the extent of provision of many of these services affects social welfare, they are not marketed *per se*. This is the rationale for the application of non-market valuation methods. However, conducting new valuation studies is highly costly and time-consuming; thus, a Benefits Transfer (BT) technique has been adopted.

The overall on-site benefits of designating a network of Scottish MPAs range between £6.3 billion and £10 billion in present values (3.5% discount rate over a 20 years period) depending on the assessed network scenario and management regimes combination. Scenario G delivers the highest overall benefits (approximately £10 billion). This underpins the importance in both ecological and economic terms of protecting spawning and nursery grounds, the additional criteria on which the network configuration of Scenario G is focused. In terms of the economic value categories, between 12% and 14% of the overall benefits derive from non-use values (£0.9 billion – £1.3 billion), while the remaining £5.5 billion – £8.9 billion arise from use values.

The results also show that, in practice, valuation results appear to be barely sensitive to the different management regimes combinations. The benefits increase only slightly when a higher proportion of the more restricted management regime (HR) is applied. This outcome may indicate that the benefits of designating a Scottish MPA network arise mostly from halting those activities that currently have negative impacts across the marine environment, as required by both management regimes. However, given the uncertainty associated with the assessment of the positive impacts arising from MPA designation under the two management regimes, and following a precautionary approach, it is difficult to be conclusive about this particular issue.

Consequently, it is important to note that both the protection of spawning and nursery grounds within the network final configuration and the implementation of a management regime that at least prevent those activities which currently have negative impacts across the marine environment (i.e. restriction of bottom towed fishing gears) are key factors critical for the benefits to be fully realised. Nonetheless, there are other important ecological and institutional factors that may have an impact upon the expected socio-economic benefits but which analysis lay beyond the scope of this study. These factors would include, for example, an analysis of the future provision of marine ecosystem's services and an assessment of how this services and functions may vary as a consequence of the climate change; or an institutional analysis evaluating how the different stakeholders may react to the implementation of the management measures.

It is considered that the presented results constitute a consistent and robust estimation based on an already proven methodology used for assessing the benefits of designating an MPA network. Nonetheless, this methodology implies some assumptions and limitations described in the previous section. It is also necessary to highlight some important aspects not incorporated into the economic assessment:

- The presented values should be interpreted as a minimum level of benefits; as the estimation does not include all the components (benefit categories) that would provide a completely representative figure of the Total Economic Value (TEV). Those benefits categories for which an economic estimation could not be provided are: 'Bioremediation of waste'; 'Resilience and resistance'; 'Biologically mediated habitat'; and 'Cultural heritage and identity'.
- Off-site benefits derived from the designation of a MPA network have been ruled out of the analysis. There are different studies showing compelling evidence of increasing abundance and catch sizes in protected and surrounding areas (Fogarty and Murawski, 2005; Gell and Roberts, 2003; Jaworsky and Penny, 2009; Lester *et al.*, 2009; Lester and Halpern, 2008; Sweeting and Polunin, 2005). Of special interest are the findings of Roberts and Hawkins (2012), which demonstrates the existence of spillover of commercially important species from marine reserves in Europe and elsewhere. However, the economic valuation of these effects is a laborious and complex process beyond the scope of this project. Therefore, further work would need to be carried out in order to assess the off-site benefits of designating a Scottish MPA network.
- The potential positive network effects have not been considered due to the lack of literature on the valuation of this systemic effect. As a consequence, the network was treated as a series of individual sites that have individual value estimates associated with them. Network effects, where sites help support each other, should be considered another form of off-site benefit. This study therefore, by focusing on individual on-site benefits, may further underestimate the overall benefits (on-site, off-site and network) of a network of Scottish MPAs.

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APPENDIX A:
MPA NETWORK SCENARIOS

Figure A 1. Illustration of MPA sites – Scenario A

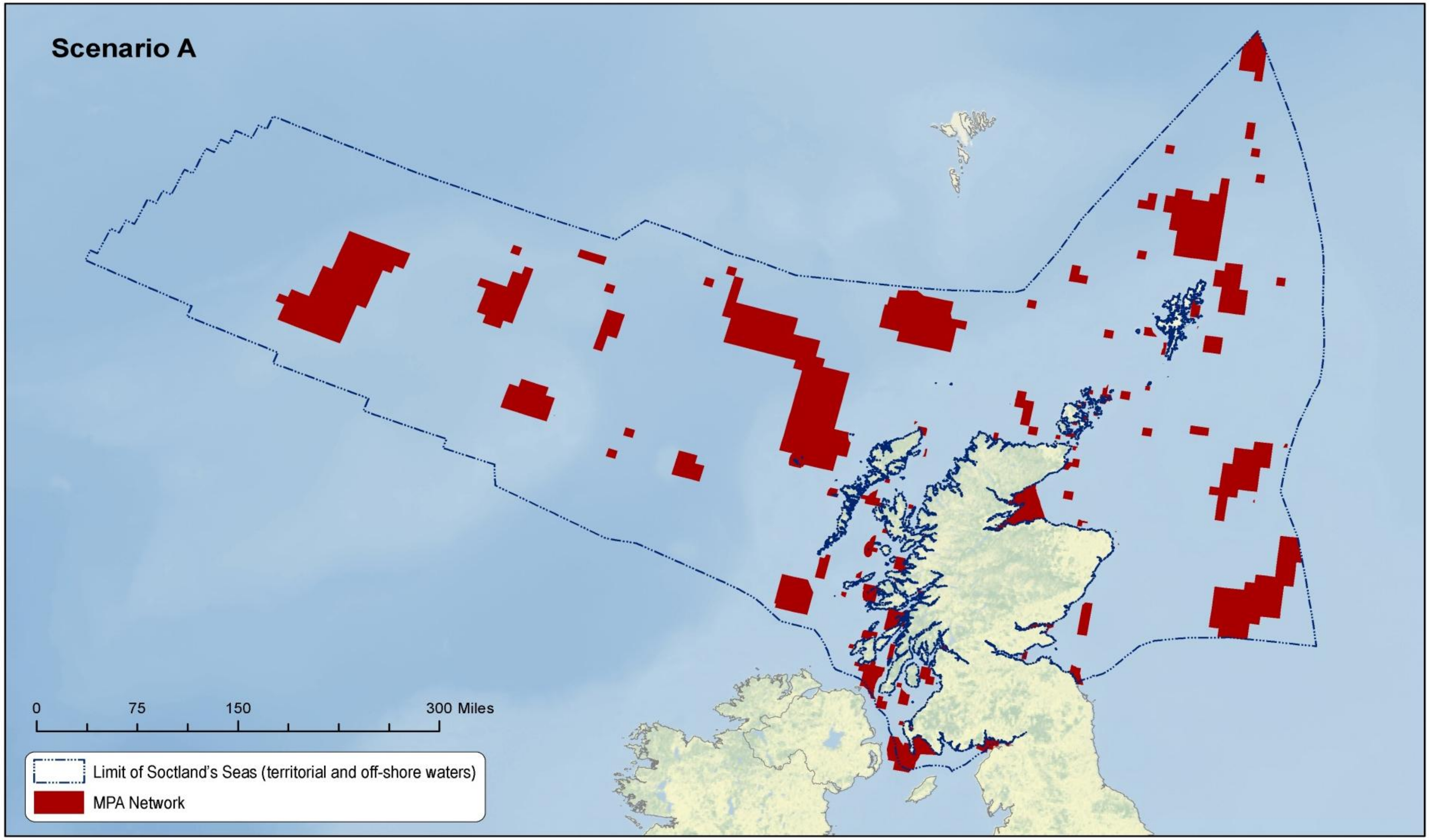


Figure A 2. Illustration of MPA sites – Scenario G

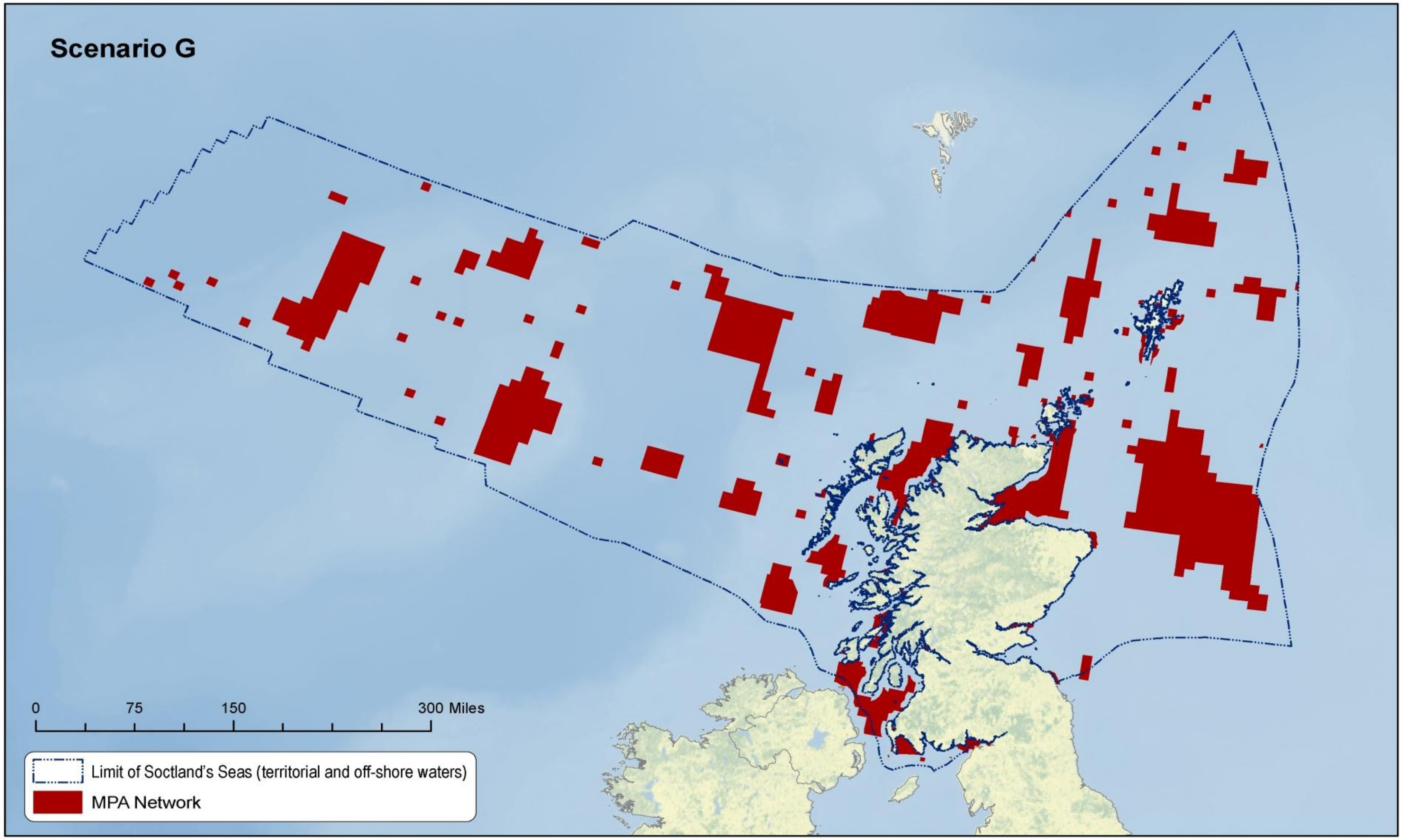
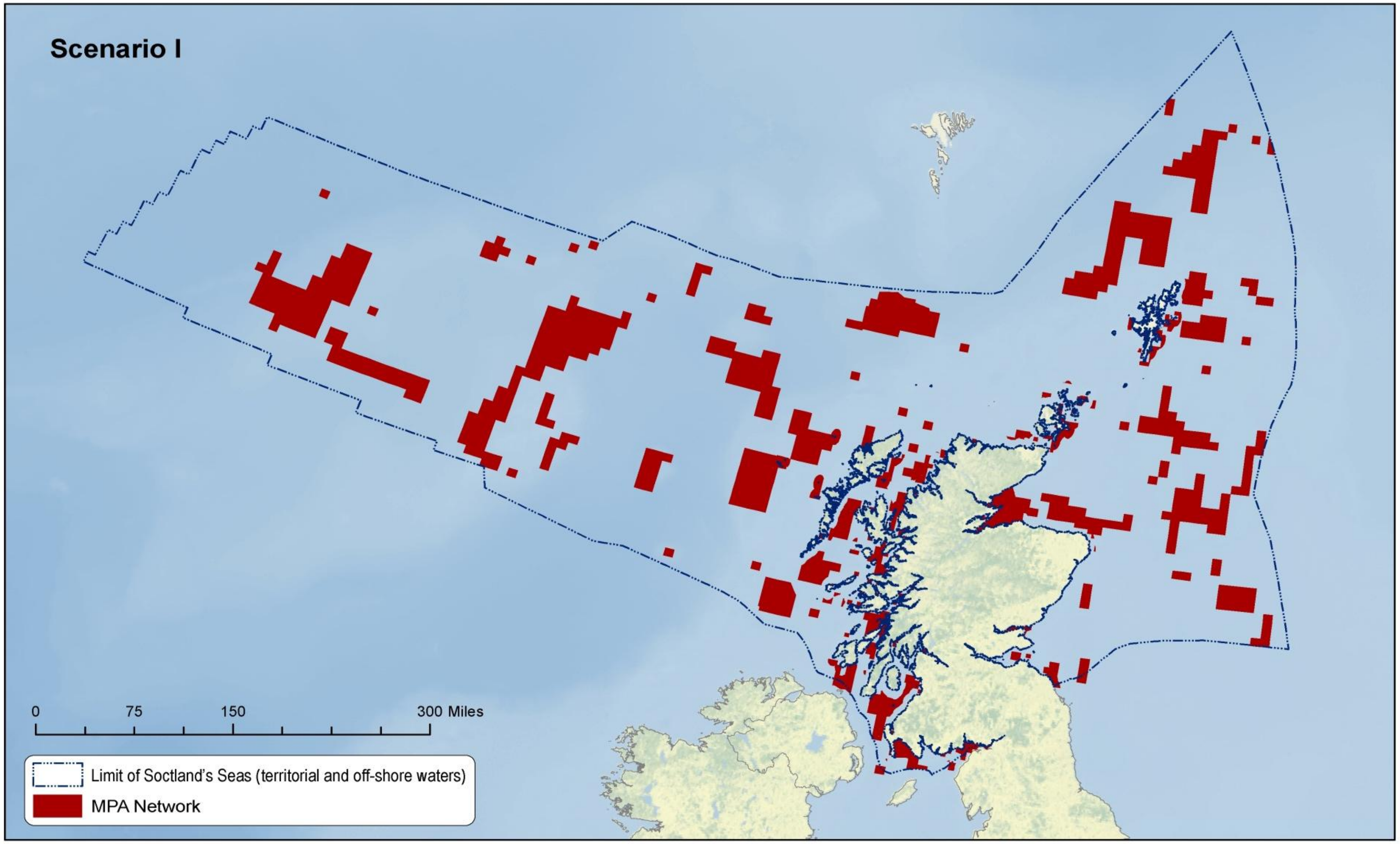


Figure A 3. Illustration of MPA sites – Scenario I



APPENDIX B:
ECONOMIC VALUATION OF MARINE ECOSYSTEMS GOODS AND SERVICES

The sections below summarise the review of the literature and adjustments made for each of the economic benefit categories. The core part of the review is directly taken from the Defra 380 report, although the present study has introduced new adjustments (e.g. the inclusion of a valuation for non-use values) derived from a subsequent literature review:

Resilience and resistance

Hughes *et al*. (2005) defined resilience and resistance as the extent to which ecosystems can absorb recurrent natural and human perturbations and continue to regenerate without slowly degrading or unexpectedly flipping to alternate states. A crucial factor shaping the evolution, maintenance and loss of biodiversity in marine ecosystems are natural and anthropogenic disturbance arising from human activities. Disturbances are ubiquitous, inherent and unavoidable, causing both instability and change. The presence of disturbances in all ecosystems, across all levels of ecological system, their occurrence at a wide range of spatial and temporal scales, is the essence of their importance. The economic value of resilience and resistance of marine ecosystems is potentially huge and their benefit is difficult to mitigate. The instrumental value (i.e. the value to humans) of resilience and resistance is the value as an 'intermediate' supporting service, i.e. it allows other 'final' services to be delivered.

<u>Estimated Value:</u> Despite the fundamental relevance and importance of this ecosystem service category, a value for this category is lacking. Estimation of resilience and resistance values is complicated by a lack of scientific knowledge about the relationships between biodiversity and resilience (Beaumont *et al*. 2006).

Biologically mediated habitat

This is defined as habitat, which is provided by marine organisms (Beaumont *et al.* 2006). Habitat structuring organisms are known to add or alter physical, chemical and biological factors and therefore are often referred to as bio-engineers (Jones *et al*., 1994). The ecological mechanisms behind the effect of habitat structuring organisms are well known in (for instance) coral reefs but are less well documented for organisms living in soft substrates of the sea bottom in temperate areas. Like the ecosystem service of resilience and resistance, biologically mediated habitat is an intermediate supporting service.

<u>Estimated Value:</u> Currently, there is no information on marine biologically mediated habitats that could be suitable transferred to the UK marine environment.

Nutrient recycling

Beaumont *et al*. (2006) defined nutrient recycling as the storage, cycling and maintenance of availability of nutrients mediated by living marine organism and estimated a range value of £800 - £2,320 billion. This estimate was considered, as a cost of treating UK waters once and as such the estimate was not an annual value but a one-off expenditure. The approach used (a 'shadow' value of a project that would return the resource to a given state) is *extremely high* and would likely dominate any assessment. Other literature was reviewed in an attempt to find a more conservative estimate for nutrient recycling. Further, an annual value was also required.

A value for nutrient recycling was derived on the basis of the original global valuation study by Costanza *et al*. (1997). The methodology employed by Costanza *et al.* (1997) to determine these gross ecosystem values involved aggregating smaller scale studies which were based on market and non-market data to estimate willingness to pay for nutrient recycling and other ecosystem services[25]. This can only be considered a crude first approximation and can introduce errors due to spatial heterogeneity of ecosystems.

The methodology in this study transposed the annual global ecosystem nutrient recycling values directly to the spatial areas of UK's territorial sea. The annual global values were estimated in 1994 US$ on a per hectare basis for the entirety of the world' marine ecosystems, i.e. no independent figure is cited for tropical versus temperate ecosystems. Although this adds a further level of crudity to the analysis, the use of the substantively lower global mean figure was deemed more appropriate than using the shadow project approach applied by Beaumont *et al*. (2006). To arrive at a current value of the UK's marine environment, the original US$ (1994) value was first adjusted to 2011 prices and then converted to 2011 £s. This was achieved by taking the original value, price inflating them through to 2011 using the US Consumer Price Index, and then converting them to Sterling value using a Bank of England average £/$ exchange rate for 2011.

According to Costanza *et al*. (1997), the net global value of nutrient recycled is approximately $118/ha/year in open oceans and $3,677/ha/year in coastal seas (1994 dollars). For the purposes of both the CRO 380 report and the present study, the lower figure of $118/ha/year has been used adopting a conservative approach. JNCC estimated the area of a polygon indicating the generalised location of the 12 nautical mile territorial waters boundary around the UK mainland and offshore islands to be 161,200 km^2. Although this estimate may be subject to some degree of error it serves to provide an approximate area within the UK 12 nautical mile limit within which UK MCZs can be located. Converting the area into hectares gives 16,120,000 hectares. Multiplying UK territorial area by an adjusted US $ prices and an average 2011 $/£ exchange rate gives an annual benefit for this category of £1.8 billion.

The approach adopted was considered to produce appropriate and conservative annualised value for the UK, despite the fact it is simple and rests upon the assumption that the annual ecosystem service values per hectare for the UK are similar to the average global values. In reality this value would be different depending on the region of study as individuals' willingness to pay is a function of both utility and income.

<u>Estimated Value:</u> The aggregate value for nutrient recycling is inputted as £1.8 billion per annum within the UK 12 nautical mile limit.

Gas and climate regulation

Beaumont *et al.* (2006) defined gas and climate regulation services of the marine environment as the balance and maintenance of the chemical composition of the atmosphere and oceans by marine living organisms. In the marine environment this process is usually referred to as natural greenhouse gas (GHG) sequestration. CO_2 is the main GHG contributing to global climate change. The marine environment plays a significant role in climate control through the regulation of carbon fluxes, in part due to its capacity to sequester CO_2 (Beaumont *et al.* 2006).

The Beaumount *et al*. (2006) values for this category of service were substituted by the quantity estimate of carbon equivalent emissions and value these using the updated Defra figures for the

[25] Costanza *et al.* (1997) does not provide details on how this figure was derived for nutrient recycling. This paper has proved to be extremely influential in the environmental economics literature and, although the approach adopted by the authors has been criticised, the valuation estimates revealed in the paper have been cited extensively and applied in policy appraisal worldwide. See for instance: http://www.uvm.edu/theview/article.php?id=1387 (accessed 3.12.2007)

shadow price of carbon[26]. The average shadow price of carbon (SPC) for 2011 prices (£/t CO_2) was estimated to be £27.6/t CO_2[27]. £27.6/t CO_2 was converted by dividing by 0.2727[28] conversion factor to its carbon equivalent of £101.21/t C. Using the photosynthesis model of Smyth *et al*. (2005), Beaumont *et al.* (2006) estimated the average annual primary production (carbon sequestered by phytoplankton) in the UK to be approximately 0.07 +/- 0.004 giga ton carbon/year. The midpoint value of this estimate is equivalent to 70,000,000 tons of carbon per year. Multiplying this carbon equivalent by the estimated shadow price of £101.21/t C gives £7,084,708,471 per year. This value contains considerable uncertainty as only carbon taken up by phytoplankton was considered in the estimate. It also could be argued that a proportion of the carbon taken up by primary production is returned to the water column in a short period of time through respiration and decay processes.

Estimated Value: The aggregate value for carbon sequestration within the UK 12 nautical mile limit is thus inputted as £7.08 billion per annum.

Bioremediation of waste

Beaumount *et al*. (2006) did not assign any value to bioremediation of waste but defined it as the removal of pollutants through storage, dilution, transformation and burial. The literature review revealed one study that provided some data on this ecosystem service: Merino (2002) documents the benefit of 60,000 tone of heavy fuel from the oil tanker Prestige that broke up around 130 miles from the Galicia coast in Spain in 2002. The clean up attempted to speed up the bioremediation process and costs around €12 million. From this an implicit value for bioremediation might have been drawn but the link is at best tenuous.

Estimated Value: No value was inputted for bioremediation of waste**.**

Leisure and recreation

Recreational services of an ecosystem are defined as providing opportunities for recreational activities (Costanza *et al*. 1997). In the marine context examples include bird watching, rock pooling, beachcombing, angling, recreational diving, whale-watching *etc*. Hence, they are directly related to resource dependent recreational and tourism activities in the marine coastal environment.

The marine coastal environment is a major attraction to visitors who are drawn by the quality of its landscape, wildlife and seawater. The environmental quality of the marine coastline is reflected in the wide range and large number of designations and protected sites that cover the coastline of the UK. For example in Wales some 70% of the coastline has been designated for its environmental quality (Welsh Assembly Government, 2007). Both travel cost (TC) and Contingent Valuation (CV) methods have been used to estimate coastal and recreation value.

Pugh and Skinner (2002) estimated values of leisure and recreation in the UK marine environment based on the total net value of marine leisure and recreation. This estimation went up to £11.77 billion. Pugh and Skinner (2002) derived their estimate from information supplied by British Tourist Board. This value was not entirely dependent upon marine biodiversity, and was considered an overestimate because the estimate included holiday tourism, cruising and leisure craft services. Therefore alternative approaches have been applied in order to derive a more precise value for leisure and recreation.

[26] DEEC does not use any more Shadow Price of Carbon for the valuation of projects or policies involving changes in carbon emissions. However, the Shadow Price valuation has been used in the present study in order to maintain the CRO380 original methodology.

[27] http://archive.defra.gov.uk/evidence/series/documents/shadowpriceofcarbondec-0712.pdf

[28] Carbon comprises 12/44 of the mass of CO_2

According to England Leisure Visits (2005), 70 million visits were made to coastal/seaside areas and average expenditure[29] per visit was estimated at £19.79 and total expenditure was equivalent to £1.4 billion in 2005. The application of expenditure as a surrogate for social welfare is a simplification as estimates for producer surplus and consumer surplus would be required for the latter. However, expenditure was used as a rough estimation. Accounting for changes in prices in 2011, this value is equivalent to £1.8 billion.

Detailed survey data were not available for Wales and Northern Ireland. A study for the Welsh Assembly Government on the Welsh coastal tourism strategy indicates that spending associated with a visit to the coast amounted to around £850 million in 2006. This figure is considered to be an overestimate because some of the activities undertaken such as shopping, watching performing arts, and playing golf are not directly related to the coast and marine biodiversity. However there is no information that could be used to adjust this figure. Therefore this figure was taken as given. Northern Ireland Tourist board estimated that tourism expenditure was £1.3 billion in 2006. This figure is not broken down by sectors of the tourism but the report indicated that 23.1% of expenditure in N. Ireland was related to the Causeway Coast. It was assumed that the expenditure related to the Causeway Coast is representative of coastal visiting expenditure in N. Ireland. However it must be noted that this may not necessarily be the case because Causeway Coast is a World Heritage Site. Summing all the figures for the respective countries in the UK gave a total sum of 3.4 billion for coastal recreation. This figure is lower than the Pugh and Skinner (2002) and is subject to a number of contentious assumptions but it is considered a better estimate.

Beaumont et al. (2006) argued that marine recreational activities that are dependent upon marine biodiversity include sea angling, diving, and whale watching. A study completed during 2004 estimated that over 1.1 million people in the UK regularly participate in recreational sea angling which contributes up to £1.3 billion per annum to the U.K economy and supports over 19,000 first round jobs[30]. In this study an omnibus survey used a sample of 10,200 households in England and Wales to identify the sea angler population and their activities. An additional 383 member of 30 angling clubs and 514 sea anglers on angling trips in 12 regional locations were used to obtain information on types of angling activity, number of visits, expenditure and consumer surplus. Four case studies produced descriptive information on the characteristics of sea angling, its economic contribution, trends and factors limiting development of the sector. Finally, a business survey was carried out with 162 tackle shops, charter skippers and boat equipment suppliers. The contribution of £1.3 billion was adjusted by inflating it through to 2011 prices using RPI to derive £1.38 billion.

In addition, a baseline study of seal watching commissioned by the International Fund for Animal Welfare (IFAW), estimated that seal watching provided at least £36 million to the UK economy in 1996[31]. Further details of the methodology adopted to arrive at this figure are not available. Inflating this value through to 2011 prices using UK RPI gives £52.5 million. Aggregating the 2011 values for marine recreational angling and seal watching gives a total value of £1.8 billion. This value is an underestimate because it does not include other recreational activities directly relation to marine biodiversity for which data could not be found (e.g. scuba diving, bird watching).

<u>Estimated Value:</u> The aggregate value for leisure and tourism is thus taken to be £1.4-3.4 billion per annum. This range of values for coastal recreation and marine wildlife watching provide a range for which sensitivity analysis to be carried out.

[29] Expenditures are used as indicators of the value of recreational purposes (e.g. Turpie and Joubert, 2001)
[30] www.scottish.parliament.uk/business/committees/environment/ inquiries/marine/env-marine-SFoSA.pdf
[31] www.ipsos-mori.com/polls/1999/ifaw0699.shtml.

Food provision

Area based designations (MPAs) have been used in many countries around the world to manage marine resources and to conserve both ecosystems and fisheries production. Considerable disagreement exists among fisheries scientists and conservation biologists about the effectiveness of such designations in terms of meeting fisheries production and conservation goals. It is argued that one of the reasons that MPAs were established in the first place was to stem overfishing problems that characterised many fisheries around the world. Benefits for establishing MPAs not only for conservation of ecosystems but also for the production of food fish have been documented.

Food production services of a marine ecosystem are defined as the extraction of marine organisms for human consumption (Beaumont *et al*., 2006). Examples include the harvesting of fish, seaweed, and shellfish from the marine environment.

A large variety of fish is landed in the UK (e.g. shellfish, demersal and pelagic fish). In 2011, total fish landed by the UK fishing fleet at domestic ports and abroad amounted to 599,600 tonnes worth around £822.2 million (DEFRA, 2011). It must be noted that the market values of food fish landed by the UK fleet of £822.2 million are ex-vessel prices. These are not representative of the true value of the resource as it does not take account of the value added along the market chain, the employment created, unrecorded bycatch, black-fish landed, value of recreational sea fish caught, retail sales and exports. Due to the lack of data availability indirect market benefits could not be accounted for. Value added activities along the marketing chain were accounted for by applying a value-added factor[32] to the ex-vessel aggregate price to derive £1,200.9 million for food provision.

Estimated Value: The aggregate value for food provision is £1,200.9 million in £2011.

Raw materials

Raw materials refer to renewable biotic resources such as wood and fibres for building, biochemicals or biodynamic compounds for all kinds of industrial purposes (de Groot *et al*., 2002). The marine environment provides raw materials that can be used directly or indirectly in the economy. Raw materials are combined with other production factors to transform them into products that satisfy human welfare, for example, seaweed for industry and fertiliser, fishmeal for aquaculture and farming, pharmaceuticals and ornamental goods such as shells. The extraction of raw material from the marine environment leads to significant employment opportunities. This category does not include raw material not supported by living marine organism such as dredge materials, oil or aggregates.

Beaumont *et al*. (2006) used the value of the total value of the fishmeal in the UK market in 2004 of £81 million (extracted from European Parliament Report, 2004) and the estimated gross income from seaweed in 1994 adjusted to 2004 prices (£349,819 to £583,032). Beaumont *et al* (2006) suggested that the estimated market value of seaweed probably lay towards the lower end of this range. The total estimated value was then summed to £81.3 million. This figure is probably an underestimate because market values could not be found for all of the marine raw materials exploited in the UK. The values derived by Beaumount *et al*. (2006) were adjusted for changes in prices in 2011 using the appropriate Consumer Price Index and used in this study.

Estimated Value: The aggregate value for raw materials is thus inputted as £152.8 million

Disturbance prevention and alleviation

Disturbance prevention and alleviation refers to the dampening of environmental disturbances by biogenic structures. This is a critically important service provided by coastal landscapes such as barrier islands, floodplains, beaches and tidal plains is disturbance prevention alleviation. The presence of

[32] Value added factor of 0.45 was applied (Pugh and Skinner 2002).

biogenic structures in the front line of sea defence can dampen and prevent a number of environmental disturbances such as tidal, storm and flood damages (Beaumont *et al*. 2006). Significant property damages have been attributed to flooding from tidal surges and rainfall as well as wind damage associated with major storm events[33].

Beaumont *et al*. (2006) took King and Lester (1995) estimated value that an 80m width of saltmarsh could result in cost savings, in sea defence terms, of £0.38 million to £0.71 million per hectare in terms of capital costs, and £7,100 per hectare in terms of annual maintenance costs (adjusted to 2004 prices). Beaumont *et al*. multiplied these values by an estimated saltmarsh area of 45,500 hectare. This equates to cost savings of between £17 billion and £32 billion for capital costs, and £0.3 billion annual maintenance costs. These estimates are likely to be an underestimate because the areas of saltmarsh taken into account are those concentrated in eastern England.

No new studies pertaining to this benefit category were found over and above those in Beaumount *et al* (2006). The values derived by Beaumount *et al*. (2006) were adjusted for changes in prices in 2011 using the appropriate Consumer Price Index and used in this study.

Estimated Value: The aggregate value for disturbance prevention and alleviation is thus inputted as £0.54 billion.

Cultural heritage and identity

Cultural services of an ecosystem are defined as providing opportunities for non-commercial uses (Costanza *et al*., 1997). Beaumont *et al*. (2006) gave marine specific examples to include religion, folklore, and painting, cultural and spiritual traditions. Communities living by and off the sea often attach special importance to marine ecosystems that have played a founding or significant role in the economic or cultural definition of the community. This identification may be associated with a strong economic interest in the extraction of the site but as economic significance decreases the community may attach increased symbolic values to the preservation of the site. For example a mussel bed may long have lost its economic significance while the symbolic importance may be high.

Estimated Value: The literature provides no information on the cultural benefits of marine biodiversity that could be used in this study. It was assumed that the lack of information was indicative of a lack of documented research rather than lack of value of the service.

Cognitive value

Cognitive value refers to cognitive development, including education and research, resulting from marine organisms (Beaumount *et al.* 2006). Marine living organisms are useful for cognitive development in education and research. For example, the marine bio-prospecting for organisms that can be used as cultures in laboratories for use in pharmacy. Increasingly, the high biodiversity found in the oceans is creating opportunities for the exploitation of living resources in areas including cold-water coral reefs, seamounts and hydrothermal vents. Soft-bodied invertebrates like sponges and sea slugs have been targeted in shallow waters, as they tend to have a range of biochemical defences that may be useful for technological or pharmaceutical applications. The major opportunities in the deep sea arise from the diverse populations of microbes in areas such as hydrothermal vents, where their adaptations to extreme conditions results in novel properties that are likely to favour exploitation and further research. Thus there is significant value in education, training and university involvement in marine science and research.

[33]http://www.talkbritain.co.uk/forum/environment-nature-wildlife/17909-flood-damage-estimated-1-5-billion.html.

Using questionnaires Pugh and Skinner (2002) conducted a survey of the marine science and technology activities in UK universities carried out by Inter-Agency Committee on Marine Science and Technology (IACMST) for the financial year 1999–2000. It was estimated that the value added research and development in the marine sector in the UK to be £292 million. In addition education and training was valued at £24.8 million. These values were summed and adjusted for price changes in 2004 by Beaumont *et al*. to derive cognitive value estimate for the UK marine resources. These estimates include all marine areas and are considered an over-estimate. No new studies pertaining to this benefit category were found over and above those in Beaumount *et al* (2006). The values derived by Beaumount *et al*. (2006) were adjusted for changes in prices in 20011 using the respectively appropriate Consumer Price Index and used in this study.

Estimated Value: The aggregate value for cognitive value is thus inputted as £491.1 million per annum.

Non-use values

As presented in Table 5, non-use values (NUVs) can be sub-divided into bequest values and existence values. The former is a value that an individual places on ensuring the availability of natural resources for future generations. The latter is the value placed on simply knowing that a natural resource is there, even if humans never directly experience it. Bequest value is an instrumental value as it is linked with human consumption whereas existence value is an intrinsic value, i.e. unrelated to human consumption.

There have been a variety of studies carried out to attempt to place a monetary value on NUVs (see Edwards-Jones *et al*, 2000) but these have in the main considered terrestrial ecosystems. The number of studies focused on marine ecosystems is scarce. Only one study has been found that estimated the non-use value of marine ecosystems in UK (McVittie and Moran, 2008). This study used both contingent valuation (CV) and choice experiment (CE) methodologies to estimate the benefits to be gained from the MCZs proposals contained wihin the UK Marine Bill, with a specific emphasis on quantifying non-use values arising from such designation. CE was considered more useful for indicating the value of changes in levels of specific non-use attributes, as was the case for the biodiversity attribute used in the survey. The "halt loss of biodiversity" level of the biodiversity attribute was considered as the most appropriate measure of non-use values arising from the CE study.

Median implicit prices (WTP) for this attribute level ranged from £20 to £128 per household per year across the different country samples and model specifications, being the median value £45.1 per household and year. These values were adjusted to 2011 prices using the appropriate CPI and then multiplied by the number of households in 2011. Although the median range has been included in the summary table, the median value has been taken as the' best estimate', while the lower bound of the range has been applied in the sensitivity analysis.

Estimated Value: The aggregate values for non-use values ranged between £0.6 billion and £3.9 billion per annum, being the 'best estimate' finally applied £1.4 billion.

APPENDIX C: APPORTIONING OF AGGREGATE ANNUAL BENEFITS ACROSS HABITAT LANDSCAPE CATEGORIES

This Appendix explains with further detail the way that the aggregate annual benefits arising from each of the ecosystem goods and services is split across the different habitat and landscape categories. The adopted approach has been directly taken (and summarised below) from the CRO 380 report[34] and it is based on the application of certain codes depending on the capacity of apportioning each of the goods and services categories:

Code A: Goods and services that could be partitioned on a biological basis

As it can be observed in Table C 1 and Table C 2 five good and services categories could be portioned on a biological basis – Code A (nutrient recycling; bioremediation of waste; gas and climate regulation; food provision; raw materials). A scoring system was applied as follows: If the habitat type (β) has a 'high' benefit for service category (α) then it is scored as a '3'; if the benefit is 'medium' it is scored as '2'; and if it is 'low' it is scored as '1'. These are cardinal (not ordinal) scores, i.e. a score of ‘3’ implies that, per unit area, that landscape/habitat has three times the impact on the given benefit category as compared to one that scores ‘1’.

The last column in Table C 2 provides a summation of these scores across each of the five benefit economic categories. These scores reflect the relative contribution of each landscape/TDH *per unit area*. Thus for nutrient recycling one hectare of shelf mud (scored 3) contributes three times as much as one hectare of aphotic reef (scored 1) for the same economic category, i.e. nutrient recycling. The positive impact of each habitat (its proportional share of the aggregate value for that economic benefit category) is a function of two things: the impact scoring and the areas. Multiplying these together and summing them gives us a total benefit score for the economic good/service.

[34] Further information on the principles behind the applied partitioning methodology can be found in Moran *et al.*, 2007 (CRO 380 report)

Table C 1. Scoring for landscape types: splitting aggregate benefit values

Goods and Services	CODING TYPE	Aphotic reef	Oceanic cold water coarse sediment	Oceanic cold water mixed sediment	Oceanic cold water mud	Oceanic cold water sand	Oceanic warm water coarse sediment	Oceanic warm water mixed sediment	Oceanic warm water mud	Oceanic warm water sand	Photic reef	Shallow strong tide stress coarse sediment	Shallow moderately tide stress coarse sediment	Shallow weak tide stress coarse sediment	Shallow strong tide stress mixed sediment	Shallow moderately tide stressed mixed sediment	Shallow weak tide stress mixed sediment	Shallow mud	Shallow sand	Shelf strong tide stress coarse sediment	Shelf moderately tide stress coarse sediment	Shelf weak tide stress coarse sediment	Shelf strong tide stress mixed sediment	Shelf moderately tide stress mixed sediment	Shelf weak tide stress mixed sediment	Shelf mud	Shelf sand	**TOTALS FOR LANDSCAPES**
E1. Nutrient recycling	A	L	M	M	M	M	M	M	M	M	M	M	M	M	M	M	H	H	H	M	M	M	M	M	H	H	H	57
E2. Bioremediation of waste	A	L	M	M	M	M	M	M	M	M	M	M	M	M	M	M	H	H	H	M	M	M	M	M	H	H	H	57
E3. Gas and climate regulation	A	L	M	M	M	M	M	M	M	M	M	M	M	M	M	M	H	H	H	M	M	M	M	M	H	H	H	57
E4. Food provision	A	M	M	M	M	M	M	M	M	M	M	M	M	H	M	M	M	M	M	L	M	H	M	M	M	H	M	54
E5. Raw materials	A	H	L	L	L	L	L	L	L	L	H	M	M	M	M	M	M	L	M	L	L	L	L	L	L	L	L	37
E6. Biologically mediated habitat	B																											
E7. Resilience and resistance	B																											
E8. Disturbance prevention and alleviation	C	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	26
E9. Leisure and recreation	D																											
E10. Cultural heritage and identity	D																											
E11. Non-use / bequest values	D																											
E12. Option use values	D																											
E13. Cognitive values	D																											

(Adopted from Moran *et al.*, 2007 – p. 60)

Coding Type A: Impact of one unit area of the habitat/landscape type relative to one unit of other habitats/landscapes (L=Low=1; M=Medium=2; H=High=3)

Coding Type B: Unit area used to split aggregate impact score, with no weighting for particular habitat/landscape types

Coding Type C: Economic impact depends on distance from shore ((L=Low=1; M=Medium=2; H=High=3)

Coding Type D: No scientific rationale available for splitting aggregate values

Table C 2. Scoring for TDH habitat types: splitting aggregate benefit values

Goods and Services	CODING TYPE	Carbonate mounds	*Lophelia pertusa* reefs	Maerl beds	*Modiolus modiolus* beds	*Ostrea edulis* beds	*Sabellaria spinulosa* reefs	Sea mounts	Sea-pen and burrowing megafauna communities	*Zostera* beds	TOTALS FOR HABITATS	**TOTALS FOR LANDSCAPES AND HABITATS SUMMED**
E1. Nutrient recycling	A	L	L	M	H	M	L	L	H	H	17	**74**
E2. Bioremediation of waste	A	L	L	M	H	M	L	L	H	H	17	**74**
E3. Gas and climate regulation	A	L	L	M	H	M	L	L	H	H	17	**74**
E4. Food provision	A	M	M	M	M	L	L	M	H	L	16	**70**
E5. Raw materials	A	L	L	M	L	L	L	L	L	L	10	**47**
E6. Biologically mediated habitat	B											
E7. Resilience and resistance	B											
E8. Disturbance prevention and alleviation	C	L	L	L	L	L	L	L	L	M	10	**36**
E9. Leisure and recreation	D											
E10. Cultural heritage and identity	D											
E11. Non-use / bequest values	D											
E12. Option use values	D											
E13. Cognitive values	D											

(Adopted from Moran *et al.*, 2007 – p. 61)

Coding Type A: Impact of one unit area of the habitat/landscape type relative to one unit of other habitats/landscapes (L=Low=1; M=Medium=2; H=High=3)

Coding Type B: Unit area used to split aggregate impact score, with no weighting for particular habitat/landscape types

Coding Type C: Economic impact depends on distance from shore ((L=Low=1; M=Medium=2; H=High=3)

Coding Type D: No scientific rationale available for splitting aggregate values

The percentage area was multiplied by the score and aggregated (See Table C 3). For instance, consider benefit categories 1-3. The third column shows the percentage area (e.g. 1.8% for aphotic reef). Thus total area of aphotic reef represents 1.8% of the total area of marine landscapes in the UK. The impact score (for categories 1-3) is 1. The multiple of these is given in column 5 (i.e. 1.8 for aphotic reef).

This same process was applied to all landscape/habitat types; the aggregate for economic categories 1-3 is 251.4 for instance[35]. The individual score for each landscape/habitat type (area*score) is then calculated as a proportion of this total. For instance, for aphotic reef this is 1.8 which is 0.7% of 251.4. Thus the proportional contribution of *all* aphotic reefs to nutrient recycling in the UK is 0.7% of the total value of nutrient recycling across all UK marine habitats. Were there not to have been an impact scoring (1-3) then the results would have been based only on area, and aphotic reef would have scored 1.8% instead of 0.7%. The same process was applied for benefit categories 4 and 5. The results differ to those for benefit categories 1-3 as the impact scorings are different. Column 9 in Table C 3 provides the percentage of total value for each of the landscape categories for food provision (E4) and column 12 for raw materials (E5).

[35] There is no unit *per se*. This is the multiple of impact score and the percentage area.

Table C 3. Proportions of total beenfits attributed to each hábitat/landscape type with Code A

Classification of landscape	**Area (km2)**	**%Ar**	**1_3**	**Multi**	**%TV**	**4**	**Multi**	**%TV**	**5**	**Multi**	**%TV**
Aphotic reef (L1)	10,968	1.8	1	1.8	0.7	2	3.6	1.6	3	5.4	4.4
Oceanic cold water coarse sediment (L2)	386	0.1	2	0.1	0.1	2	0.1	0.1	1	0.1	0.1
Oceanic cold water mixed sediment (L3)	4,880	0.8	2	1.6	0.6	2	1.6	0.7	1	0.8	0.6
Oceanic cold water mud (L4)	23,509	3.9	2	7.7	3.1	2	7.7	3.4	1	3.9	3.1
Oceanic cold water sand (L5)	5,597	0.9	2	1.8	0.7	2	1.8	0.8	1	0.9	0.7
Oceanic warm water coarse sediment (L6)	3,781	0.6	2	1.2	0.5	2	1.2	0.6	1	0.6	0.5
Oceanic warm water mixed sediment (L7)	5,407	0.9	2	1.8	0.7	2	1.8	0.8	1	0.9	0.7
Oceanic warm water mud (L8)	56,327	9.3	2	18.5	7.4	2	18.5	8.2	1	9.3	7.5
Oceanic warm water sand (L9)	6,076	1.0	2	2.0	0.8	2	2.0	0.9	1	1.0	0.8
Photic reef (L10)	7,155	1.2	2	2.4	0.9	2	2.4	1.0	3	3.5	2.9
Shallow strong tide stress coarse sediment (L11)	2,840	0.5	2	0.9	0.4	2	0.9	0.4	2	0.9	0.8
Shallow moderate tide stress coarse sediment (L12)	16,745	2.8	2	5.5	2.2	2	5.5	2.4	2	5.5	4.4
Shallow weak tide stress coarse sediment (L13)	33,694	5.5	2	11.1	4.4	3	16.6	7.4	2	11.1	9.0
Shallow strong tide stress mixed sediment (L14)	952	0.2	2	0.3	0.1	2	0.3	0.1	2	0.3	0.3
Shallow moderate tide stress mixed sediment (L15)	2,021	0.3	2	0.7	0.3	2	0.7	0.3	2	0.7	0.5
Shallow weak tide stress mixed sediment (L16)	2,922	0.5	3	1.4	0.6	2	1.0	0.4	2	1.0	0.8
Shallow mud (L17)	6,893	1.1	3	3.4	1.4	2	2.3	1.0	1	1.1	0.9
Shallow sand (L18)	48,218	7.9	3	23.8	9.5	2	15.8	7.0	2	15.8	12.8
Shelf strong tide stress coarse sediment (L19)	2,840	0.5	2	0.9	0.4	1	0.5	0.2	1	0.5	0.4
Shelf moderate tide stress coarse sediment (L20)	17,433	2.9	2	5.7	2.3	2	5.7	2.5	1	2.9	2.3
Shelf weak tide stress coarse sediment (L21)	76,492	12.6	2	25.1	10.0	3	37.7	16.7	1	12.6	10.2
Shelf strong tide stress mixed sediment (L22)	285	0.0	2	0.1	0.0	2	0.1	0.0	1	0.0	0.0
Shelf moderate tide stress mixed sediment (L23)	2,260	0.4	2	0.7	0.3	2	0.7	0.3	1	0.4	0.3
Shelf weak tide stress mixed sediment (L24)	3,951	0.6	3	1.9	0.8	2	1.3	0.6	1	0.6	0.5
Shelf mud (L25)	44,605	7.3	3	22.0	8.7	3	22.0	9.8	1	7.3	5.9
Shelf sand (L26)	215,215	35.4	3	106.1	42.2	2	70.7	31.4	1	35.4	28.6
Carbonate mounds (TDH1)	233	0.0	1	0.0	0.0	2	0.1	0.0	1	0.0	0.0
Lophelia pertusa reefs (TDH2)	1855	0.3	1	0.3	0.1	2	0.6	0.3	1	0.3	0.2
Maerl beds (TDH3)	357	0.1	2	0.1	0.0	2	0.1	0.1	2	0.1	0.1
Modiolus modiolus beds (TDH4)	220	0.0	3	0.1	0.0	2	0.1	0.0	1	0.0	0.0
Ostrea edulis beds (TDH5)	14	0.0	2	0.0	0.0	1	0.0	0.0	1	0.0	0.0
Sabellaria spinulosa reefs (TDH6)	105	0.0	1	0.0	0.0	1	0.0	0.0	1	0.0	0.0
Sea mounts (TDH7)	61	0.0	1	0.0	0.0	2	0.0	0.0	1	0.0	0.0
Sea-pen and burrowing megafauna communities (TDH8)	3118	0.5	3	1.5	0.6	3	1.5	0.7	1	0.5	0.4
Zostera beds (TDH9)	1217	0.2	3	0.6	0.2	1	0.2	0.1	1	0.2	0.2
TOTAL	608,632	100	74	251.4	100	70	225.3	100	47	123.7	100

(Adopted from Moran *et al.*, 2007 – p. 64)

Code B: Relative contribution scored by area

The two rows coded B in Table C 1 and Table C 2 (biologically mediated habitat; resilience and resistance) are those economic good categories for which unit area is used to attribute proportions of impacts. These are presented as overall percentages of area in column 3 of Table C 3, as well as in the summary table: .).

Code C: Services for which there is a biological basis/location specificity

'Disturbance prevention and alleviation' is coded C. The methodological process applied was the same as the one for Code A but differs in that the economic benefit depends on the distance from the shore. All landscapes and TDHs other than Zostera beds were given a low score and considered to have equal contributions to this. The total for the column row is 36 and the individual cells within Tables 17 and 18 again allow for this proportional split as per the analytical approach adopted for the Code A rows. The score for Zostera beds is 0.4 as this is the multiple of the percentage area (0.2%) and the benefit score 92). The calculation for each landscape/habitat category is provided in Table 17 and again in the summary table (Table 18). Since only Zostera beds are given a score other than 1, the final percentage of total value attributed to each landscape/habitat was very similar to the attribution by area, i.e. code B.

Code D: Services for which there is no biological basis for partitioning

Five benefit categories (leisure and recreation; cultural heritage and identity; non-use/bequest values; option use values; cognitive values) could not be differentiated based on any biological or geographical reasoning. Thus each was (arbitrarily) apportioned the same share of the total value, i.e. 1/35th.

Table C 4. Proportions of total values attributed to each landscape/habitat type for 'disturbance prevention and alleviation'

Classification of landscape	Area (km2)	%Ar	Benefit category 8	Multi	%TV
Aphotic reef (L1)	10,968	1.8	1	1.8	1.8
Oceanic cold water coarse sediment (L2)	386	0.1	1	0.1	0.1
Oceanic cold water mixed sediment (L3)	4,880	0.8	1	0.8	0.8
Oceanic cold water mud (L4)	23,509	3.9	1	3.9	3.9
Oceanic cold water sand (L5)	5,597	0.9	1	0.9	0.9
Oceanic warm water coarse sediment (L6)	3,781	0.6	1	0.6	0.6
Oceanic warm water mixed sediment (L7)	5,407	0.9	1	0.9	0.9
Oceanic warm water mud (L8)	56,327	9.3	1	9.3	9.2
Oceanic warm water sand (L9)	6,076	1.0	1	1.0	1.0
Photic reef (L10)	7,155	1.2	1	1.2	1.2
Shallow strong tide stress coarse sediment (L11)	2,840	0.5	1	0.5	0.5
Shallow moderate tide stress coarse sediment (L12)	16,745	2.8	1	2.8	2.7
Shallow weak tide stress coarse sediment (L13)	33,694	5.5	1	5.5	5.5
Shallow strong tide stress mixed sediment (L14)	952	0.2	1	0.2	0.2
Shallow moderate tide stress mixed sediment (L15)	2,021	0.3	1	0.3	0.3
Shallow weak tide stress mixed sediment (L16)	2,922	0.5	1	0.5	0.5
Shallow mud (L17)	6,893	1.1	1	1.1	1.1
Shallow sand (L18)	48,218	7.9	1	7.9	7.9
Shelf strong tide stress coarse sediment (L19)	2,840	0.5	1	0.5	0.5
Shelf moderate tide stress coarse sediment (L20)	17,433	2.9	1	2.9	2.9
Shelf weak tide stress coarse sediment (L21)	76,492	12.6	1	12.6	12.5
Shelf strong tide stress mixed sediment (L22)	285	0.0	1	0.0	0.0
Shelf moderate tide stress mixed sediment (L23)	2,260	0.4	1	0.4	0.4
Shelf weak tide stress mixed sediment (L24)	3,951	0.6	1	0.6	0.6
Shelf mud (L25)	44,605	7.3	1	7.3	7.3
Shelf sand (L26)	215,215	35.4	1	35.4	35.3
Carbonate mounds (TDH1)	233	0.0	1	0.0	0.0
Lophelia pertusa reefs (TDH2)	1855	0.3	1	0.3	0.3
Maerl beds (TDH3)	357	0.1	1	0.1	0.1
Modiolus modiolus beds (TDH4)	220	0.0	1	0.0	0.0
Ostrea edulis beds (TDH5)	14	0.0	1	0.0	0.0
Sabellaria spinulosa reefs (TDH6)	105	0.0	1	0.0	0.0
Sea mounts (TDH7)	61	0.0	1	0.0	0.0
Sea-pen and burrowing megafauna communities (TDH8)	3118	0.5	1	0.5	0.5
Zostera beds (TDH9)	1217	0.2	2	0.4	0.4
TOTAL	**608,632**	**100.0**	**36**	**100.2**	**100.0**

(Adopted from Moran *et al.*, 2007 – p. 66)

Summary: Splitting aggregate benefits across habitat/landscape categories

A summary of the proportional impact of each habitat type to each economic good/service category is presented in Table C 5. The figures in Table C 5 represent the proportions of the total benefit that UK marine ecosystems provide for a given economic good/service that is attributable to a particular habitats/landscape type regardless of whether or not it is protected under the MCZ designation.

Table C 5. Proportion of total annual benefit from good and services categories 1-13 attributed to each habitat/landscape

	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13
	%TV	%TV	%TV	%TV	%TV	%TV	%TV	%TV	%TV	%TV	%TV	%TV	%TV
L1	0.72	0.72	0.72	1.60	4.37	1.80	1.80	1.80	2.86	2.86	2.86	2.86	2.86
L2	0.05	0.05	0.05	0.06	0.05	0.06	0.06	0.06	2.86	2.86	2.86	2.86	2.86
L3	0.64	0.64	0.64	0.71	0.65	0.80	0.80	0.80	2.86	2.86	2.86	2.86	2.86
L4	3.07	3.07	3.07	3.43	3.12	3.86	3.86	3.85	2.86	2.86	2.86	2.86	2.86
L5	0.73	0.73	0.73	0.82	0.74	0.92	0.92	0.92	2.86	2.86	2.86	2.86	2.86
L6	0.49	0.49	0.49	0.55	0.50	0.62	0.62	0.62	2.86	2.86	2.86	2.86	2.86
L7	0.71	0.71	0.71	0.79	0.72	0.89	0.89	0.89	2.86	2.86	2.86	2.86	2.86
L8	7.36	7.36	7.36	8.22	7.48	9.25	9.25	9.24	2.86	2.86	2.86	2.86	2.86
L9	0.79	0.79	0.79	0.89	0.81	1.00	1.00	1.00	2.86	2.86	2.86	2.86	2.86
L10	0.94	0.94	0.94	1.04	2.85	1.18	1.18	1.17	2.86	2.86	2.86	2.86	2.86
L11	0.37	0.37	0.37	0.41	0.75	0.47	0.47	0.47	2.86	2.86	2.86	2.86	2.86
L12	2.19	2.19	2.19	2.44	4.45	2.75	2.75	2.75	2.86	2.86	2.86	2.86	2.86
L13	4.40	4.40	4.40	7.37	8.95	5.54	5.54	5.52	2.86	2.86	2.86	2.86	2.86
L14	0.12	0.12	0.12	0.14	0.25	0.16	0.16	0.16	2.86	2.86	2.86	2.86	2.86
L15	0.26	0.26	0.26	0.29	0.54	0.33	0.33	0.33	2.86	2.86	2.86	2.86	2.86
L16	0.57	0.57	0.57	0.43	0.78	0.48	0.48	0.48	2.86	2.86	2.86	2.86	2.86
L17	1.35	1.35	1.35	1.01	0.92	1.13	1.13	1.13	2.86	2.86	2.86	2.86	2.86
L18	9.45	9.45	9.45	7.03	12.81	7.92	7.92	7.91	2.86	2.86	2.86	2.86	2.86
L19	0.37	0.37	0.37	0.21	0.38	0.47	0.47	0.47	2.86	2.86	2.86	2.86	2.86
L20	2.28	2.28	2.28	2.54	2.32	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86
L21	10.00	10.00	10.00	16.74	10.16	12.57	12.57	12.54	2.86	2.86	2.86	2.86	2.86
L22	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	2.86	2.86	2.86	2.86	2.86
L23	0.30	0.30	0.30	0.33	0.30	0.37	0.37	0.37	2.86	2.86	2.86	2.86	2.86
L24	0.77	0.77	0.77	0.58	0.52	0.65	0.65	0.65	2.86	2.86	2.86	2.86	2.86
L25	8.74	8.74	8.74	9.76	5.93	7.33	7.33	7.31	2.86	2.86	2.86	2.86	2.86
L26	42.19	42.19	42.19	31.40	28.60	35.36	35.36	35.29	2.86	2.86	2.86	2.86	2.86
TDH1	0.02	0.02	0.02	0.03	0.03	0.04	0.04	0.04	2.86	2.86	2.86	2.86	2.86
TDH2	0.12	0.12	0.12	0.27	0.25	0.30	0.30	0.30	2.86	2.86	2.86	2.86	2.86
TDH3	0.05	0.05	0.05	0.05	0.09	0.06	0.06	0.06	2.86	2.86	2.86	2.86	2.86
TDH4	0.04	0.04	0.04	0.03	0.03	0.04	0.04	0.04	2.86	2.86	2.86	2.86	2.86
TDH5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.86	2.86	2.86	2.86	2.86
TDH6	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	2.86	2.86	2.86	2.86	2.86
TDH7	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	2.86	2.86	2.86	2.86	2.86
TDH8	0.61	0.61	0.61	0.68	0.41	0.51	0.51	0.51	2.86	2.86	2.86	2.86	2.86
TDH9	0.24	0.24	0.24	0.09	0.16	0.20	0.20	0.40	2.86	2.86	2.86	2.86	2.86
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

APPENDIX D: ECONOMIC VALUATION OF MARINE ECOSYSTEMS GOODS AND SERVICES

Table D 1. Percentage of the total aggregate value for goods and services categories apportioned to the extent of habitats and landscapes protected under Scenario A.

L/TDH	%protected	E1/A	E2/A	E3/A	E4/A	E5/A	E6/A	E7/A	E8/A	E9/A	E10/A	E11/A	E12/A	E13/A
L1	15.21%	0.11	0.11	0.11	0.24	0.66	0.27	0.27	0.27	0.44	0.44	0.44	0.44	0.44
L2	19.28%	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.55	0.55	0.55	0.55	0.55
L3	11.93%	0.08	0.08	0.08	0.08	0.08	0.10	0.10	0.10	0.34	0.34	0.34	0.34	0.34
L4	10.04%	0.31	0.31	0.31	0.34	0.31	0.39	0.39	0.39	0.29	0.29	0.29	0.29	0.29
L5	11.60%	0.08	0.08	0.08	0.10	0.09	0.11	0.11	0.11	0.33	0.33	0.33	0.33	0.33
L6	34.37%	0.17	0.17	0.17	0.19	0.17	0.21	0.21	0.21	0.98	0.98	0.98	0.98	0.98
L7	10.47%	0.07	0.07	0.07	0.08	0.08	0.09	0.09	0.09	0.30	0.30	0.30	0.30	0.30
L8	10.44%	0.77	0.77	0.77	0.86	0.78	0.97	0.97	0.97	0.30	0.30	0.30	0.30	0.30
L9	19.81%	0.16	0.16	0.16	0.18	0.16	0.20	0.20	0.20	0.57	0.57	0.57	0.57	0.57
L10	8.03%	0.08	0.08	0.08	0.08	0.23	0.09	0.09	0.09	0.23	0.23	0.23	0.23	0.23
L11	2.09%	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.06	0.06	0.06	0.06	0.06
L12	1.77%	0.04	0.04	0.04	0.04	0.08	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
L13	4.33%	0.19	0.19	0.19	0.32	0.39	0.24	0.24	0.24	0.12	0.12	0.12	0.12	0.12
L14	0.51%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
L15	0.64%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.02	0.02
L16	4.90%	0.03	0.03	0.03	0.02	0.04	0.02	0.02	0.02	0.14	0.14	0.14	0.14	0.14
L17	10.27%	0.14	0.14	0.14	0.10	0.09	0.12	0.12	0.12	0.29	0.29	0.29	0.29	0.29
L18	4.22%	0.40	0.40	0.40	0.30	0.54	0.33	0.33	0.33	0.12	0.12	0.12	0.12	0.12
L19	6.24%	0.02	0.02	0.02	0.01	0.02	0.03	0.03	0.03	0.18	0.18	0.18	0.18	0.18
L20	2.62%	0.06	0.06	0.06	0.07	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
L21	6.03%	0.60	0.60	0.60	1.01	0.61	0.76	0.76	0.76	0.17	0.17	0.17	0.17	0.17
L22	20.55%	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.59	0.59	0.59	0.59	0.59
L23	1.23%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.04	0.04	0.04
L24	8.62%	0.07	0.07	0.07	0.05	0.04	0.06	0.06	0.06	0.25	0.25	0.25	0.25	0.25
L25	10.21%	0.89	0.89	0.89	1.00	0.61	0.75	0.75	0.75	0.29	0.29	0.29	0.29	0.29
L26	6.51%	2.75	2.75	2.75	2.04	1.86	2.30	2.30	2.30	0.19	0.19	0.19	0.19	0.19
TDH1	10.73%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.31	0.31	0.31	0.31
TDH2	3.18%	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.09	0.09	0.09	0.09	0.09
TDH3	28.29%	0.01	0.01	0.01	0.01	0.03	0.02	0.02	0.02	0.81	0.81	0.81	0.81	0.81
TDH4	25.91%	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.74	0.74	0.74	0.74	0.74
TDH5	28.57%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.82	0.82	0.82	0.82	0.82
TDH6	0.95%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.03	0.03	0.03
TDH7	3.28%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.09	0.09	0.09	0.09
TDH8	19.34%	0.12	0.12	0.12	0.13	0.08	0.10	0.10	0.10	0.55	0.55	0.55	0.55	0.55
TDH9	9.86%	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.04	0.28	0.28	0.28	0.28	0.28

Table D 2. Percentage of the total aggregate value for goods and services categories apportioned to the extent of habitats and landscapes protected under Scenario G.

L/TDH	%protected	E1/G	E2/G	E3/G	E4/G	E5/G	E6/G	E7/G	E8/G	E9/G	E10/G	E11/G	E12/G	E13/G
L1	9.64%	0.07	0.07	0.07	0.15	0.42	0.17	0.17	0.17	0.28	0.28	0.28	0.28	0.28
L2	32.02%	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.92	0.92	0.92	0.92	0.92
L3	15.10%	0.10	0.10	0.10	0.11	0.10	0.12	0.12	0.12	0.43	0.43	0.43	0.43	0.43
L4	10.74%	0.33	0.33	0.33	0.37	0.34	0.41	0.41	0.41	0.31	0.31	0.31	0.31	0.31
L5	12.47%	0.09	0.09	0.09	0.10	0.09	0.11	0.11	0.11	0.36	0.36	0.36	0.36	0.36
L6	33.30%	0.16	0.16	0.16	0.18	0.17	0.21	0.21	0.21	0.95	0.95	0.95	0.95	0.95
L7	16.69%	0.12	0.12	0.12	0.13	0.12	0.15	0.15	0.15	0.48	0.48	0.48	0.48	0.48
L8	10.56%	0.78	0.78	0.78	0.87	0.79	0.98	0.98	0.98	0.30	0.30	0.30	0.30	0.30
L9	12.75%	0.10	0.10	0.10	0.11	0.10	0.13	0.13	0.13	0.36	0.36	0.36	0.36	0.36
L10	9.67%	0.09	0.09	0.09	0.10	0.28	0.11	0.11	0.11	0.28	0.28	0.28	0.28	0.28
L11	2.02%	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.06	0.06	0.06	0.06	0.06
L12	2.63%	0.06	0.06	0.06	0.06	0.12	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.08
L13	6.81%	0.30	0.30	0.30	0.50	0.61	0.38	0.38	0.38	0.19	0.19	0.19	0.19	0.19
L14	0.51%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
L15	0.87%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.02	0.02
L16	7.13%	0.04	0.04	0.04	0.03	0.06	0.03	0.03	0.03	0.20	0.20	0.20	0.20	0.20
L17	13.43%	0.18	0.18	0.18	0.14	0.12	0.15	0.15	0.15	0.38	0.38	0.38	0.38	0.38
L18	5.12%	0.48	0.48	0.48	0.36	0.66	0.41	0.41	0.40	0.15	0.15	0.15	0.15	0.15
L19	9.13%	0.03	0.03	0.03	0.02	0.03	0.04	0.04	0.04	0.26	0.26	0.26	0.26	0.26
L20	4.63%	0.11	0.11	0.11	0.12	0.11	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
L21	6.93%	0.69	0.69	0.69	1.16	0.70	0.87	0.87	0.87	0.20	0.20	0.20	0.20	0.20
L22	17.47%	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.50	0.50	0.50	0.50	0.50
L23	1.73%	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.05	0.05	0.05	0.05	0.05
L24	34.59%	0.27	0.27	0.27	0.20	0.18	0.22	0.22	0.22	0.99	0.99	0.99	0.99	0.99
L25	39.22%	3.43	3.43	3.43	3.83	2.33	2.87	2.87	2.87	1.12	1.12	1.12	1.12	1.12
L26	8.80%	3.71	3.71	3.71	2.76	2.52	3.11	3.11	3.10	0.25	0.25	0.25	0.25	0.25
TDH1	11.16%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.32	0.32	0.32	0.32
TDH2	5.07%	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.14	0.14	0.14	0.14	0.14
TDH3	48.46%	0.02	0.02	0.02	0.02	0.04	0.03	0.03	0.03	1.39	1.39	1.39	1.39	1.39
TDH4	26.82%	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.77	0.77	0.77	0.77	0.77
TDH5	28.57%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.82	0.82	0.82	0.82	0.82
TDH6	0.95%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.03	0.03	0.03
TDH7	4.92%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.14	0.14	0.14	0.14
TDH8	55.97%	0.34	0.34	0.34	0.38	0.23	0.29	0.29	0.29	1.60	1.60	1.60	1.60	1.60
TDH9	10.85%	0.03	0.03	0.03	0.01	0.02	0.02	0.02	0.04	0.31	0.31	0.31	0.31	0.31

Table D 3. Percentage of the total aggregate value for goods and services categories apportioned to the extent of habitats and landscapes protected under Scenario I.

L/TDH	%protected	E1/I	E2/I	E3/I	E4/I	E5/I	E6/I	E7/I	E8/I	E9/I	E10/I	E11/I	E12/I	E13/I
L1	21.15%	0.15	0.15	0.15	0.34	0.92	0.38	0.38	0.38	0.60	0.60	0.60	0.60	0.60
L2	28.34%	0.01	0.01	0.01	0.02	0.01	0.02	0.02	0.02	0.81	0.81	0.81	0.81	0.81
L3	14.86%	0.10	0.10	0.10	0.11	0.10	0.12	0.12	0.12	0.42	0.42	0.42	0.42	0.42
L4	10.29%	0.32	0.32	0.32	0.35	0.32	0.40	0.40	0.40	0.29	0.29	0.29	0.29	0.29
L5	13.44%	0.10	0.10	0.10	0.11	0.10	0.12	0.12	0.12	0.38	0.38	0.38	0.38	0.38
L6	33.31%	0.16	0.16	0.16	0.18	0.17	0.21	0.21	0.21	0.95	0.95	0.95	0.95	0.95
L7	22.27%	0.16	0.16	0.16	0.18	0.16	0.20	0.20	0.20	0.64	0.64	0.64	0.64	0.64
L8	10.64%	0.78	0.78	0.78	0.87	0.80	0.98	0.98	0.98	0.30	0.30	0.30	0.30	0.30
L9	22.18%	0.18	0.18	0.18	0.20	0.18	0.22	0.22	0.22	0.63	0.63	0.63	0.63	0.63
L10	12.82%	0.12	0.12	0.12	0.13	0.37	0.15	0.15	0.15	0.37	0.37	0.37	0.37	0.37
L11	2.99%	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.09	0.09	0.09	0.09	0.09
L12	1.99%	0.04	0.04	0.04	0.05	0.09	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06
L13	5.29%	0.23	0.23	0.23	0.39	0.47	0.29	0.29	0.29	0.15	0.15	0.15	0.15	0.15
L14	6.27%	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.18	0.18	0.18	0.18	0.18
L15	0.71%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.02	0.02
L16	7.51%	0.04	0.04	0.04	0.03	0.06	0.04	0.04	0.04	0.21	0.21	0.21	0.21	0.21
L17	20.16%	0.27	0.27	0.27	0.20	0.19	0.23	0.23	0.23	0.58	0.58	0.58	0.58	0.58
L18	4.55%	0.43	0.43	0.43	0.32	0.58	0.36	0.36	0.36	0.13	0.13	0.13	0.13	0.13
L19	8.80%	0.03	0.03	0.03	0.02	0.03	0.04	0.04	0.04	0.25	0.25	0.25	0.25	0.25
L20	2.53%	0.06	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
L21	6.11%	0.61	0.61	0.61	1.02	0.62	0.77	0.77	0.77	0.17	0.17	0.17	0.17	0.17
L22	7.30%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.21	0.21	0.21	0.21
L23	1.18%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.03	0.03	0.03
L24	13.05%	0.10	0.10	0.10	0.08	0.07	0.08	0.08	0.08	0.37	0.37	0.37	0.37	0.37
L25	22.35%	1.95	1.95	1.95	2.18	1.33	1.64	1.64	1.63	0.64	0.64	0.64	0.64	0.64
L26	7.34%	3.10	3.10	3.10	2.30	2.10	2.59	2.59	2.59	0.21	0.21	0.21	0.21	0.21
TDH1	10.73%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.31	0.31	0.31	0.31
TDH2	5.12%	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.15	0.15	0.15	0.15	0.15
TDH3	49.02%	0.02	0.02	0.02	0.02	0.04	0.03	0.03	0.03	1.40	1.40	1.40	1.40	1.40
TDH4	30.45%	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.87	0.87	0.87	0.87	0.87
TDH5	28.57%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.82	0.82	0.82	0.82	0.82
TDH6	0.95%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.03	0.03	0.03
TDH7	4.92%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.14	0.14	0.14	0.14
TDH8	56.29%	0.34	0.34	0.34	0.38	0.23	0.29	0.29	0.29	1.61	1.61	1.61	1.61	1.61
TDH9	11.18%	0.03	0.03	0.03	0.01	0.02	0.02	0.02	0.04	0.32	0.32	0.32	0.32	0.32

APPENDIX E:
EXTENT OF KNOWLEDGE OF THE IMPACT OF HUMAN ACTIVITIES ON MARINE LANSCAPE AND HABITAT TYPES

The present Appendix contains further information regarding the literature review carried out by the CRO 380 report in order to assess the extent of current knowledge about the impacts of human activities on the marine environment. It also includes the tables summarising the extent of knowledge attribute to each habitat/landscape type by good and services category.

Assessment of JNCC landscapes

For many of the landscape units the information derives from the same sources. For example the ecological functioning of all shallow sedimentary habitats, their response to impacts and dynamics are similar and derived from a comprehensive body of studies, many of which provide information relevant to more than one landscape type. This in part is the result of key ecological principles being expressed in all the systems with similar ecological outcome and in part derives from the fact that the studies forming the information base consider ecological units that in many cases do not simply map, one for one, on to the JNCC landscapes. The extent of knowledge is thus described for each habitat type but they are grouped where the assessment is the same.

Aphotic reef and photic reef

For all of the goods and services the extent of knowledge was considered high or medium.

Oceanic sedimentary landscapes

For all the oceanic sedimentary landscapes, the extent of knowledge for the majority of the goods and services was considered low. A 'medium' score was given for 'cognitive values' as the landscape has research value but the educational aspect of it is unknown. A high level of knowledge was attributed to 'disturbance prevention and alleviation', as it is definitively known that oceanic sedimentary landscapes have little value for this service.

Shallow sedimentary landscapes

The extent of knowledge is considered as either high or medium for all the shallow sedimentary landscapes types. However, the authors rarely define their study sites in terms of JNCC landscape types thus we have had to use the available information and some interpretation to derive accounts for these landscape types.

Shallow mud, shallow sand and shelf sedimentary landscapes

For all of the goods and services the extent of knowledge was considered high or medium.

Shelf mud and shelf sand

For the majority of the goods and services for the shelf sand and mud landscapes the extent of knowledge was considered high or medium due to the extensive demersal and Nephrops fisheries that occur on these landscapes.

Assessment of extent of knowledge for each TDH habitat

All TDHs are well-studied, as this is a prerequisite to their being assigned TDH status.

Carbonate mounds and *Lophelia pertusa* reefs

These two OSPAR TDHs were considered to have the same level of knowledge due to their tendency to occur in similar areas in deep waters. For the majority of the goods and services there was considered to be a high or medium, with the exception of 'nutrient cycling', 'gas and climate regulation' and 'bioremediation of waste' where there is little literature on how the actual habitats deliver these processes.

Maerl beds

There was considered to be a high level of knowledge overall of how maerl beds affect the provision of ecological goods and services.

***Modiolus modiolus* beds**

The level of knowledge for the majority of goods and services was considered to be either high or medium for this habitat.

***Ostrea edulis* beds**

For the majority of goods and services there was deemed a high level of knowledge of how they provided the specific ecological goods and services.

***Sabellaria spinulosa* reefs**

There was judged to be either a high or medium level of knowledge of how the habitat provides ecological goods and services.

Sea mounts

The level of knowledge for sea mounts and their provision of ecological goods and services was considered to be of a high or medium level.

Sea-pen and burrowing megafauna communities

The level of knowledge for this habitat was judged to be of a high or medium level.

***Zostera* beds**

For the majority of the ecological goods and services that this habitat can deliver there was deemed to be a high level of knowledge.

Table E 1. Summary of the available knowledge of the link between non-intertidal habitat types and the delivery of ecosystems' goods and services

Goods and Services	Carbonate moundes	*Lophelia pertusa* reefs	Maerl beds	*Modiolus modiolus* beds	*Ostrea edulis* beds	*Sabellaria spinulosa* reefs	Sea mounts	Sea-pen and burrowing megafauna communitites	*Zostera* beds
Resilience and resistance	H	H	H	H	H	H	H	H	H
Biologically mediated habitat	H	H	H	H	H	H	H	H	H
Nutrient recycling	L	L	M	M	M	M	M	M	H
Gas and climate regulation	L	L	M	M	M	M	M	M	H
Bioremediation of waste	L	L	M	M	M	M	M	M	H
Option use values	M	M	M	M	M	M	M	M	M
Non-use / bequest values	H	H	H	H	H	H	H	H	H
Leisure and recreation	M	M	H	H	H	H	M	H	H
Food provision	M	M	H	H	H	M	M	M	H
Raw materials	M	M	H	M	M	M	M	M	H
Disturbance prevention and alleviation	H	H	H	H	H	H	H	H	H
Cultural heritage and identity	M	M	M	M	H	M	M	M	H
Cognitive values	H	H	H	H	H	H	H	H	H

(Adopted from Moran *et al.*, 2007 – p. 30)

Table E 2. Summary of the available knowledge of the link between JNCC landscape types and the delivery of ecosystems' goods and services

Goods and Services	Aphotic reef	Oceanic cold water coarse sediment	Oceanic cold water mixed sediment	Oceanic cold water mud	Oceanic cold water sand	Oceanic warm water coarse sediment	Oceanic warm water mixed sediment	Oceanic warm water mud	Oceanic warm water sand	Photic reef	Shallow strong tide stress coarse sediment	Shallow moderately tide stress coarse sediment	Shallow weak tide stress coarse sediment	Shallow strong tide stress mixed sediment	Shallow moderately tide stressed mixed sediment	Shallow weak tide stress mixed sediment	Shallow mud	Shallow sand	Shelf strong tide stress coarse sediment	Shelf moderately tide stress coarse sediment	Shelf weak tide stress coarse sediment	Shelf strong tide stress mixed sediment	Shelf moderately tide stress mixed sediment	Shelf weak tide stress mixed sediment	Shelf mud	Shelf sand
Resilience and resistance	H	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	H	M	M	M	M	M	M	H	H
Biologically mediated habitat	H	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	H	M	M	M	M	M	M	H	H
Nutrient recycling	H	L	L	L	L	L	L	L	L	H	M	M	M	M	M	M	H	H	M	M	M	M	M	M	H	H
Gas and climate regulation	H	L	L	L	L	L	L	L	L	H	M	M	M	M	M	M	H	H	M	M	M	M	M	M	H	H
Bioremediation of waste	H	L	L	L	L	L	L	L	L	H	M	M	M	M	M	M	H	H	M	M	M	M	M	M	H	H
Leisure and recreation	H	M	M	M	M	M	M	M	M	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
Food provision	H	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
Raw materials	M	L	L	L	L	L	L	L	L	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Disturbance prevention and alleviation	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
Cultural heritage and identity	M	L	L	L	L	L	L	L	L	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Cognitive values	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Option use values	M	L	L	L	L	L	L	L	L	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Non-use / bequest values	M	L	L	L	L	L	L	L	L	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M

(Adopted from Moran *et al.*, 2007 – p. 31)

APPENDIX F:
IMPACT CODES SUMMARISING THE MARGINAL EFFECTS OF MPA DESIGNATION

The present Appendix contains the tables summarising the impact codes assigned after the evaluation of the marginal effects on each of the marine habitats and landscapes by ecosystem's good and services categories. A full justification of the application of such impact codes can be seen in Moran *et al.*, 2007 (CRO 380 report – Appendix B).

Table F 1. Positive impact of the HR-MPA management regime on JNCC marine landscapes as compared to the *status quo* scenario

Goods and Services	Aphotic reef	Oceanic cold water coarse sediment	Oceanic cold water mixed sediment	Oceanic cold water mud	Oceanic cold water sand	Oceanic warm water coarse sediment	Oceanic warm water mixed sediment	Oceanic warm water mud	Oceanic warm water sand	Photic reef	Shallow strong tide stress coarse sediment	Shallow moderately tide stress coarse sediment	Shallow weak tide stress coarse sediment	Shallow strong tide stress mixed sediment	Shallow moderately tide stressed mixed sediment	Shallow weak tide stress mixed sediment	Shallow mud	Shallow sand	Shelf strong tide stress coarse sediment	Shelf moderately tide stress coarse sediment	Shelf weak tide stress coarse sediment	Shelf strong tide stress mixed sediment	Shelf moderately tide stress mixed sediment	Shelf weak tide stress mixed sediment	Shelf mud	Shelf sand
Resilience and resistance	H10/20E	H15/20E	H15/20E	H15/20E	H15/20E	H10/20E	H10/20E	H10/20E	H10/20E	H5/20E	H5/20E	H5/20E	VH8/20E	H5/20E	H5/20E	H5/20E	M5/20E	M5/20L	M5/20E	M5/20E	VH8/20E	H5/20E	H5/20E	H8/20E	H5/20E	H5/20E
Biologically mediated habitat	H10/20E	H15/20E	H15/20E	H15/20E	H15/20E	H10/20E	H10/20E	H10/20E	H10/20E	H5/20E	H5/20E	H5/20E	VH8/20E	H5/20E	H5/20E	H5/20E	M5/20E	M5/20L	M5/20E	M5/20E	VH8/20E	H5/20E	H5/20E	H8/20E	H5/20E	H5/20E
Nutrient recycling	H10/20E	H15/20E	H15/20E	H15/20E	H15/20E	H10/20E	H10/20E	H10/20E	H10/20E	H5/20E	H5/20E	H5/20E	VH8/20E	H5/20E	H5/20E	H5/20E	M5/20E	M5/20L	M5/20E	M5/20E	VH8/20E	H5/20E	H5/20E	H8/20E	H5/20E	H5/20E
Gas and climate regulation	H10/20E	H15/20E	H15/20E	H15/20E	H15/20E	H10/20E	H10/20E	H10/20E	H10/20E	H5/20E	H5/20E	H5/20E	VH8/20E	H5/20E	H5/20E	H5/20E	M5/20E	M5/20L	M5/20E	M5/20E	VH8/20E	H5/20E	H5/20E	H8/20E	H5/20E	H5/20E
Bioremediation of waste	H10/20E	H15/20E	H15/20E	H15/20E	H15/20E	H10/20E	H10/20E	H10/20E	H10/20E	H5/20E	H5/20E	H5/20E	VH8/20E	H5/20E	H5/20E	H5/20E	M5/20E	M5/20L	M5/20E	M5/20E	VH8/20E	H5/20E	H5/20E	H8/20E	H5/20E	H5/20E
Option use values	H10/20E	H15/20E	H15/20E	H15/20E	H15/20E	H10/20E	H10/20E	H10/20E	H10/20E	H5/20E	H5/20E	H5/20E	VH8/20E	H5/20E	H5/20E	H5/20E	M5/20E	M5/20L	M5/20E	M5/20E	VH8/20E	H5/20E	H5/20E	H8/20E	H5/20E	H5/20E
Non-use / bequest values	H10/20E	H15/20E	H15/20E	H15/20E	H15/20E	H10/20E	H10/20E	H10/20E	H10/20E	H5/20E	H5/20E	H5/20E	VH8/20E	H5/20E	H5/20E	H5/20E	M5/20E	M5/20L	M5/20E	M5/20E	VH8/20E	H5/20E	H5/20E	H8/20E	H5/20E	H5/20E
Leisure and recreation	H10/20E	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	H5/20E	M5/20E	M5/20E	H5/20E	M5/20E	M5/20E	M5/20E	L5/20E	M5/20L	L5/20E	L5/20E	L8/20E	L5/20E	L8/20E	L8/20E	VL0/20S	VL0/20S
Food provision	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S
Raw materials	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S
Disturbance prevention and alleviation	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S
Cultural heritage and identity	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S
Cognitive values	H10/20E	H15/20E	H15/20E	H15/20E	H15/20E	H10/20E	H10/20E	H10/20E	H10/20E	H5/20E	H5/20E	H5/20E	VH8/20E	H5/20E	H5/20E	H5/20E	M5/20E	M5/20L	M5/20E	M5/20E	VH8/20E	H5/20E	H5/20E	H8/20E	H5/20E	H5/20E

(Adopted from Moran *et al.*, 2007 – p. 38)

Table F 2. Positive impact of the HR-MPA management regime on non-intertidal TDH habitats as compared to the *status quo* scenario

Goods and Services	Carbonate mounds	*Lophelia pertusa* reefs	Maerl beds	*Modiolus modiolus* beds	*Ostrea edulis* beds	*Sabellaria spinulosa* reefs	Sea mounts	Sea-pen and burrowing megafauna communities	*Zostera* beds
Resilience and resistance	VH 20/20E	VH 20/20E	VH 20/20E	VH 15/20E	VH 15/20E	VH 5/20E	VH 20/20E	VH 10/20E	VH 10/20E
Biologically mediated habitat	VH 20/20E	VH 20/20E	VH 20/20E	VH 15/20E	VH 15/20E	VH 5/20E	VH 20/20E	VH 10/20E	VH 10/20E
Nutrient recycling	VH 20/20E	VH 20/20E	VH 20/20E	VH 15/20E	VH 15/20E	VH 5/20E	VH 20/20E	VH 10/20E	VH 10/20E
Gas and climate regulation	VH 20/20E	VH 20/20E	VH 20/20E	VH 15/20E	VH 15/20E	VH 5/20E	VH 20/20E	VH 10/20E	VH 10/20E
Bioremediation of waste	VH 20/20E	VH 20/20E	VH 20/20E	VH 15/20E	VH 15/20E	VH 5/20E	VH 20/20E	VH 10/20E	VH 10/20E
Option use values	VH 20/20E	VH 20/20E	VH 20/20E	VH 15/20E	VH 15/20E	VH 5/20E	VH 20/20E	VH 10/20E	VH 10/20E
Non-use / bequest values	VH 20/20E	VH 20/20E	VH 20/20E	VH 15/20E	VH 15/20E	VH 5/20E	VH 20/20E	VH 10/20E	VH 10/20E
Leisure and recreation	VL 0/20 S	VL 0/20 S	M 20/20E	M 15/20E	M 15/20E	M 5/20E	VL 0/20 S	M 10/20E	VH 10/20E
Food provision	VL 0/20 S	VL 0/20 S	VL 0/20 S	VL 0/20 S	VL 0/20 S	VL 0/20 S	VL 0/20 S	VL 0/20 S	VL 0/20 S
Raw materials	VL 0/20 S	VL 0/20 S	VL 0/20 S	VL 0/20 S	VL 0/20 S	VL 0/20 S	VL 0/20 S	VL 0/20 S	VL 0/20 S
Disturbance prevention and alleviation	VL 0/20 S	VL 0/20 S	VL 0/20 S	VL 0/20 S	VL 0/20 S	VL 0/20 S	VL 0/20 S	VL 0/20 S	H 10/20E
Cultural heritage and identity	VH 20/20E	VH 20/20E	VH 20/20E	VH 15/20E	VH 15/20E	VH 5/20E	VH 20/20E	VH 10/20E	VH 10/20E
Cognitive values	VH 20/20E	VH 20/20E	VH 20/20E	VH 15/20E	VH 15/20E	VH 5/20E	VH 20/20E	VH 10/20E	VH 10/20E

(Adopted from Moran *et al.*, 2007 – p. 39)

Table F 3. Positive impact of the MCS-MPA management regime on JNCC marine landscapes as compared to the *status quo* scenario

Goods and Services	Aphotic reef	Oceanic cold water coarse sediment	Oceanic cold water mixed sediment	Oceanic cold water mud	Oceanic cold water sand	Oceanic warm water coarse sediment	Oceanic warm water mixed sediment	Oceanic warm water mud	Oceanic warm water sand	Photic reef	Shallow strong tide stress coarse sediment	Shallow moderately tide stress coarse sediment	Shallow weak tide stress coarse sediment	Shallow strong tide stress mixed sediment	Shallow moderately tide stressed mixed sediment	Shallow weal tide stress mixed sediment	Shallow mud	Shallow sand	Shelf strong tide stress coarse sediment	Shelf moderately tide stress coarse sediment	Shelf weak tide stress coarse sediment	Shelf strong tide stress mixed sediment	Shelf moderately tide stress mixed sediment	Shelf weak tide stress mixed sediment	Shelf mud	Shelf sand
Resilience and resistance	H10/20E	H15/20E	H15/20E	H15/20E	H15/20E	H10/20E	H10/20E	H10/20E	H10/20E	H5/20E	M5/20E	M5/20E	H8/20E	M5/20E	M5/20E	M5/20E	M5/20E	M5/20E	M5/20E	M5/20E	VH8/20E	H5/20E	H5/20E	H8/20E	H5/20E	H5/20E
Biologically mediated habitat	H10/20E	H15/20E	H15/20E	H15/20E	H15/20E	H10/20E	H10/20E	H10/20E	H10/20E	H5/20E	M5/20E	M5/20E	H8/20E	M5/20E	M5/20E	M5/20E	M5/20E	M5/20E	M5/20E	M5/20E	VH8/20E	H5/20E	H5/20E	H8/20E	H5/20E	H5/20E
Nutrient recycling	H10/20E	H15/20E	H15/20E	H15/20E	H15/20E	H10/20E	H10/20E	H10/20E	H10/20E	H5/20E	M5/20E	M5/20E	H8/20E	M5/20E	M5/20E	M5/20E	M5/20E	M5/20E	M5/20E	M5/20E	VH8/20E	H5/20E	H5/20E	H8/20E	H5/20E	H5/20E
Gas and climate regulation	H10/20E	H15/20E	H15/20E	H15/20E	H15/20E	H10/20E	H10/20E	H10/20E	H10/20E	H5/20E	M5/20E	M5/20E	H8/20E	M5/20E	M5/20E	M5/20E	M5/20E	M5/20E	M5/20E	M5/20E	VH8/20E	H5/20E	H5/20E	H8/20E	H5/20E	H5/20E
Bioremediation of waste	H10/20E	H15/20E	H15/20E	H15/20E	H15/20E	H10/20E	H10/20E	H10/20E	H10/20E	H5/20E	M5/20E	M5/20E	H8/20E	M5/20E	M5/20E	M5/20E	M5/20E	M5/20E	M5/20E	M5/20E	VH8/20E	H5/20E	H5/20E	H8/20E	H5/20E	H5/20E
Option use values	H10/20E	H15/20E	H15/20E	H15/20E	H15/20E	H10/20E	H10/20E	H10/20E	H10/20E	H5/20E	M5/20E	M5/20E	H8/20E	M5/20E	M5/20E	M5/20E	M5/20E	M5/20E	M5/20E	M5/20E	VH8/20E	H5/20E	H5/20E	H8/20E	H5/20E	H5/20E
Non-use / bequest values	H10/20E	H15/20E	H15/20E	H15/20E	H15/20E	H10/20E	H10/20E	H10/20E	H10/20E	H5/20E	M5/20E	M5/20E	H8/20E	M5/20E	M5/20E	M5/20E	M5/20E	M5/20E	M5/20E	M5/20E	VH8/20E	H5/20E	H5/20E	H8/20E	H5/20E	H5/20E
Leisure and recreation	H10/20E	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	H5/20E	L5/20E	L5/20E	H8/20E	M5/20E	M5/20E	M5/20E	L5/20E	L5/20E	L5/20L	L5/20L	L5/20L	L5/20L	L5/20L	L5/20L	VL0/20S	VL0/20S
Food provision	M6/20E	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	L5/20E	L5/20E	L8/20E	L5/20E	L5/20E	L5/20E	VL5/20L	VL5/20L	VL5/20L	VL5/20L	VL5/20L	VL5/20L	VL5/20L	VL5/20L	VL5/20L	VL5/20L
Raw materials	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL5/20L	VL5/20L	VL5/20L	VL5/20L	VL5/20L	VL5/20L	VL5/20L	VL5/20L	VL5/20L	VL5/20L
Disturbance prevention and alleviation	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S
Cultural heritage and identity	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S	VL0/20S
Cognitive values	H10/20E	H15/20E	H15/20E	H15/20E	H15/20E	H10/20E	H10/20E	H10/20E	H10/20E	H5/20E	M5/20E	M5/20E	H8/20E	M5/20E	M5/20E	M5/20E	M5/20E	M5/20E	M5/20E	M5/20E	VH8/20E	H5/20E	H5/20E	H8/20E	H5/20E	H5/20E

(Adopted from Moran *et al.*, 2007 – p. 40)

Table F 4. Positive impact of the MCS-MPA management regime on non-intertidal TDH habitats as compared to the *status quo* scenario

Goods and Services	Carbonate mounds	*Lophelia pertusa* reefs	Maerl beds	*Modiolus modiolus* beds	*Ostrea edulis* beds	*Sabellaria spinulosa* reefs	Sea mounts	Sea-pen and burrowing megafauna communities	*Zostera* beds
Resilience and resistance	VH 20/20E	VH 20/20E	VH 20/20E	VH 15/20E	VH 15/20E	VH 5/20E	VH 20/20E	VH 10/20E	VH 10/20E
Biologically mediated habitat	VH 20/20E	VH 20/20E	VH 20/20E	VH 15/20E	VH 15/20E	VH 5/20E	VH 20/20E	VH 10/20E	VH 10/20E
Nutrient recycling	VH 20/20E	VH 20/20E	VH 20/20E	VH 15/20E	VH 15/20E	VH 5/20E	VH 20/20E	VH 10/20E	VH 10/20E
Gas and climate regulation	VH 20/20E	VH 20/20E	VH 20/20E	VH 15/20E	VH 15/20E	VH 5/20E	VH 20/20E	VH 10/20E	VH 10/20E
Bioremediation of waste	VH 20/20E	VH 20/20E	VH 20/20E	VH 15/20E	VH 15/20E	VH 5/20E	VH 20/20E	VH 10/20E	VH 10/20E
Option use values	VH 20/20E	VH 20/20E	VH 20/20E	VH 15/20E	VH 15/20E	VH 5/20E	VH 20/20E	VH 10/20E	VH 10/20E
Non-use / bequest values	VH 20/20E	VH 20/20E	VH 20/20E	VH 15/20E	VH 15/20E	VH 5/20E	VH 20/20E	VH 10/20E	VH 10/20E
Leisure and recreation	VL 0/20 S	VL 0/20 S	M 20/20E	M 15/20E	M 15/20E	M 5/20E	VL 0/20 S	M 10/20E	VH 10/20E
Food provision	VL 0/20 S	VL 0/20 S	VL 0/20 S	VL 0/20 S	VL 0/20 S	VL 0/20 S	VL 0/20 S	VL 0/20 S	VL 0/20 S
Raw materials	VL 0/20 S	VL 0/20 S	VL 0/20 S	VL 0/20 S	VL 0/20 S	VL 0/20 S	VL 0/20 S	VL 0/20 S	VL 0/20 S
Disturbance prevention and alleviation	VL 0/20 S	VL 0/20 S	VL 0/20 S	VL 0/20 S	VL 0/20 S	VL 0/20 S	VL 0/20 S	VL 0/20 S	H 10/20E
Cultural heritage and identity	VH 20/20E	VH 20/20E	VH 20/20E	VH 15/20E	VH 15/20E	VH 5/20E	VH 20/20E	VH 10/20E	VH 10/20E
Cognitive values	VH 20/20E	VH 20/20E	VH 20/20E	VH 15/20E	VH 15/20E	VH 5/20E	VH 20/20E	VH 10/20E	VH 10/20E

(Adopted from Moran *et al.*, 2007 – p. 41)

APPENDIX G: HOW TO CONVERT IMPACT CODING TO AN SCALAR COEFFICIENT AND RESULTING MATRICES

As it has been already stated through the document, the coding for the marginal impact that arises from MCZ designation (HR-MPA and MCS-MPA) comprises three elements:

1. The *extent* of the expected change with respect to the counterfactual of no MCZ designation;
2. The timing of impact with respect to when the *maximum benefit is realised* in the 20 year time span;
3. The *trajectory* of the impact path.

Thus the coding might be, for instance, M10/20L. For this case, 'M' pertains to the extent of impact (medium), '10/20' to the timing of impact (the maximum level of benefits is achieved at year 10), and 'L' to the trajectory of impact (follows a linear trajectory).

These three elements together determine the impact coding, which tables have been presented in the section above. The two timing elements (2 and 3 above) are dealt with together below. We first consider the extent of impact (1).

The extent of impact

Regardless of *when* an impact arises (elements 2 and 3 above), the scalar must account for the fact that the positive impact of MPA designation (either HR-MPA or MCS-MPA) will vary both between habitats/landscapes and across different economic benefit categories. The first element of the assigned code accounts for this differentiating extent of the impact. The extent of the impact might be 'very high' (VH), 'high' (H), 'medium' (M), 'low' (L) or 'very low' (VL). Each of these categories is associated to a percentage range representing the extent of the positive impact of MPA designation as compared with the status quo. The mid-point values have been used in the normal assessment ('best estimates'), while the low point has been used for sensitivity analysis (See Table 9).

The timing of impacts

The coding for timing of impact has two elements representing the moment at which the maximum level of benefit is achieved (first element) and the trajectory followed until this maximum level is achieved (second element). The coding has been converted into a second scale factor (that is then multiplied by the first scale factor derived of the extent of impact) for both present value and undiscounted mean annual value.

By way of example, consider Figure G 1 that pertains to the calculation for 10 years:

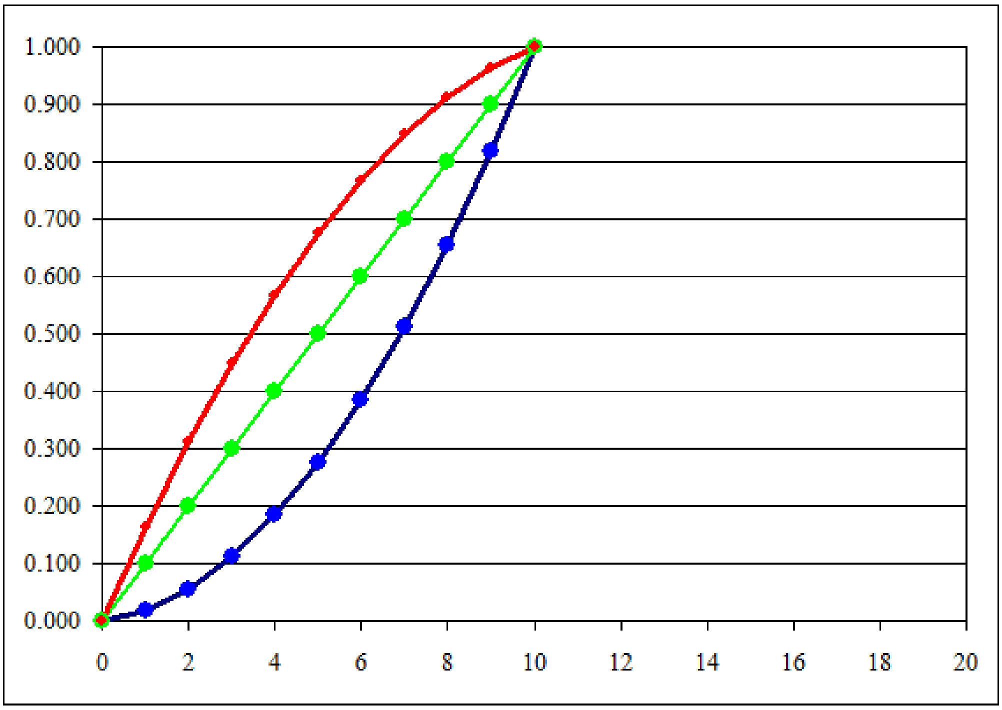


Figure G 1. Timing of impact scale factors for 10 years
(Adopted from Moran *et al.*, 2007 – p. 147)

The top curve represents a coding for 10/20S, the middle for 10/20L and the bottom for 10/20E. For the undiscounted mean annual benefits, the total areas under the respective curves are calculated and divided by 20. For (net) present values, the calculation is made with a continuous discount rate of 3.5%. The figures that arise for 10/20 are given in Table G 1. NPV2 refers to the area from 10 years to 20 years, i.e. the rectangle in the Figure G 1**Error! Reference source not found.**. This is calculated separately merely for mathematical ease of analysis.

Table G 1. Net present values and discounted means for 10/20 timing impact factor

	End (E)	Linear	Start (S)
Area	13.5	15.0	16.2
NPV_1	2.7	4.0	5.0
NPV_2	5.9	5.9	5.9
NPV_{total}	8.7	9.9	10.9

(Adopted from Moran *et al.*, 2007 – p. 147)

There are an infinite number of potential red and blue curves, i.e. a curve that is exponential/log that has intercepts at (0,0) and (10,1). The red and blue curves have been selected randomly. Table G 2 presents the generic formula applied and the curves generated for a sample of the years.

Table G 2. Functions and equations used for 10, 15 and 20 years timing impact coding

$y = \alpha_0 + \alpha_1 t + \alpha_2 t^2$				
		α_0	α_1	α_2
10	Exp	0.000	0.010	0.009
	Linear	0.000	0.100	0.000
	Log	0.000	0.170	-0.007
15		α_0	α_1	α_2
	Exp	0.000	0.010	0.004
	Linear	0.000	0.067	0.000
	Log	0.000	0.127	-0.004
20		α_0	α_1	α_2
	Exp	0.000	0.010	0.002
	Linear	0.000	0.050	0.000
	Log	0.000	0.090	-0.002

(Adopted from Moran *et al.*, 2007 – p. 148)

The resulting tables for both management regimes and for net present and undiscounted values are presented below:

Table G 3. Present value (3.5% discount rate) scalar coefficients for HR-MPA

HR-MPA NPV	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13
L1	6.06	6.06	6.06	0.01	0.01	6.06	6.06	0.01	6.06	0.01	6.06	6.06	6.06
L2	4.48	4.48	4.48	0.01	0.01	4.48	4.48	0.01	0.01	0.01	4.48	4.48	4.48
L3	4.48	4.48	4.48	0.01	0.01	4.48	4.48	0.01	0.01	0.01	4.48	4.48	4.48
L4	4.48	4.48	4.48	0.01	0.01	4.48	4.48	0.01	0.01	0.01	4.48	4.48	4.48
L5	4.48	4.48	4.48	0.01	0.01	4.48	4.48	0.01	0.01	0.01	4.48	4.48	4.48
L6	6.06	6.06	6.06	0.01	0.01	6.06	6.06	0.01	0.01	0.01	6.06	6.06	6.06
L7	6.06	6.06	6.06	0.01	0.01	6.06	6.06	0.01	0.01	0.01	6.06	6.06	6.06
L8	6.06	6.06	6.06	0.01	0.01	6.06	6.06	0.01	0.01	0.01	6.06	6.06	6.06
L9	6.06	6.06	6.06	0.01	0.01	6.06	6.06	0.01	0.01	0.01	6.06	6.06	6.06
L10	7.91	7.91	7.91	0.01	0.01	7.91	7.91	0.01	7.91	0.01	7.91	7.91	7.91
L11	7.91	7.91	7.91	0.01	0.01	7.91	7.91	0.01	3.39	0.01	7.91	7.91	7.91
L12	7.91	7.91	7.91	0.01	0.01	7.91	7.91	0.01	3.39	0.01	7.91	7.91	7.91
L13	9.14	9.14	9.14	0.01	0.01	9.14	9.14	0.01	7.91	0.01	9.14	9.14	9.14
L14	7.91	7.91	7.91	0.01	0.01	7.91	7.91	0.01	3.39	0.01	7.91	7.91	7.91
L15	7.91	7.91	7.91	0.01	0.01	7.91	7.91	0.01	3.39	0.01	7.91	7.91	7.91
L16	7.91	7.91	7.91	0.01	0.01	7.91	7.91	0.01	3.39	0.01	7.91	7.91	7.91
L17	3.39	3.39	3.39	0.01	0.01	3.39	3.39	0.01	0.56	0.01	3.39	3.39	3.39
L18	3.61	3.61	3.61	0.01	0.01	3.61	3.61	0.01	3.61	0.01	3.61	3.61	3.61
L19	3.39	3.39	3.39	0.01	0.01	3.39	3.39	0.01	0.56	0.01	3.39	3.39	3.39
L20	7.91	7.91	7.91	0.01	0.01	7.91	7.91	0.01	0.56	0.01	7.91	7.91	7.91
L21	9.14	9.14	9.14	0.01	0.01	9.14	9.14	0.01	0.48	0.01	9.14	9.14	9.14
L22	7.91	7.91	7.91	0.01	0.01	7.91	7.91	0.01	0.56	0.01	7.91	7.91	7.91
L23	7.91	7.91	7.91	0.01	0.01	7.91	7.91	0.01	0.56	0.01	7.91	7.91	7.91
L24	6.73	6.73	6.73	0.01	0.01	6.73	6.73	0.01	0.48	0.01	6.73	6.73	6.73
L25	7.91	7.91	7.91	0.01	0.01	7.91	7.91	0.01	0.01	0.01	7.91	7.91	7.91
L26	7.91	7.91	7.91	0.01	0.01	7.91	7.91	0.01	0.01	0.01	7.91	7.91	7.91
TDH1	4.23	4.23	4.23	0.01	0.01	4.23	4.23	0.01	0.01	4.23	4.23	4.23	4.23
TDH2	4.23	4.23	4.23	0.01	0.01	4.23	4.23	0.01	0.01	4.23	4.23	4.23	4.23
TDH3	4.23	4.23	4.23	0.01	0.01	4.23	4.23	0.01	1.34	4.23	4.23	4.23	4.23
TDH4	6.07	6.07	6.07	0.01	0.01	6.07	6.07	0.01	1.92	6.07	6.07	6.07	6.07
TDH5	6.07	6.07	6.07	0.01	0.01	6.07	6.07	0.01	1.92	6.07	6.07	6.07	6.07
TDH6	10.73	10.73	10.73	0.01	0.01	10.73	10.73	0.01	3.39	10.73	10.73	10.73	10.73
TDH7	4.23	4.23	4.23	0.01	0.01	4.23	4.23	0.01	0.01	4.23	4.23	4.23	4.23
TDH8	8.22	8.22	8.22	0.01	0.01	8.22	8.22	0.01	2.6	8.22	8.22	8.22	8.22
TDH9	8.22	8.22	8.22	0.01	0.01	8.22	8.22	5.04	8.22	8.22	8.22	8.22	8.22

(Adopted from Moran *et al.*, 2007 – p. 149)

Table G 4. Present value (3.5% discount rate) scalar coefficients for MCS-MPA

MCS-MPA NPV	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13
L1	6.06	6.06	6.06	2.73	0.01	6.06	6.06	0.01	6.06	0.01	6.06	6.06	6.06
L2	4.48	4.48	4.48	0.01	0.01	4.48	4.48	0.01	0.01	0.01	4.48	4.48	4.48
L3	4.48	4.48	4.48	0.01	0.01	4.48	4.48	0.01	0.01	0.01	4.48	4.48	4.48
L4	4.48	4.48	4.48	0.01	0.01	4.48	4.48	0.01	0.01	0.01	4.48	4.48	4.48
L5	4.48	4.48	4.48	0.01	0.01	4.48	4.48	0.01	0.01	0.01	4.48	4.48	4.48
L6	6.06	6.06	6.06	0.01	0.01	6.06	6.06	0.01	0.01	0.01	6.06	6.06	6.06
L7	6.06	6.06	6.06	0.01	0.01	6.06	6.06	0.01	0.01	0.01	6.06	6.06	6.06
L8	6.06	6.06	6.06	0.01	0.01	6.06	6.06	0.01	0.01	0.01	6.06	6.06	6.06
L9	6.06	6.06	6.06	0.01	0.01	6.06	6.06	0.01	0.01	0.01	6.06	6.06	6.06
L10	7.91	7.91	7.91	0.01	0.01	7.91	7.91	0.01	7.91	0.01	7.91	7.91	7.91
L11	3.39	3.39	3.39	0.56	0.01	3.39	3.39	0.01	0.56	0.01	3.39	3.39	3.39
L12	3.39	3.39	3.39	0.56	0.01	3.39	3.39	0.01	0.56	0.01	3.39	3.39	3.39
L13	6.73	6.73	6.73	0.4	0.01	6.73	6.73	0.01	6.73	0.01	6.73	6.73	6.73
L14	3.39	3.39	3.39	0.56	0.01	3.39	3.39	0.01	3.39	0.01	3.39	3.39	3.39
L15	3.39	3.39	3.39	0.56	0.01	3.39	3.39	0.01	3.39	0.01	3.39	3.39	3.39
L16	3.39	3.39	3.39	0.56	0.01	3.39	3.39	0.01	3.39	0.01	3.39	3.39	3.39
L17	3.39	3.39	3.39	0.06	0.06	3.39	3.39	0.01	0.56	0.01	3.39	3.39	3.39
L18	3.39	3.39	3.39	0.06	0.06	3.39	3.39	0.01	0.56	0.01	3.39	3.39	3.39
L19	3.39	3.39	3.39	0.06	0.06	3.39	3.39	0.01	0.6	0.01	3.39	3.39	3.39
L20	7.91	7.91	7.91	0.06	0.06	7.91	7.91	0.01	0.6	0.01	7.91	7.91	7.91
L21	9.14	9.14	9.14	0.06	0.06	9.14	9.14	0.01	0.6	0.01	9.14	9.14	9.14
L22	7.91	7.91	7.91	0.06	0.06	7.91	7.91	0.01	0.6	0.01	7.91	7.91	7.91
L23	7.91	7.91	7.91	0.06	0.06	7.91	7.91	0.01	0.6	0.01	7.91	7.91	7.91
L24	6.73	6.73	6.73	0.06	0.06	6.73	6.73	0.01	0.6	0.01	6.73	6.73	6.73
L25	7.91	7.91	7.91	0.06	0.06	7.91	7.91	0.01	0.01	0.01	7.91	7.91	7.91
L26	7.91	7.91	7.91	0.06	0.06	7.91	7.91	0.01	0.01	0.01	7.91	7.91	7.91
TDH1	4.23	4.23	4.23	0.01	0.01	4.23	4.23	0.01	0.01	4.23	4.23	4.23	4.23
TDH2	4.23	4.23	4.23	0.01	0.01	4.23	4.23	0.01	0.01	4.23	4.23	4.23	4.23
TDH3	4.23	4.23	4.23	0.01	0.01	4.23	4.23	0.01	1.34	4.23	4.23	4.23	4.23
TDH4	6.07	6.07	6.07	0.01	0.01	6.07	6.07	0.01	1.92	6.07	6.07	6.07	6.07
TDH5	6.07	6.07	6.07	0.01	0.01	6.07	6.07	0.01	1.92	6.07	6.07	6.07	6.07
TDH6	6.07	6.07	6.07	0.01	0.01	6.07	6.07	0.01	3.39	6.07	6.07	6.07	6.07
TDH7	4.23	4.23	4.23	0.01	0.01	4.23	4.23	0.01	0.01	4.23	4.23	4.23	4.23
TDH8	8.22	8.22	8.22	0.01	0.01	8.22	8.22	0.01	2.6	8.22	8.22	8.22	8.22
TDH9	8.22	8.22	8.22	0.01	0.01	8.22	8.22	5.04	8.22	8.22	8.22	8.22	8.22

(Adopted from Moran *et al.*, 2007 – p. 150)

Table G 5. Undiscounted scalar coefficients for HR-MPA

HR-MPA Undisc.	**E1**	**E2**	**E3**	**E4**	**E5**	**E6**	**E7**	**E8**	**E9**	**E10**	**E11**	**E12**	**E13**
L1	0.54	0.54	0.54	0.00	0.00	0.56	0.56	0.00	0.56	0.00	0.56	0.56	0.56
L2	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	0.00	0.00	0.51	0.51	0.51
L3	0.50	0.50	0.50	0.00	0.00	0.50	0.50	0.00	0.00	0.00	0.57	0.57	0.57
L4	0.50	0.50	0.50	0.00	0.00	0.52	0.52	0.00	0.00	0.00	0.53	0.53	0.53
L5	0.43	0.43	0.43	0.00	0.00	0.50	0.50	0.00	0.00	0.00	0.50	0.50	0.50
L6	0.58	0.58	0.58	0.00	0.00	0.56	0.56	0.00	0.00	0.00	0.58	0.58	0.58
L7	0.33	0.33	0.33	0.00	0.00	0.67	0.67	0.00	0.00	0.00	0.60	0.60	0.60
L8	0.56	0.56	0.56	0.00	0.00	0.57	0.57	0.00	0.00	0.00	0.55	0.55	0.55
L9	0.55	0.55	0.55	0.00	0.00	0.56	0.56	0.00	0.00	0.00	0.56	0.56	0.56
L10	0.62	0.62	0.62	0.00	0.00	0.63	0.63	0.00	0.64	0.00	0.64	0.64	0.64
L11	0.60	0.60	0.60	0.00	0.00	0.67	0.67	0.00	0.26	0.00	0.63	0.63	0.63
L12	0.63	0.63	0.63	0.00	0.00	0.64	0.64	0.00	0.27	0.00	0.64	0.64	0.64
L13	0.82	0.82	0.82	0.00	0.00	0.83	0.83	0.00	0.63	0.00	0.83	0.83	0.83
L14	0.67	0.67	0.67	0.00	0.00	0.50	0.50	0.00	0.27	0.00	0.64	0.64	0.64
L15	0.56	0.56	0.56	0.00	0.00	0.64	0.64	0.00	0.27	0.00	0.64	0.64	0.64
L16	0.71	0.71	0.71	0.00	0.00	0.67	0.67	0.00	0.27	0.00	0.65	0.65	0.65
L17	0.28	0.28	0.28	0.00	0.00	0.27	0.27	0.00	0.05	0.00	0.26	0.26	0.26
L18	0.26	0.26	0.26	0.00	0.00	0.26	0.26	0.00	0.26	0.00	0.26	0.26	0.26
L19	0.29	0.29	0.29	0.00	0.00	0.22	0.22	0.00	0.04	0.00	0.26	0.26	0.26
L20	0.65	0.65	0.65	0.00	0.00	0.65	0.65	0.00	0.05	0.00	0.63	0.63	0.63
L21	0.82	0.82	0.82	0.00	0.00	0.82	0.82	0.00	0.03	0.00	0.81	0.81	0.81
L22	1.00	1.00	1.00	0.00	0.00	0.50	0.50	0.00	0.05	0.00	0.64	0.64	0.64
L23	0.67	0.67	0.67	0.00	0.00	0.63	0.63	0.00	0.05	0.00	0.65	0.65	0.65
L24	0.67	0.67	0.67	0.00	0.00	0.63	0.63	0.00	0.03	0.00	0.60	0.60	0.60
L25	0.64	0.64	0.64	0.00	0.00	0.64	0.64	0.00	0.00	0.00	0.65	0.65	0.65
L26	0.64	0.64	0.64	0.00	0.00	0.64	0.64	0.00	0.00	0.00	0.63	0.63	0.63
TDH1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.58	0.58	0.58	0.58
TDH2	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	0.00	0.67	0.67	0.67	0.67
TDH3	0.50	0.50	0.50	0.00	0.00	0.50	0.50	0.00	0.19	0.60	0.60	0.60	0.60
TDH4	1.00	1.00	1.00	0.00	0.00	0.50	0.50	0.00	0.22	0.70	0.70	0.70	0.70
TDH5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.71	0.71	0.71	0.71
TDH6	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	0.28	0.87	0.87	0.87	0.87
TDH7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.60	0.60	0.60
TDH8	0.82	0.82	0.82	0.00	0.00	0.70	0.70	0.00	0.24	0.76	0.76	0.76	0.76
TDH9	0.75	0.75	0.75	0.00	0.00	0.71	0.71	1.14	0.77	0.77	0.77	0.77	0.77

Table G 6. Undiscounted scalar coefficients for MCS-MPA

MSC-MPA Undisc.	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13
L1	0.54	0.54	0.54	0.29	0.00	0.56	0.56	0.00	0.56	0.00	0.56	0.56	0.56
L2	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	0.00	0.00	0.51	0.51	0.51
L3	0.50	0.50	0.50	0.00	0.00	0.50	0.50	0.00	0.00	0.00	0.57	0.57	0.57
L4	0.50	0.50	0.50	0.00	0.00	0.52	0.52	0.00	0.00	0.00	0.53	0.53	0.53
L5	0.43	0.43	0.43	0.00	0.00	0.50	0.50	0.00	0.00	0.00	0.50	0.50	0.50
L6	0.58	0.58	0.58	0.00	0.00	0.56	0.56	0.00	0.00	0.00	0.58	0.58	0.58
L7	0.33	0.33	0.33	0.00	0.00	0.67	0.67	0.00	0.00	0.00	0.60	0.60	0.60
L8	0.56	0.56	0.56	0.00	0.00	0.57	0.57	0.00	0.00	0.00	0.55	0.55	0.55
L9	0.55	0.55	0.55	0.00	0.00	0.56	0.56	0.00	0.00	0.00	0.56	0.56	0.56
L10	0.62	0.62	0.62	0.00	0.00	0.63	0.63	0.00	0.64	0.00	0.64	0.64	0.64
L11	0.20	0.20	0.20	0.00	0.00	0.33	0.33	0.00	0.05	0.00	0.26	0.26	0.26
L12	0.29	0.29	0.29	0.05	0.00	0.27	0.27	0.00	0.04	0.00	0.27	0.27	0.27
L13	0.61	0.61	0.61	0.00	0.00	0.61	0.61	0.00	0.60	0.00	0.60	0.60	0.60
L14	0.33	0.33	0.33	0.00	0.00	0.25	0.25	0.00	0.27	0.00	0.27	0.27	0.27
L15	0.22	0.22	0.22	0.00	0.00	0.27	0.27	0.00	0.27	0.00	0.27	0.27	0.27
L16	0.29	0.29	0.29	0.00	0.00	0.33	0.33	0.00	0.27	0.00	0.27	0.27	0.27
L17	0.28	0.28	0.28	0.00	0.00	0.27	0.27	0.00	0.05	0.00	0.26	0.26	0.26
L18	0.28	0.28	0.28	0.00	0.00	0.28	0.28	0.00	0.04	0.00	0.27	0.27	0.27
L19	0.29	0.29	0.29	0.00	0.00	0.22	0.22	0.00	0.04	0.00	0.26	0.26	0.26
L20	0.65	0.65	0.65	0.00	0.00	0.65	0.65	0.00	0.05	0.00	0.63	0.63	0.63
L21	0.82	0.82	0.82	0.00	0.00	0.82	0.82	0.00	0.03	0.00	0.81	0.81	0.81
L22	1.00	1.00	1.00	0.00	0.00	0.50	0.50	0.00	0.05	0.00	0.64	0.64	0.64
L23	0.67	0.67	0.67	0.00	0.00	0.63	0.63	0.00	0.05	0.00	0.65	0.65	0.65
L24	0.67	0.67	0.67	0.00	0.00	0.63	0.63	0.00	0.06	0.00	0.60	0.60	0.60
L25	0.64	0.64	0.64	0.00	0.00	0.64	0.64	0.00	0.00	0.00	0.65	0.65	0.65
L26	0.64	0.64	0.64	0.00	0.00	0.64	0.64	0.00	0.00	0.00	0.63	0.63	0.63
TDH1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.58	0.58	0.58	0.58
TDH2	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	0.00	0.67	0.67	0.67	0.67
TDH3	0.50	0.50	0.50	0.00	0.00	0.50	0.50	0.00	0.19	0.60	0.60	0.60	0.60
TDH4	1.00	1.00	1.00	0.00	0.00	0.50	0.50	0.00	0.22	0.70	0.70	0.70	0.70
TDH5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.71	0.71	0.71	0.71
TDH6	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	0.28	0.87	0.87	0.87	0.87
TDH7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.60	0.60	0.60
TDH8	0.82	0.82	0.82	0.00	0.00	0.70	0.70	0.00	0.24	0.76	0.76	0.76	0.76
TDH9	0.75	0.75	0.75	0.00	0.00	0.71	0.71	1.14	0.77	0.77	0.77	0.77	0.77

APPENDIX H:
FINAL IMPACT FACTORS

Table H 1. Present Value Final Impact Factors
Scenario A and HR-MPA management regime (discount rate 3.5%)

NPV A HR-MPA	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13
L1	0.664	0.664	0.664	0.002	0.007	1.660	1.660	0.003	2.637	0.004	2.637	2.637	2.637
L2	0.043	0.043	0.043	0.000	0.000	0.052	0.052	0.000	0.006	0.006	2.471	2.471	2.471
L3	0.342	0.342	0.342	0.001	0.001	0.428	0.428	0.001	0.003	0.003	1.529	1.529	1.529
L4	1.380	1.380	1.380	0.003	0.003	1.735	1.735	0.004	0.003	0.003	1.286	1.286	1.286
L5	0.379	0.379	0.379	0.001	0.001	0.478	0.478	0.001	0.003	0.003	1.486	1.486	1.486
L6	1.021	1.021	1.021	0.002	0.002	1.291	1.291	0.002	0.010	0.010	5.957	5.957	5.957
L7	0.450	0.450	0.450	0.001	0.001	0.564	0.564	0.001	0.003	0.003	1.814	1.814	1.814
L8	4.658	4.658	4.658	0.009	0.008	5.854	5.854	0.010	0.003	0.003	1.810	1.810	1.810
L9	0.948	0.948	0.948	0.002	0.002	1.200	1.200	0.002	0.006	0.006	3.433	3.433	3.433
L10	0.597	0.597	0.597	0.001	0.002	0.750	0.750	0.001	1.817	0.002	1.817	1.817	1.817
L11	0.061	0.061	0.061	0.000	0.000	0.078	0.078	0.000	0.202	0.001	0.472	0.472	0.472
L12	0.307	0.307	0.307	0.000	0.001	0.386	0.386	0.000	0.172	0.001	0.402	0.402	0.402
L13	1.742	1.742	1.742	0.003	0.004	2.193	2.193	0.002	0.980	0.001	1.132	1.132	1.132
L14	0.005	0.005	0.005	0.000	0.000	0.007	0.007	0.000	0.050	0.000	0.116	0.116	0.116
L15	0.013	0.013	0.013	0.000	0.000	0.017	0.017	0.000	0.062	0.000	0.144	0.144	0.144
L16	0.221	0.221	0.221	0.000	0.000	0.186	0.186	0.000	0.475	0.001	1.109	1.109	1.109
L17	0.470	0.470	0.470	0.001	0.001	0.393	0.393	0.001	0.164	0.003	0.996	0.996	0.996
L18	1.439	1.439	1.439	0.003	0.005	1.206	1.206	0.003	0.436	0.001	0.436	0.436	0.436
L19	0.078	0.078	0.078	0.000	0.000	0.099	0.099	0.000	0.100	0.002	0.605	0.605	0.605
L20	0.472	0.472	0.472	0.001	0.001	0.592	0.592	0.001	0.042	0.001	0.592	0.592	0.592
L21	5.510	5.510	5.510	0.010	0.006	6.926	6.926	0.008	0.083	0.002	1.576	1.576	1.576
L22	0.065	0.065	0.065	0.000	0.000	0.081	0.081	0.000	0.329	0.006	4.650	4.650	4.650
L23	0.029	0.029	0.029	0.000	0.000	0.036	0.036	0.000	0.020	0.000	0.279	0.279	0.279
L24	0.447	0.447	0.447	0.000	0.000	0.377	0.377	0.001	0.118	0.002	1.659	1.659	1.659
L25	7.062	7.062	7.062	0.010	0.006	5.922	5.922	0.007	0.003	0.003	2.311	2.311	2.311
L26	21.719	21.719	21.719	0.020	0.019	18.203	18.203	0.023	0.002	0.002	1.472	1.472	1.472
TDH1	0.009	0.009	0.009	0.000	0.000	0.018	0.018	0.000	0.003	1.298	1.298	1.298	1.298
TDH2	0.016	0.016	0.016	0.000	0.000	0.040	0.040	0.000	0.001	0.385	0.385	0.385	0.385
TDH3	0.060	0.060	0.060	0.000	0.000	0.072	0.072	0.000	1.084	3.423	3.423	3.423	3.423
TDH4	0.063	0.063	0.063	0.000	0.000	0.063	0.063	0.000	1.423	4.498	4.498	4.498	4.498
TDH5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.569	4.960	4.960	4.960	4.960
TDH6	0.001	0.001	0.001	0.000	0.000	0.002	0.002	0.000	0.092	0.292	0.292	0.292	0.292
TDH7	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.001	0.397	0.397	0.397	0.397
TDH8	0.970	0.970	0.970	0.001	0.001	0.811	0.811	0.001	1.438	4.547	4.547	4.547	4.547
TDH9	0.195	0.195	0.195	0.000	0.000	0.162	0.162	0.199	2.318	2.318	2.318	2.318	2.318
TOTAL	**51.438**	**51.438**	**51.438**	**0.073**	**0.071**	**51.886**	**51.886**	**0.272**	**15.657**	**22.186**	**64.307**	**64.307**	**64.307**

Table H 2. Present Value Final Impact Factors
Scenario A and MCS-MPA management regime (discount rate 3.5%)

NPV A MCS-MPA	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13
L1	0.664	0.664	0.664	0.665	0.007	1.660	1.660	0.003	2.637	0.004	2.637	2.637	2.637
L2	0.043	0.043	0.043	0.000	0.000	0.052	0.052	0.000	0.006	0.006	2.471	2.471	2.471
L3	0.342	0.342	0.342	0.001	0.001	0.428	0.428	0.001	0.003	0.003	1.529	1.529	1.529
L4	1.380	1.380	1.380	0.003	0.003	1.735	1.735	0.004	0.003	0.003	1.286	1.286	1.286
L5	0.379	0.379	0.379	0.001	0.001	0.478	0.478	0.001	0.003	0.003	1.486	1.486	1.486
L6	1.021	1.021	1.021	0.002	0.002	1.291	1.291	0.002	0.010	0.010	5.957	5.957	5.957
L7	0.450	0.450	0.450	0.001	0.001	0.564	0.564	0.001	0.003	0.003	1.814	1.814	1.814
L8	4.658	4.658	4.658	0.009	0.008	5.854	5.854	0.010	0.003	0.003	1.810	1.810	1.810
L9	0.948	0.948	0.948	0.002	0.002	1.200	1.200	0.002	0.006	0.006	3.433	3.433	3.433
L10	0.597	0.597	0.597	0.001	0.002	0.750	0.750	0.001	1.817	0.002	1.817	1.817	1.817
L11	0.026	0.026	0.026	0.005	0.000	0.033	0.033	0.000	0.033	0.001	0.202	0.202	0.202
L12	0.132	0.132	0.132	0.024	0.001	0.165	0.165	0.000	0.028	0.001	0.172	0.172	0.172
L13	1.283	1.283	1.283	0.128	0.004	1.615	1.615	0.002	0.834	0.001	0.834	0.834	0.834
L14	0.002	0.002	0.002	0.000	0.000	0.003	0.003	0.000	0.050	0.000	0.050	0.050	0.050
L15	0.006	0.006	0.006	0.001	0.000	0.007	0.007	0.000	0.062	0.000	0.062	0.062	0.062
L16	0.095	0.095	0.095	0.012	0.000	0.080	0.080	0.000	0.475	0.001	0.475	0.475	0.475
L17	0.470	0.470	0.470	0.006	0.006	0.393	0.393	0.001	0.164	0.003	0.996	0.996	0.996
L18	1.351	1.351	1.351	0.018	0.032	1.133	1.133	0.003	0.068	0.001	0.409	0.409	0.409
L19	0.078	0.078	0.078	0.001	0.001	0.099	0.099	0.000	0.107	0.002	0.605	0.605	0.605
L20	0.472	0.472	0.472	0.004	0.004	0.592	0.592	0.001	0.045	0.001	0.592	0.592	0.592
L21	5.510	5.510	5.510	0.061	0.037	6.926	6.926	0.008	0.103	0.002	1.576	1.576	1.576
L22	0.065	0.065	0.065	0.000	0.000	0.081	0.081	0.000	0.353	0.006	4.650	4.650	4.650
L23	0.029	0.029	0.029	0.000	0.000	0.036	0.036	0.000	0.021	0.000	0.279	0.279	0.279
L24	0.447	0.447	0.447	0.003	0.003	0.377	0.377	0.001	0.148	0.002	1.659	1.659	1.659
L25	7.062	7.062	7.062	0.060	0.036	5.922	5.922	0.007	0.003	0.003	2.311	2.311	2.311
L26	21.719	21.719	21.719	0.123	0.112	18.203	18.203	0.023	0.002	0.002	1.472	1.472	1.472
TDH1	0.009	0.009	0.009	0.000	0.000	0.018	0.018	0.000	0.003	1.298	1.298	1.298	1.298
TDH2	0.016	0.016	0.016	0.000	0.000	0.040	0.040	0.000	0.001	0.385	0.385	0.385	0.385
TDH3	0.060	0.060	0.060	0.000	0.000	0.072	0.072	0.000	1.084	3.423	3.423	3.423	3.423
TDH4	0.063	0.063	0.063	0.000	0.000	0.063	0.063	0.000	1.423	4.498	4.498	4.498	4.498
TDH5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.569	4.960	4.960	4.960	4.960
TDH6	0.001	0.001	0.001	0.000	0.000	0.001	0.001	0.000	0.092	0.165	0.165	0.165	0.165
TDH7	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.001	0.397	0.397	0.397	0.397
TDH8	0.970	0.970	0.970	0.001	0.001	0.811	0.811	0.001	1.438	4.547	4.547	4.547	4.547
TDH9	0.195	0.195	0.195	0.000	0.000	0.162	0.162	0.199	2.318	2.318	2.318	2.318	2.318
TOTAL	**50.543**	**50.543**	**50.543**	**1.131**	**0.264**	**50.849**	**50.849**	**0.272**	**14.916**	**22.059**	**62.573**	**62.573**	**62.573**

Table H 3. Present Value Final Impact Factors
Scenario G and HR-MPA management regime (discount rate 3.5%)

NPV G HR-MPA	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13
L1	0.420	0.420	0.420	0.002	0.004	1.051	1.051	0.002	1.670	0.003	1.670	1.670	1.670
L2	0.072	0.072	0.072	0.000	0.000	0.086	0.086	0.000	0.009	0.009	4.102	4.102	4.102
L3	0.433	0.433	0.433	0.001	0.001	0.541	0.541	0.001	0.004	0.004	1.935	1.935	1.935
L4	1.477	1.477	1.477	0.004	0.003	1.857	1.857	0.004	0.003	0.003	1.376	1.376	1.376
L5	0.408	0.408	0.408	0.001	0.001	0.514	0.514	0.001	0.004	0.004	1.598	1.598	1.598
L6	0.989	0.989	0.989	0.002	0.002	1.251	1.251	0.002	0.010	0.010	5.772	5.772	5.772
L7	0.718	0.718	0.718	0.001	0.001	0.900	0.900	0.001	0.005	0.005	2.893	2.893	2.893
L8	4.711	4.711	4.711	0.009	0.008	5.921	5.921	0.010	0.003	0.003	1.831	1.831	1.831
L9	0.610	0.610	0.610	0.001	0.001	0.773	0.773	0.001	0.004	0.004	2.210	2.210	2.210
L10	0.719	0.719	0.719	0.001	0.003	0.903	0.903	0.001	2.188	0.003	2.188	2.188	2.188
L11	0.059	0.059	0.059	0.000	0.000	0.075	0.075	0.000	0.196	0.001	0.457	0.457	0.457
L12	0.455	0.455	0.455	0.001	0.001	0.572	0.572	0.001	0.255	0.001	0.595	0.595	0.595
L13	2.739	2.739	2.739	0.005	0.006	3.449	3.449	0.004	1.541	0.002	1.780	1.780	1.780
L14	0.005	0.005	0.005	0.000	0.000	0.007	0.007	0.000	0.050	0.000	0.116	0.116	0.116
L15	0.018	0.018	0.018	0.000	0.000	0.023	0.023	0.000	0.085	0.000	0.197	0.197	0.197
L16	0.322	0.322	0.322	0.000	0.001	0.271	0.271	0.000	0.692	0.002	1.614	1.614	1.614
L17	0.614	0.614	0.614	0.001	0.001	0.514	0.514	0.002	0.215	0.004	1.302	1.302	1.302
L18	1.746	1.746	1.746	0.004	0.007	1.464	1.464	0.004	0.529	0.001	0.529	0.529	0.529
L19	0.114	0.114	0.114	0.000	0.000	0.145	0.145	0.000	0.146	0.003	0.885	0.885	0.885
L20	0.835	0.835	0.835	0.001	0.001	1.047	1.047	0.001	0.074	0.001	1.047	1.047	1.047
L21	6.338	6.338	6.338	0.012	0.007	7.967	7.967	0.009	0.095	0.002	1.813	1.813	1.813
L22	0.055	0.055	0.055	0.000	0.000	0.069	0.069	0.000	0.280	0.005	3.951	3.951	3.951
L23	0.041	0.041	0.041	0.000	0.000	0.051	0.051	0.000	0.028	0.000	0.391	0.391	0.391
L24	1.792	1.792	1.792	0.002	0.002	1.513	1.513	0.002	0.475	0.010	6.658	6.658	6.658
L25	27.113	27.113	27.113	0.038	0.023	22.739	22.739	0.029	0.011	0.011	8.872	8.872	8.872
L26	29.351	29.351	29.351	0.028	0.025	24.600	24.600	0.031	0.003	0.003	1.990	1.990	1.990
TDH1	0.009	0.009	0.009	0.000	0.000	0.019	0.019	0.000	0.003	1.350	1.350	1.350	1.350
TDH2	0.026	0.026	0.026	0.000	0.000	0.064	0.064	0.000	0.001	0.613	0.613	0.613	0.613
TDH3	0.102	0.102	0.102	0.000	0.000	0.123	0.123	0.000	1.857	5.863	5.863	5.863	5.863
TDH4	0.065	0.065	0.065	0.000	0.000	0.065	0.065	0.000	1.473	4.656	4.656	4.656	4.656
TDH5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.569	4.960	4.960	4.960	4.960
TDH6	0.001	0.001	0.001	0.000	0.000	0.002	0.002	0.000	0.092	0.292	0.292	0.292	0.292
TDH7	0.000	0.000	0.000	0.000	0.000	0.002	0.002	0.000	0.001	0.595	0.595	0.595	0.595
TDH8	2.806	2.806	2.806	0.004	0.002	2.346	2.346	0.003	4.162	13.157	13.157	13.157	13.157
TDH9	0.214	0.214	0.214	0.000	0.000	0.178	0.178	0.219	2.550	2.550	2.550	2.550	2.550
TOTAL	**85.381**	**85.381**	**85.381**	**0.118**	**0.102**	**81.102**	**81.102**	**0.329**	**20.280**	**34.128**	**91.807**	**91.807**	**91.807**

Table H 4. Present Value Final Impact Factors
Scenario G and MCS-MPA management regime (discount rate 3.5%)

NPV G MCS-MPA	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13
L1	0.420	0.420	0.420	0.421	0.004	1.051	1.051	0.002	1.670	0.003	1.670	1.670	1.670
L2	0.072	0.072	0.072	0.000	0.000	0.086	0.086	0.000	0.009	0.009	4.102	4.102	4.102
L3	0.433	0.433	0.433	0.001	0.001	0.541	0.541	0.001	0.004	0.004	1.935	1.935	1.935
L4	1.477	1.477	1.477	0.004	0.003	1.857	1.857	0.004	0.003	0.003	1.376	1.376	1.376
L5	0.408	0.408	0.408	0.001	0.001	0.514	0.514	0.001	0.004	0.004	1.598	1.598	1.598
L6	0.989	0.989	0.989	0.002	0.002	1.251	1.251	0.002	0.010	0.010	5.772	5.772	5.772
L7	0.718	0.718	0.718	0.001	0.001	0.900	0.900	0.001	0.005	0.005	2.893	2.893	2.893
L8	4.711	4.711	4.711	0.009	0.008	5.921	5.921	0.010	0.003	0.003	1.831	1.831	1.831
L9	0.610	0.610	0.610	0.001	0.001	0.773	0.773	0.001	0.004	0.004	2.210	2.210	2.210
L10	0.719	0.719	0.719	0.001	0.003	0.903	0.903	0.001	2.188	0.003	2.188	2.188	2.188
L11	0.025	0.025	0.025	0.005	0.000	0.032	0.032	0.000	0.032	0.001	0.196	0.196	0.196
L12	0.195	0.195	0.195	0.036	0.001	0.245	0.245	0.001	0.042	0.001	0.255	0.255	0.255
L13	2.017	2.017	2.017	0.201	0.006	2.539	2.539	0.004	1.311	0.002	1.311	1.311	1.311
L14	0.002	0.002	0.002	0.000	0.000	0.003	0.003	0.000	0.050	0.000	0.050	0.050	0.050
L15	0.008	0.008	0.008	0.001	0.000	0.010	0.010	0.000	0.085	0.000	0.085	0.085	0.085
L16	0.138	0.138	0.138	0.017	0.001	0.116	0.116	0.000	0.692	0.002	0.692	0.692	0.692
L17	0.614	0.614	0.614	0.008	0.007	0.514	0.514	0.002	0.215	0.004	1.302	1.302	1.302
L18	1.640	1.640	1.640	0.022	0.039	1.375	1.375	0.004	0.082	0.001	0.496	0.496	0.496
L19	0.114	0.114	0.114	0.001	0.002	0.145	0.145	0.000	0.157	0.003	0.885	0.885	0.885
L20	0.835	0.835	0.835	0.007	0.006	1.047	1.047	0.001	0.079	0.001	1.047	1.047	1.047
L21	6.338	6.338	6.338	0.070	0.042	7.967	7.967	0.009	0.119	0.002	1.813	1.813	1.813
L22	0.055	0.055	0.055	0.000	0.000	0.069	0.069	0.000	0.300	0.005	3.951	3.951	3.951
L23	0.041	0.041	0.041	0.000	0.000	0.051	0.051	0.000	0.030	0.000	0.391	0.391	0.391
L24	1.792	1.792	1.792	0.012	0.011	1.513	1.513	0.002	0.594	0.010	6.658	6.658	6.658
L25	27.113	27.113	27.113	0.230	0.140	22.739	22.739	0.029	0.011	0.011	8.872	8.872	8.872
L26	29.351	29.351	29.351	0.166	0.151	24.600	24.600	0.031	0.003	0.003	1.990	1.990	1.990
TDH1	0.009	0.009	0.009	0.000	0.000	0.019	0.019	0.000	0.003	1.350	1.350	1.350	1.350
TDH2	0.026	0.026	0.026	0.000	0.000	0.064	0.064	0.000	0.001	0.613	0.613	0.613	0.613
TDH3	0.102	0.102	0.102	0.000	0.000	0.123	0.123	0.000	1.857	5.863	5.863	5.863	5.863
TDH4	0.065	0.065	0.065	0.000	0.000	0.065	0.065	0.000	1.473	4.656	4.656	4.656	4.656
TDH5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.569	4.960	4.960	4.960	4.960
TDH6	0.001	0.001	0.001	0.000	0.000	0.001	0.001	0.000	0.092	0.165	0.165	0.165	0.165
TDH7	0.000	0.000	0.000	0.000	0.000	0.002	0.002	0.000	0.001	0.595	0.595	0.595	0.595
TDH8	2.806	2.806	2.806	0.004	0.002	2.346	2.346	0.003	4.162	13.157	13.157	13.157	13.157
TDH9	0.214	0.214	0.214	0.000	0.000	0.178	0.178	0.219	2.550	2.550	2.550	2.550	2.550
TOTAL	**84.061**	**84.061**	**84.061**	**1.221**	**0.435**	**79.562**	**79.562**	**0.329**	**19.407**	**34.001**	**89.476**	**89.476**	**89.476**

Table H 5. Present Value Final Impact Factors
Scenario I and HR-MPA management regime (discount rate 3.5%)

NPV I HR-MPA	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13
L1	0.923	0.923	0.923	0.003	0.009	2.307	2.307	0.004	3.666	0.006	3.666	3.666	3.666
L2	0.063	0.063	0.063	0.000	0.000	0.076	0.076	0.000	0.008	0.008	3.631	3.631	3.631
L3	0.426	0.426	0.426	0.001	0.001	0.532	0.532	0.001	0.004	0.004	1.903	1.903	1.903
L4	1.415	1.415	1.415	0.004	0.003	1.779	1.779	0.004	0.003	0.003	1.318	1.318	1.318
L5	0.439	0.439	0.439	0.001	0.001	0.554	0.554	0.001	0.004	0.004	1.722	1.722	1.722
L6	0.989	0.989	0.989	0.002	0.002	1.251	1.251	0.002	0.010	0.010	5.772	5.772	5.772
L7	0.958	0.958	0.958	0.002	0.002	1.201	1.201	0.002	0.006	0.006	3.860	3.860	3.860
L8	4.744	4.744	4.744	0.009	0.008	5.963	5.963	0.010	0.003	0.003	1.844	1.844	1.844
L9	1.062	1.062	1.062	0.002	0.002	1.344	1.344	0.002	0.006	0.006	3.844	3.844	3.844
L10	0.953	0.953	0.953	0.001	0.004	1.196	1.196	0.001	2.900	0.004	2.900	2.900	2.900
L11	0.088	0.088	0.088	0.000	0.000	0.111	0.111	0.000	0.290	0.001	0.677	0.677	0.677
L12	0.345	0.345	0.345	0.000	0.001	0.434	0.434	0.001	0.193	0.001	0.451	0.451	0.451
L13	2.127	2.127	2.127	0.004	0.005	2.678	2.678	0.003	1.197	0.002	1.383	1.383	1.383
L14	0.059	0.059	0.059	0.000	0.000	0.079	0.079	0.000	0.607	0.002	1.417	1.417	1.417
L15	0.015	0.015	0.015	0.000	0.000	0.019	0.019	0.000	0.069	0.000	0.161	0.161	0.161
L16	0.339	0.339	0.339	0.000	0.001	0.285	0.285	0.000	0.728	0.002	1.698	1.698	1.698
L17	0.923	0.923	0.923	0.002	0.002	0.772	0.772	0.002	0.323	0.006	1.955	1.955	1.955
L18	1.553	1.553	1.553	0.003	0.006	1.301	1.301	0.004	0.470	0.001	0.470	0.470	0.470
L19	0.110	0.110	0.110	0.000	0.000	0.140	0.140	0.000	0.141	0.003	0.853	0.853	0.853
L20	0.455	0.455	0.455	0.001	0.001	0.571	0.571	0.001	0.040	0.001	0.571	0.571	0.571
L21	5.587	5.587	5.587	0.010	0.006	7.023	7.023	0.008	0.084	0.002	1.598	1.598	1.598
L22	0.023	0.023	0.023	0.000	0.000	0.029	0.029	0.000	0.117	0.002	1.652	1.652	1.652
L23	0.028	0.028	0.028	0.000	0.000	0.035	0.035	0.000	0.019	0.000	0.267	0.267	0.267
L24	0.676	0.676	0.676	0.001	0.001	0.571	0.571	0.001	0.179	0.004	2.513	2.513	2.513
L25	15.454	15.454	15.454	0.022	0.013	12.961	12.961	0.016	0.006	0.006	5.057	5.057	5.057
L26	24.485	24.485	24.485	0.023	0.021	20.521	20.521	0.026	0.002	0.002	1.660	1.660	1.660
TDH1	0.009	0.009	0.009	0.000	0.000	0.018	0.018	0.000	0.003	1.298	1.298	1.298	1.298
TDH2	0.026	0.026	0.026	0.000	0.000	0.065	0.065	0.000	0.001	0.620	0.620	0.620	0.620
TDH3	0.104	0.104	0.104	0.000	0.000	0.124	0.124	0.000	1.879	5.930	5.930	5.930	5.930
TDH4	0.074	0.074	0.074	0.000	0.000	0.074	0.074	0.000	1.672	5.287	5.287	5.287	5.287
TDH5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.569	4.960	4.960	4.960	4.960
TDH6	0.001	0.001	0.001	0.000	0.000	0.002	0.002	0.000	0.092	0.292	0.292	0.292	0.292
TDH7	0.000	0.000	0.000	0.000	0.000	0.002	0.002	0.000	0.001	0.595	0.595	0.595	0.595
TDH8	2.822	2.822	2.822	0.004	0.002	2.360	2.360	0.003	4.185	13.232	13.232	13.232	13.232
TDH9	0.220	0.220	0.220	0.000	0.000	0.184	0.184	0.225	2.627	2.627	2.627	2.627	2.627
TOTAL	**67.497**	**67.497**	**67.497**	**0.096**	**0.091**	**66.564**	**66.564**	**0.319**	**23.107**	**34.930**	**87.684**	**87.684**	**87.684**

Table H 6. Present Value Final Impact Factors
Scenario I and MCS-MPA management regime (discount rate 3.5%)

NPV I MCS-MPA	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13
L1	0.923	0.923	0.923	0.924	0.009	2.307	2.307	0.004	3.666	0.006	3.666	3.666	3.666
L2	0.063	0.063	0.063	0.000	0.000	0.076	0.076	0.000	0.008	0.008	3.631	3.631	3.631
L3	0.426	0.426	0.426	0.001	0.001	0.532	0.532	0.001	0.004	0.004	1.903	1.903	1.903
L4	1.415	1.415	1.415	0.004	0.003	1.779	1.779	0.004	0.003	0.003	1.318	1.318	1.318
L5	0.439	0.439	0.439	0.001	0.001	0.554	0.554	0.001	0.004	0.004	1.722	1.722	1.722
L6	0.989	0.989	0.989	0.002	0.002	1.251	1.251	0.002	0.010	0.010	5.772	5.772	5.772
L7	0.958	0.958	0.958	0.002	0.002	1.201	1.201	0.002	0.006	0.006	3.860	3.860	3.860
L8	4.744	4.744	4.744	0.009	0.008	5.963	5.963	0.010	0.003	0.003	1.844	1.844	1.844
L9	1.062	1.062	1.062	0.002	0.002	1.344	1.344	0.002	0.006	0.006	3.844	3.844	3.844
L10	0.953	0.953	0.953	0.001	0.004	1.196	1.196	0.001	2.900	0.004	2.900	2.900	2.900
L11	0.038	0.038	0.038	0.007	0.000	0.048	0.048	0.000	0.048	0.001	0.290	0.290	0.290
L12	0.148	0.148	0.148	0.027	0.001	0.186	0.186	0.001	0.032	0.001	0.193	0.193	0.193
L13	1.566	1.566	1.566	0.156	0.005	1.972	1.972	0.003	1.018	0.002	1.018	1.018	1.018
L14	0.025	0.025	0.025	0.005	0.000	0.034	0.034	0.000	0.607	0.002	0.607	0.607	0.607
L15	0.006	0.006	0.006	0.001	0.000	0.008	0.008	0.000	0.069	0.000	0.069	0.069	0.069
L16	0.145	0.145	0.145	0.018	0.001	0.122	0.122	0.000	0.728	0.002	0.728	0.728	0.728
L17	0.923	0.923	0.923	0.012	0.011	0.772	0.772	0.002	0.323	0.006	1.955	1.955	1.955
L18	1.458	1.458	1.458	0.019	0.035	1.222	1.222	0.004	0.073	0.001	0.441	0.441	0.441
L19	0.110	0.110	0.110	0.001	0.002	0.140	0.140	0.000	0.151	0.003	0.853	0.853	0.853
L20	0.455	0.455	0.455	0.004	0.004	0.571	0.571	0.001	0.043	0.001	0.571	0.571	0.571
L21	5.587	5.587	5.587	0.061	0.037	7.023	7.023	0.008	0.105	0.002	1.598	1.598	1.598
L22	0.023	0.023	0.023	0.000	0.000	0.029	0.029	0.000	0.125	0.002	1.652	1.652	1.652
L23	0.028	0.028	0.028	0.000	0.000	0.035	0.035	0.000	0.020	0.000	0.267	0.267	0.267
L24	0.676	0.676	0.676	0.005	0.004	0.571	0.571	0.001	0.224	0.004	2.513	2.513	2.513
L25	15.454	15.454	15.454	0.131	0.080	12.961	12.961	0.016	0.006	0.006	5.057	5.057	5.057
L26	24.485	24.485	24.485	0.138	0.126	20.521	20.521	0.026	0.002	0.002	1.660	1.660	1.660
TDH1	0.009	0.009	0.009	0.000	0.000	0.018	0.018	0.000	0.003	1.298	1.298	1.298	1.298
TDH2	0.026	0.026	0.026	0.000	0.000	0.065	0.065	0.000	0.001	0.620	0.620	0.620	0.620
TDH3	0.104	0.104	0.104	0.000	0.000	0.124	0.124	0.000	1.879	5.930	5.930	5.930	5.930
TDH4	0.074	0.074	0.074	0.000	0.000	0.074	0.074	0.000	1.672	5.287	5.287	5.287	5.287
TDH5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.569	4.960	4.960	4.960	4.960
TDH6	0.001	0.001	0.001	0.000	0.000	0.001	0.001	0.000	0.092	0.165	0.165	0.165	0.165
TDH7	0.000	0.000	0.000	0.000	0.000	0.002	0.002	0.000	0.001	0.595	0.595	0.595	0.595
TDH8	2.822	2.822	2.822	0.004	0.002	2.360	2.360	0.003	4.185	13.232	13.232	13.232	13.232
TDH9	0.220	0.220	0.220	0.000	0.000	0.184	0.184	0.225	2.627	2.627	2.627	2.627	2.627
TOTAL	**66.358**	**66.358**	**66.358**	**1.536**	**0.340**	**65.248**	**65.248**	**0.319**	**22.216**	**34.803**	**84.647**	**84.647**	**84.647**

Table H 7. Undiscounted mean annual Final Impact Factors
Scenario A and HR-MPA management regime

NOMINAL A HR-MPA	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13
L1	0.059	0.059	0.059	0.000	0.000	0.154	0.154	0.000	0.244	0.000	0.244	0.244	0.244
L2	0.000	0.000	0.000	0.000	0.000	0.012	0.012	0.000	0.000	0.000	0.282	0.282	0.282
L3	0.038	0.038	0.038	0.000	0.000	0.048	0.048	0.000	0.000	0.000	0.195	0.195	0.195
L4	0.154	0.154	0.154	0.000	0.000	0.201	0.201	0.000	0.000	0.000	0.151	0.151	0.151
L5	0.036	0.036	0.036	0.000	0.000	0.053	0.053	0.000	0.000	0.000	0.166	0.166	0.166
L6	0.098	0.098	0.098	0.000	0.000	0.120	0.120	0.000	0.000	0.000	0.568	0.568	0.568
L7	0.025	0.025	0.025	0.000	0.000	0.062	0.062	0.000	0.000	0.000	0.180	0.180	0.180
L8	0.429	0.429	0.429	0.000	0.000	0.550	0.550	0.000	0.000	0.000	0.164	0.164	0.164
L9	0.086	0.086	0.086	0.000	0.000	0.111	0.111	0.000	0.000	0.000	0.318	0.318	0.318
L10	0.046	0.046	0.046	0.000	0.000	0.059	0.059	0.000	0.147	0.000	0.147	0.147	0.147
L11	0.005	0.005	0.005	0.000	0.000	0.007	0.007	0.000	0.016	0.000	0.038	0.038	0.038
L12	0.024	0.024	0.024	0.000	0.000	0.031	0.031	0.000	0.014	0.000	0.033	0.033	0.033
L13	0.157	0.157	0.157	0.000	0.000	0.199	0.199	0.000	0.079	0.000	0.102	0.102	0.102
L14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.000	0.009	0.009	0.009
L15	0.001	0.001	0.001	0.000	0.000	0.001	0.001	0.000	0.005	0.000	0.012	0.012	0.012
L16	0.020	0.020	0.020	0.000	0.000	0.016	0.016	0.000	0.038	0.000	0.091	0.091	0.091
L17	0.039	0.039	0.039	0.000	0.000	0.031	0.031	0.000	0.015	0.000	0.077	0.077	0.077
L18	0.105	0.105	0.105	0.000	0.000	0.087	0.087	0.000	0.032	0.000	0.032	0.032	0.032
L19	0.007	0.007	0.007	0.000	0.000	0.007	0.007	0.000	0.007	0.000	0.047	0.047	0.047
L20	0.039	0.039	0.039	0.000	0.000	0.049	0.049	0.000	0.003	0.000	0.047	0.047	0.047
L21	0.497	0.497	0.497	0.000	0.000	0.624	0.624	0.000	0.006	0.000	0.139	0.139	0.139
L22	0.008	0.008	0.008	0.000	0.000	0.005	0.005	0.000	0.028	0.000	0.375	0.375	0.375
L23	0.002	0.002	0.002	0.000	0.000	0.003	0.003	0.000	0.002	0.000	0.023	0.023	0.023
L24	0.044	0.044	0.044	0.000	0.000	0.035	0.035	0.000	0.007	0.000	0.148	0.148	0.148
L25	0.570	0.570	0.570	0.000	0.000	0.476	0.476	0.000	0.000	0.000	0.189	0.189	0.189
L26	1.761	1.761	1.761	0.000	0.000	1.474	1.474	0.000	0.000	0.000	0.116	0.116	0.116
TDH1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.178	0.178	0.178	0.178
TDH2	0.000	0.000	0.000	0.000	0.000	0.010	0.010	0.000	0.000	0.061	0.061	0.061	0.061
TDH3	0.007	0.007	0.007	0.000	0.000	0.008	0.008	0.000	0.152	0.489	0.489	0.489	0.489
TDH4	0.010	0.010	0.010	0.000	0.000	0.005	0.005	0.000	0.164	0.521	0.521	0.521	0.521
TDH5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.180	0.577	0.577	0.577	0.577
TDH6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.024	0.024	0.024	0.024
TDH7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.056	0.056	0.056	0.056
TDH8	0.097	0.097	0.097	0.000	0.000	0.069	0.069	0.000	0.133	0.420	0.420	0.420	0.420
TDH9	0.018	0.018	0.018	0.000	0.000	0.014	0.014	0.045	0.218	0.218	0.218	0.218	0.218
TOTAL	**4.382**	**4.382**	**4.382**	**0.000**	**0.000**	**4.522**	**4.522**	**0.045**	**1.500**	**2.543**	**6.436**	**6.436**	**6.436**

Table H 8. Undiscounted mean annual Final Impact Factors
Scenario A and MCS-MPA management regime

NOMINAL A MCS-MPA	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13
L1	0.059	0.059	0.059	0.070	0.000	0.154	0.154	0.000	0.244	0.000	0.244	0.244	0.244
L2	0.000	0.000	0.000	0.000	0.000	0.012	0.012	0.000	0.000	0.000	0.282	0.282	0.282
L3	0.038	0.038	0.038	0.000	0.000	0.048	0.048	0.000	0.000	0.000	0.195	0.195	0.195
L4	0.154	0.154	0.154	0.000	0.000	0.201	0.201	0.000	0.000	0.000	0.151	0.151	0.151
L5	0.036	0.036	0.036	0.000	0.000	0.053	0.053	0.000	0.000	0.000	0.166	0.166	0.166
L6	0.098	0.098	0.098	0.000	0.000	0.120	0.120	0.000	0.000	0.000	0.568	0.568	0.568
L7	0.025	0.025	0.025	0.000	0.000	0.062	0.062	0.000	0.000	0.000	0.180	0.180	0.180
L8	0.429	0.429	0.429	0.000	0.000	0.550	0.550	0.000	0.000	0.000	0.164	0.164	0.164
L9	0.086	0.086	0.086	0.000	0.000	0.111	0.111	0.000	0.000	0.000	0.318	0.318	0.318
L10	0.046	0.046	0.046	0.000	0.000	0.059	0.059	0.000	0.147	0.000	0.147	0.147	0.147
L11	0.002	0.002	0.002	0.000	0.000	0.003	0.003	0.000	0.003	0.000	0.016	0.016	0.016
L12	0.011	0.011	0.011	0.002	0.000	0.013	0.013	0.000	0.002	0.000	0.014	0.014	0.014
L13	0.116	0.116	0.116	0.000	0.000	0.146	0.146	0.000	0.075	0.000	0.075	0.075	0.075
L14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.000	0.004	0.004	0.004
L15	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.005	0.000	0.005	0.005	0.005
L16	0.008	0.008	0.008	0.000	0.000	0.008	0.008	0.000	0.038	0.000	0.038	0.038	0.038
L17	0.039	0.039	0.039	0.000	0.000	0.031	0.031	0.000	0.015	0.000	0.077	0.077	0.077
L18	0.110	0.110	0.110	0.000	0.000	0.092	0.092	0.000	0.005	0.000	0.033	0.033	0.033
L19	0.007	0.007	0.007	0.000	0.000	0.007	0.007	0.000	0.007	0.000	0.047	0.047	0.047
L20	0.039	0.039	0.039	0.000	0.000	0.049	0.049	0.000	0.003	0.000	0.047	0.047	0.047
L21	0.497	0.497	0.497	0.000	0.000	0.624	0.624	0.000	0.006	0.000	0.139	0.139	0.139
L22	0.008	0.008	0.008	0.000	0.000	0.005	0.005	0.000	0.028	0.000	0.375	0.375	0.375
L23	0.002	0.002	0.002	0.000	0.000	0.003	0.003	0.000	0.002	0.000	0.023	0.023	0.023
L24	0.044	0.044	0.044	0.000	0.000	0.035	0.035	0.000	0.014	0.000	0.148	0.148	0.148
L25	0.570	0.570	0.570	0.000	0.000	0.476	0.476	0.000	0.000	0.000	0.189	0.189	0.189
L26	1.761	1.761	1.761	0.000	0.000	1.474	1.474	0.000	0.000	0.000	0.116	0.116	0.116
TDH1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.178	0.178	0.178	0.178
TDH2	0.000	0.000	0.000	0.000	0.000	0.010	0.010	0.000	0.000	0.061	0.061	0.061	0.061
TDH3	0.007	0.007	0.007	0.000	0.000	0.008	0.008	0.000	0.152	0.489	0.489	0.489	0.489
TDH4	0.010	0.010	0.010	0.000	0.000	0.005	0.005	0.000	0.164	0.521	0.521	0.521	0.521
TDH5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.180	0.577	0.577	0.577	0.577
TDH6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.024	0.024	0.024	0.024
TDH7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.056	0.056	0.056	0.056
TDH8	0.097	0.097	0.097	0.000	0.000	0.069	0.069	0.000	0.133	0.420	0.420	0.420	0.420
TDH9	0.018	0.018	0.018	0.000	0.000	0.014	0.014	0.045	0.218	0.218	0.218	0.218	0.218
TOTAL	**4.316**	**4.316**	**4.316**	**0.072**	**0.000**	**4.443**	**4.443**	**0.045**	**1.453**	**2.543**	**6.303**	**6.303**	**6.303**

Table H 9. Undiscounted mean annual Final Impact Factors
Scenario G and HR-MPA management regime

NOMINAL G HR-MPA	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13
L1	0.037	0.037	0.037	0.000	0.000	0.098	0.098	0.000	0.154	0.000	0.154	0.154	0.154
L2	0.000	0.000	0.000	0.000	0.000	0.019	0.019	0.000	0.000	0.000	0.468	0.468	0.468
L3	0.048	0.048	0.048	0.000	0.000	0.060	0.060	0.000	0.000	0.000	0.247	0.247	0.247
L4	0.165	0.165	0.165	0.000	0.000	0.216	0.216	0.000	0.000	0.000	0.162	0.162	0.162
L5	0.039	0.039	0.039	0.000	0.000	0.057	0.057	0.000	0.000	0.000	0.178	0.178	0.178
L6	0.095	0.095	0.095	0.000	0.000	0.116	0.116	0.000	0.000	0.000	0.550	0.550	0.550
L7	0.040	0.040	0.040	0.000	0.000	0.099	0.099	0.000	0.000	0.000	0.286	0.286	0.286
L8	0.434	0.434	0.434	0.000	0.000	0.556	0.556	0.000	0.000	0.000	0.166	0.166	0.166
L9	0.055	0.055	0.055	0.000	0.000	0.071	0.071	0.000	0.000	0.000	0.205	0.205	0.205
L10	0.056	0.056	0.056	0.000	0.000	0.071	0.071	0.000	0.177	0.000	0.177	0.177	0.177
L11	0.004	0.004	0.004	0.000	0.000	0.006	0.006	0.000	0.015	0.000	0.037	0.037	0.037
L12	0.036	0.036	0.036	0.000	0.000	0.046	0.046	0.000	0.020	0.000	0.048	0.048	0.048
L13	0.247	0.247	0.247	0.000	0.000	0.312	0.312	0.000	0.124	0.000	0.161	0.161	0.161
L14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.000	0.009	0.009	0.009
L15	0.001	0.001	0.001	0.000	0.000	0.002	0.002	0.000	0.007	0.000	0.016	0.016	0.016
L16	0.029	0.029	0.029	0.000	0.000	0.023	0.023	0.000	0.055	0.000	0.132	0.132	0.132
L17	0.050	0.050	0.050	0.000	0.000	0.040	0.040	0.000	0.020	0.000	0.101	0.101	0.101
L18	0.127	0.127	0.127	0.000	0.000	0.106	0.106	0.000	0.039	0.000	0.039	0.039	0.039
L19	0.010	0.010	0.010	0.000	0.000	0.010	0.010	0.000	0.010	0.000	0.069	0.069	0.069
L20	0.068	0.068	0.068	0.000	0.000	0.086	0.086	0.000	0.006	0.000	0.083	0.083	0.083
L21	0.571	0.571	0.571	0.000	0.000	0.718	0.718	0.000	0.006	0.000	0.160	0.160	0.160
L22	0.007	0.007	0.007	0.000	0.000	0.004	0.004	0.000	0.024	0.000	0.319	0.319	0.319
L23	0.003	0.003	0.003	0.000	0.000	0.004	0.004	0.000	0.002	0.000	0.032	0.032	0.032
L24	0.178	0.178	0.178	0.000	0.000	0.141	0.141	0.000	0.028	0.000	0.594	0.594	0.594
L25	2.187	2.187	2.187	0.000	0.000	1.829	1.829	0.000	0.000	0.000	0.726	0.726	0.726
L26	2.379	2.379	2.379	0.000	0.000	1.992	1.992	0.000	0.000	0.000	0.157	0.157	0.157
TDH1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.185	0.185	0.185	0.185
TDH2	0.000	0.000	0.000	0.000	0.000	0.015	0.015	0.000	0.000	0.097	0.097	0.097	0.097
TDH3	0.012	0.012	0.012	0.000	0.000	0.015	0.015	0.000	0.261	0.837	0.837	0.837	0.837
TDH4	0.011	0.011	0.011	0.000	0.000	0.005	0.005	0.000	0.169	0.540	0.540	0.540	0.540
TDH5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.180	0.577	0.577	0.577	0.577
TDH6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.024	0.024	0.024	0.024
TDH7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.084	0.084	0.084	0.084
TDH8	0.279	0.279	0.279	0.000	0.000	0.200	0.200	0.000	0.385	1.215	1.215	1.215	1.215
TDH9	0.020	0.020	0.020	0.000	0.000	0.015	0.015	0.050	0.240	0.240	0.240	0.240	0.240
TOTAL	**7.191**	**7.191**	**7.191**	**0.000**	**0.000**	**6.935**	**6.935**	**0.050**	**1.935**	**3.798**	**9.075**	**9.075**	**9.075**

Table H 10. Undiscounted mean annual Final Impact Factors
Scenario G and MCS-MPA management regime

NOMINAL G MCS-MPA	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13
L1	0.037	0.037	0.037	0.044	0.000	0.098	0.098	0.000	0.154	0.000	0.154	0.154	0.154
L2	0.000	0.000	0.000	0.000	0.000	0.019	0.019	0.000	0.000	0.000	0.468	0.468	0.468
L3	0.048	0.048	0.048	0.000	0.000	0.060	0.060	0.000	0.000	0.000	0.247	0.247	0.247
L4	0.165	0.165	0.165	0.000	0.000	0.216	0.216	0.000	0.000	0.000	0.162	0.162	0.162
L5	0.039	0.039	0.039	0.000	0.000	0.057	0.057	0.000	0.000	0.000	0.178	0.178	0.178
L6	0.095	0.095	0.095	0.000	0.000	0.116	0.116	0.000	0.000	0.000	0.550	0.550	0.550
L7	0.040	0.040	0.040	0.000	0.000	0.099	0.099	0.000	0.000	0.000	0.286	0.286	0.286
L8	0.434	0.434	0.434	0.000	0.000	0.556	0.556	0.000	0.000	0.000	0.166	0.166	0.166
L9	0.055	0.055	0.055	0.000	0.000	0.071	0.071	0.000	0.000	0.000	0.205	0.205	0.205
L10	0.056	0.056	0.056	0.000	0.000	0.071	0.071	0.000	0.177	0.000	0.177	0.177	0.177
L11	0.001	0.001	0.001	0.000	0.000	0.003	0.003	0.000	0.003	0.000	0.015	0.015	0.015
L12	0.016	0.016	0.016	0.003	0.000	0.020	0.020	0.000	0.003	0.000	0.020	0.020	0.020
L13	0.182	0.182	0.182	0.000	0.000	0.229	0.229	0.000	0.117	0.000	0.117	0.117	0.117
L14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.000	0.004	0.004	0.004
L15	0.001	0.001	0.001	0.000	0.000	0.001	0.001	0.000	0.007	0.000	0.007	0.007	0.007
L16	0.012	0.012	0.012	0.000	0.000	0.011	0.011	0.000	0.055	0.000	0.055	0.055	0.055
L17	0.050	0.050	0.050	0.000	0.000	0.040	0.040	0.000	0.020	0.000	0.101	0.101	0.101
L18	0.133	0.133	0.133	0.000	0.000	0.112	0.112	0.000	0.006	0.000	0.040	0.040	0.040
L19	0.010	0.010	0.010	0.000	0.000	0.010	0.010	0.000	0.010	0.000	0.069	0.069	0.069
L20	0.068	0.068	0.068	0.000	0.000	0.086	0.086	0.000	0.006	0.000	0.083	0.083	0.083
L21	0.571	0.571	0.571	0.000	0.000	0.718	0.718	0.000	0.006	0.000	0.160	0.160	0.160
L22	0.007	0.007	0.007	0.000	0.000	0.004	0.004	0.000	0.024	0.000	0.319	0.319	0.319
L23	0.003	0.003	0.003	0.000	0.000	0.004	0.004	0.000	0.002	0.000	0.032	0.032	0.032
L24	0.178	0.178	0.178	0.000	0.000	0.141	0.141	0.000	0.057	0.000	0.594	0.594	0.594
L25	2.187	2.187	2.187	0.000	0.000	1.829	1.829	0.000	0.000	0.000	0.726	0.726	0.726
L26	2.379	2.379	2.379	0.000	0.000	1.992	1.992	0.000	0.000	0.000	0.157	0.157	0.157
TDH1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.185	0.185	0.185	0.185
TDH2	0.000	0.000	0.000	0.000	0.000	0.015	0.015	0.000	0.000	0.097	0.097	0.097	0.097
TDH3	0.012	0.012	0.012	0.000	0.000	0.015	0.015	0.000	0.261	0.837	0.837	0.837	0.837
TDH4	0.011	0.011	0.011	0.000	0.000	0.005	0.005	0.000	0.169	0.540	0.540	0.540	0.540
TDH5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.180	0.577	0.577	0.577	0.577
TDH6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.024	0.024	0.024	0.024
TDH7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.084	0.084	0.084	0.084
TDH8	0.279	0.279	0.279	0.000	0.000	0.200	0.200	0.000	0.385	1.215	1.215	1.215	1.215
TDH9	0.020	0.020	0.020	0.000	0.000	0.015	0.015	0.050	0.240	0.240	0.240	0.240	0.240
TOTAL	**7.091**	**7.091**	**7.091**	**0.047**	**0.000**	**6.815**	**6.815**	**0.050**	**1.896**	**3.798**	**8.891**	**8.891**	**8.891**

Table H 11. Undiscounted mean annual Final Impact Factors
Scenario I and HR-MPA management regime

NOMINAL I HR-MPA	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13
L1	0.082	0.082	0.082	0.000	0.000	0.214	0.214	0.000	0.339	0.000	0.339	0.339	0.339
L2	0.000	0.000	0.000	0.000	0.000	0.017	0.017	0.000	0.000	0.000	0.414	0.414	0.414
L3	0.048	0.048	0.048	0.000	0.000	0.059	0.059	0.000	0.000	0.000	0.243	0.243	0.243
L4	0.158	0.158	0.158	0.000	0.000	0.206	0.206	0.000	0.000	0.000	0.155	0.155	0.155
L5	0.042	0.042	0.042	0.000	0.000	0.062	0.062	0.000	0.000	0.000	0.192	0.192	0.192
L6	0.095	0.095	0.095	0.000	0.000	0.116	0.116	0.000	0.000	0.000	0.550	0.550	0.550
L7	0.053	0.053	0.053	0.000	0.000	0.132	0.132	0.000	0.000	0.000	0.382	0.382	0.382
L8	0.437	0.437	0.437	0.000	0.000	0.560	0.560	0.000	0.000	0.000	0.167	0.167	0.167
L9	0.096	0.096	0.096	0.000	0.000	0.124	0.124	0.000	0.000	0.000	0.356	0.356	0.356
L10	0.074	0.074	0.074	0.000	0.000	0.095	0.095	0.000	0.235	0.000	0.235	0.235	0.235
L11	0.007	0.007	0.007	0.000	0.000	0.009	0.009	0.000	0.023	0.000	0.054	0.054	0.054
L12	0.027	0.027	0.027	0.000	0.000	0.035	0.035	0.000	0.015	0.000	0.037	0.037	0.037
L13	0.192	0.192	0.192	0.000	0.000	0.243	0.243	0.000	0.096	0.000	0.125	0.125	0.125
L14	0.005	0.005	0.005	0.000	0.000	0.005	0.005	0.000	0.048	0.000	0.115	0.115	0.115
L15	0.001	0.001	0.001	0.000	0.000	0.001	0.001	0.000	0.006	0.000	0.013	0.013	0.013
L16	0.031	0.031	0.031	0.000	0.000	0.024	0.024	0.000	0.058	0.000	0.139	0.139	0.139
L17	0.076	0.076	0.076	0.000	0.000	0.061	0.061	0.000	0.030	0.000	0.152	0.152	0.152
L18	0.113	0.113	0.113	0.000	0.000	0.094	0.094	0.000	0.034	0.000	0.034	0.034	0.034
L19	0.009	0.009	0.009	0.000	0.000	0.009	0.009	0.000	0.009	0.000	0.066	0.066	0.066
L20	0.037	0.037	0.037	0.000	0.000	0.047	0.047	0.000	0.003	0.000	0.045	0.045	0.045
L21	0.504	0.504	0.504	0.000	0.000	0.633	0.633	0.000	0.006	0.000	0.141	0.141	0.141
L22	0.003	0.003	0.003	0.000	0.000	0.002	0.002	0.000	0.010	0.000	0.133	0.133	0.133
L23	0.002	0.002	0.002	0.000	0.000	0.003	0.003	0.000	0.002	0.000	0.022	0.022	0.022
L24	0.067	0.067	0.067	0.000	0.000	0.053	0.053	0.000	0.011	0.000	0.224	0.224	0.224
L25	1.247	1.247	1.247	0.000	0.000	1.043	1.043	0.000	0.000	0.000	0.414	0.414	0.414
L26	1.985	1.985	1.985	0.000	0.000	1.662	1.662	0.000	0.000	0.000	0.131	0.131	0.131
TDH1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.178	0.178	0.178	0.178
TDH2	0.000	0.000	0.000	0.000	0.000	0.015	0.015	0.000	0.000	0.098	0.098	0.098	0.098
TDH3	0.012	0.012	0.012	0.000	0.000	0.015	0.015	0.000	0.264	0.847	0.847	0.847	0.847
TDH4	0.012	0.012	0.012	0.000	0.000	0.006	0.006	0.000	0.192	0.613	0.613	0.613	0.613
TDH5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.180	0.577	0.577	0.577	0.577
TDH6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.024	0.024	0.024	0.024
TDH7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.084	0.084	0.084	0.084
TDH8	0.281	0.281	0.281	0.000	0.000	0.201	0.201	0.000	0.388	1.222	1.222	1.222	1.222
TDH9	0.020	0.020	0.020	0.000	0.000	0.016	0.016	0.051	0.247	0.247	0.247	0.247	0.247
TOTAL	**5.716**	**5.716**	**5.716**	**0.000**	**0.000**	**5.763**	**5.763**	**0.051**	**2.203**	**3.889**	**8.769**	**8.769**	**8.769**

Table H 12. Undiscounted mean annual Final Impact Factors
Scenario I and MCS-MPA management regime

NOMINAL I MCS-MPA	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13
L1	0.082	0.082	0.082	0.097	0.000	0.214	0.214	0.000	0.339	0.000	0.339	0.339	0.339
L2	0.000	0.000	0.000	0.000	0.000	0.017	0.017	0.000	0.000	0.000	0.414	0.414	0.414
L3	0.048	0.048	0.048	0.000	0.000	0.059	0.059	0.000	0.000	0.000	0.243	0.243	0.243
L4	0.158	0.158	0.158	0.000	0.000	0.206	0.206	0.000	0.000	0.000	0.155	0.155	0.155
L5	0.042	0.042	0.042	0.000	0.000	0.062	0.062	0.000	0.000	0.000	0.192	0.192	0.192
L6	0.095	0.095	0.095	0.000	0.000	0.116	0.116	0.000	0.000	0.000	0.550	0.550	0.550
L7	0.053	0.053	0.053	0.000	0.000	0.132	0.132	0.000	0.000	0.000	0.382	0.382	0.382
L8	0.437	0.437	0.437	0.000	0.000	0.560	0.560	0.000	0.000	0.000	0.167	0.167	0.167
L9	0.096	0.096	0.096	0.000	0.000	0.124	0.124	0.000	0.000	0.000	0.356	0.356	0.356
L10	0.074	0.074	0.074	0.000	0.000	0.095	0.095	0.000	0.235	0.000	0.235	0.235	0.235
L11	0.002	0.002	0.002	0.000	0.000	0.005	0.005	0.000	0.005	0.000	0.023	0.023	0.023
L12	0.012	0.012	0.012	0.002	0.000	0.015	0.015	0.000	0.003	0.000	0.015	0.015	0.015
L13	0.142	0.142	0.142	0.000	0.000	0.178	0.178	0.000	0.091	0.000	0.091	0.091	0.091
L14	0.003	0.003	0.003	0.000	0.000	0.003	0.003	0.000	0.048	0.000	0.048	0.048	0.048
L15	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.006	0.000	0.006	0.006	0.006
L16	0.012	0.012	0.012	0.000	0.000	0.012	0.012	0.000	0.058	0.000	0.058	0.058	0.058
L17	0.076	0.076	0.076	0.000	0.000	0.061	0.061	0.000	0.030	0.000	0.152	0.152	0.152
L18	0.118	0.118	0.118	0.000	0.000	0.099	0.099	0.000	0.005	0.000	0.036	0.036	0.036
L19	0.009	0.009	0.009	0.000	0.000	0.009	0.009	0.000	0.009	0.000	0.066	0.066	0.066
L20	0.037	0.037	0.037	0.000	0.000	0.047	0.047	0.000	0.003	0.000	0.045	0.045	0.045
L21	0.504	0.504	0.504	0.000	0.000	0.633	0.633	0.000	0.006	0.000	0.141	0.141	0.141
L22	0.003	0.003	0.003	0.000	0.000	0.002	0.002	0.000	0.010	0.000	0.133	0.133	0.133
L23	0.002	0.002	0.002	0.000	0.000	0.003	0.003	0.000	0.002	0.000	0.022	0.022	0.022
L24	0.067	0.067	0.067	0.000	0.000	0.053	0.053	0.000	0.021	0.000	0.224	0.224	0.224
L25	1.247	1.247	1.247	0.000	0.000	1.043	1.043	0.000	0.000	0.000	0.414	0.414	0.414
L26	1.985	1.985	1.985	0.000	0.000	1.662	1.662	0.000	0.000	0.000	0.131	0.131	0.131
TDH1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.178	0.178	0.178	0.178
TDH2	0.000	0.000	0.000	0.000	0.000	0.015	0.015	0.000	0.000	0.098	0.098	0.098	0.098
TDH3	0.012	0.012	0.012	0.000	0.000	0.015	0.015	0.000	0.264	0.847	0.847	0.847	0.847
TDH4	0.012	0.012	0.012	0.000	0.000	0.006	0.006	0.000	0.192	0.613	0.613	0.613	0.613
TDH5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.180	0.577	0.577	0.577	0.577
TDH6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.024	0.024	0.024	0.024
TDH7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.084	0.084	0.084	0.084
TDH8	0.281	0.281	0.281	0.000	0.000	0.201	0.201	0.000	0.388	1.222	1.222	1.222	1.222
TDH9	0.020	0.020	0.020	0.000	0.000	0.016	0.016	0.051	0.247	0.247	0.247	0.247	0.247
TOTAL	**5.629**	**5.629**	**5.629**	**0.099**	**0.000**	**5.663**	**5.663**	**0.051**	**2.149**	**3.889**	**8.528**	**8.528**	**8.528**

APPENDIX I:
BENEFITS OF PROTECTING THE ENTIRE NETWORKS UNDER HR-MPA AND MCS-MPA MANAGEMENT REGIMES

Table I 1. Net present values (£) for protecting the entire networks under HR-MPA and MCS-MPA management regimes (discount rate 3.5%)

Network/ management		**Nutrient recycling (E1)**	**Gas/climate regulation (E3)**	**Food provision (E4)**	**Raw materials (E5)**	**Disturbance prevention/ alleviation (E8)**	**Leisure and recreation (E9)**	**Non-use/ bequest values (E11)**	**Cognitive value (E13)**	**SUM**
Total Value		**1,801,055,521**	**7,084,708,471**	**1,200,890,000**	**152,848,000**	**540,760,000**	**4,372,400,000**	**1,363,276,766**	**491,069,277**	
A/HR-MPA	%	51.44%	51.44%	0.07%	0.07%	0.27%	15.66%	64.31%	64.31%	
	Total	926,421,912	3,644,212,570	880,281	108,362	1,471,105	684,608,335	876,682,390	315,793,366	**6,450,178,322**
A/MCS-MPA	%	50.54%	50.54%	1.13%	0.26%	0.27%	14.92%	62.57%	62.57%	
	Total	910,307,673	3,580,824,915	13,582,542	403,025	1,471,105	652,188,256	853,043,171	307,277,695	**6,319,098,382**
G/HR-MPA	%	85.38%	85.38%	0.12%	0.10%	0.33%	20.28%	91.81%	91.81%	
	Total	1,537,765,751	6,049,020,654	1,416,196	155,840	1,780,887	886,720,562	1,251,583,501	450,835,937	**10,179,279,328**
G/MCS-MPA	%	84.06%	84.06%	1.22%	0.43%	0.33%	19.41%	89.48%	89.48%	
	Total	1,513,994,123	5,955,511,567	14,666,225	664,752	1,780,887	848,568,364	1,219,805,520	439,389,113	**9,994,380,551**
I/HR-MPA	%	67.50%	67.50%	0.10%	0.09%	0.32%	23.11%	87.68%	87.68%	
	Total	1,215,661,464	4,781,977,551	1,155,696	138,847	1,723,230	1,010,311,037	1,195,375,600	430,587,720	**8,636,931,144**
I/MCS-MPA	%	66.36%	66.36%	1.54%	0.34%	0.32%	22.22%	84.65%	84.65%	
	Total	1,195,147,469	4,701,282,831	18,443,749	519,435	1,723,230	971,376,998	1,153,972,885	415,675,191	**8,458,141,789**

Table I 2. Undiscounted mean annual values (£) for protecting the entire networks under HR-MPA and MCS-MPA management regimes.

Network/ management		**Nutrient recycling (E1)**	**Gas/climate regulation (E3)**	**Food provision (E4)**	**Raw materials (E5)**	**Disturbance prevention/ alleviation (E8)**	**Leisure and recreation (E9)**	**Non-use/ bequest values (E11)**	**Cognitive value (E13)**	**SUM**
Total Value		**1,801,055,521**	**7,084,708,471**	**1,200,890,000**	**152,848,000**	**540,760,000**	**4,372,400,000**	**1,363,276,766**	**491,069,277**	
A/HR-MPA	%	4.38%	4.38%	0.00%	0.00%	0.05%	1.50%	6.44%	6.44%	
	Total	78,916,115	310,427,780	0	0	243,751	65,606,306	87,740,493	31,605,410	**574,539,855**
A/MCS-MPA	%	4.32%	4.32%	0.07%	0.00%	0.05%	1.45%	6.30%	6.30%	
	Total	77,732,822	305,773,129	861,865	0	243,751	63,509,908	85,927,335	30,953,223	**565,002,034**
G/HR-MPA	%	7.19%	7.19%	0.00%	0.00%	0.05%	1.94%	9.08%	9.07%	
	Total	129,512,917	509,457,510	0	0	268,127	84,623,526	123,717,367	44,563,195	**892,142,642**
G/MCS-MPA	%	7.09%	7.09%	0.05%	0.00%	0.05%	1.90%	8.89%	8.89%	
	Total	127,707,097	502,354,060	568,438	0	268,127	82,882,796	121,208,937	43,662,350	**878,651,805**
I/HR-MPA	%	5.72%	5.72%	0.00%	0.00%	0.05%	2.20%	8.77%	8.77%	
	Total	102,939,596	404,927,565	0	0	276,252	96,340,644	119,545,740	43,060,447	**767,090,243**
I/MCS-MPA	%	5.63%	5.63%	0.10%	0.00%	0.05%	2.15%	8.53%	8.53%	
	Total	101,388,058	398,824,370	1,191,098	0	276,252	93,972,479	116,260,243	41,876,942	**753,789,442**

APPENDIX J:
NET PRESENT VALUES OF PROTECTING THE ENTIRE NETWORKS UNDER HR-MPA AND MCS-MPA MANAGEMENT REGIMES BY LANDSCAPE AND HABITAT TYPE

Table J 1. Net Present Values (discount rate 3.5%) arising from designation of Scenario A network by landscape and habitat type (compared with NPV arising from the CRO 380 report)

Landscape/ Habitat	Extent of Landscapes/Habitats			Scenario A MCS-MPA		Scenario A HR-MPA	
	Total (whole UK)[1]	% Protected (present study)[2]	% Protected (CRO 380)[3]	NPV (present study)[4]	NPV (CRO 380)[5]	NPV (present study)[4]	NPV (CRO 380)[5]
L1	15,117	15.2%	17.5%	231,173,753	135,462,092	223,222,694	128,648,362
L2	1,559	19.3%	15.6%	49,896,856	12,881,441	49,896,856	12,881,441
L3	12,876	11.9%	2.6%	58,928,898	8,172,911	58,928,898	8,172,911
L4	26,724	10.0%	6.6%	146,686,845	89,655,135	146,686,845	89,655,135
L5	6,738	11.6%	9.1%	61,442,139	33,874,085	61,442,139	33,874,085
L6	9,090	34.4%	25.0%	201,604,387	91,167,402	201,604,387	91,167,402
L7	20,928	10.5%	3.5%	73,791,971	17,073,032	73,791,971	17,073,032
L8	72,686	10.4%	7.0%	447,773,060	304,043,161	447,773,060	304,043,161
L9	14,714	19.8%	25.5%	148,186,232	137,360,660	148,186,232	137,360,660
L10	3,919	8.0%	13.6%	166,186,903	153,421,517	166,186,903	153,421,517
L11	8,206	2.1%	13.2%	7,601,673	25,223,333	23,042,636	68,674,216
L12	17,429	1.8%	15.9%	16,437,364	125,123,099	42,298,246	300,145,015
L13	35,582	4.3%	22.1%	167,451,715	709,439,647	218,701,797	944,141,236
L14	992	0.5%	23.6%	3,291,485	51,970,822	4,765,579	78,019,674
L15	2,121	0.6%	32.3%	4,360,940	86,112,685	6,542,834	140,819,531
L16	4,001	4.9%	13.0%	38,165,582	47,463,554	61,006,355	87,244,770
L17	8,217	10.3%	13.3%	67,505,644	67,073,180	67,436,144	66,973,040
L18	53,990	4.2%	35.7%	130,897,091	1,116,717,757	155,051,333	1,230,158,910
L19	2,996	6.2%	18.4%	22,884,373	34,487,524	22,562,343	34,207,524
L20	18,303	2.6%	15.0%	54,961,035	277,748,584	54,785,504	277,268,304
L21	83,074	6.0%	10.8%	524,190,254	958,001,982	522,632,820	956,487,182
L22	293	20.6%	36.7%	107,426,408	56,936,362	106,392,780	56,376,362
L23	2,357	1.2%	21.6%	8,710,834	74,994,048	8,646,360	74,714,048
L24	9,287	8.6%	12.1%	76,960,204	73,549,750	75,633,400	72,989,750
L25	47,638	10.2%	12.0%	671,281,674	806,607,446	670,636,768	806,029,906
L26	227,075	6.5%	11.2%	1,959,077,696	3,568,627,630	1,957,708,392	3,566,748,270
TDH1	233	10.7%	10.7%	25,011,713	6,846,760	25,011,713	6,846,760
TDH2	1,855	3.2%	3.2%	8,611,207	3,675,590	8,611,207	3,675,590
TDH3	357	28.3%	35.3%	116,194,403	44,932,931	116,194,403	44,932,931
TDH4	220	25.9%	50.9%	151,204,488	91,531,902	151,204,488	91,531,902
TDH5	14	28.6%	57.1%	160,575,832	89,741,220	160,575,832	89,741,220
TDH6	105	1.0%	49.5%	7,154,628	108,091,520	9,547,777	139,871,711
TDH7	61	3.3%	1.6%	7,396,311	906,600	7,396,311	906,600
TDH8	3,118	19.3%	18.7%	233,375,131	N/A	233,375,131	N/A
TDH9	1,217	9.9%	33.9%	162,703,372	129,068,055	162,702,203	129,068,055
TOTAL				**6,319,098,382**	**9,536,505,214**	**6,450,178,322**	**10,242,352,825**

[1]Values of TDH refers to number of records of the different habitats, while extent of landscapes is expressed in Km[2]

[2]Scope of the study: Scottish territorial and offshore waters

[3]Scope of the study: English territorial and UK offshore waters

[4]Values expressed in £2011 prices

[5]Values expressed in £2006 prices

Table J 2. Net Present Values (discount rate 3.5%) arising from designation of Scenario G network by landscape and habitat type (compared with NPV arising from the CRO 380 report)

Landscape/ Habitat	Extent of Landscapes/Habitats			Scenario I MCS-MPA		Scenario I HR-MPA	
	Total (whole UK)[1]	% Protected (present study)[2]	% Protected (CRO 380)[3]	NPV (present study)[4]	NPV (CRO 380)[5]	NPV (present study)[4]	NPV (CRO 380)[5]
L1	15,117	21.2%	23.9%	321,394,078	184,957,357	310,339,954	175,754,397
L2	1,559	28.3%	0.0%	73,322,165	0	73,322,165	0
L3	12,876	14.9%	5.8%	73,349,667	19,570,043	73,349,667	19,570,043
L4	26,724	10.3%	6.4%	150,345,861	87,656,754	150,345,861	87,656,754
L5	6,738	13.4%	8.9%	71,157,461	32,829,565	71,157,461	32,829,565
L6	9,090	33.3%	17.4%	195,369,422	63,245,059	195,369,422	63,245,059
L7	20,928	22.3%	5.1%	157,058,089	24,973,964	157,058,089	24,973,964
L8	72,686	10.6%	9.9%	456,070,795	429,402,952	456,070,795	429,402,952
L9	14,714	22.2%	26.2%	165,953,775	140,766,201	165,953,775	140,766,201
L10	3,919	12.8%	13.2%	265,289,807	148,891,966	265,289,807	148,891,966
L11	8,206	3.0%	15.1%	10,886,854	28,500,813	33,000,871	78,052,707
L12	17,429	2.0%	29.2%	18,459,315	229,947,296	47,501,330	551,248,833
L13	35,582	5.3%	28.3%	204,451,786	909,736,198	267,026,067	1,210,688,927
L14	992	6.3%	27.8%	40,151,290	61,477,072	58,133,065	91,881,464
L15	2,121	0.7%	19.0%	4,859,911	50,581,813	7,291,454	83,315,647
L16	4,001	7.5%	22.1%	58,436,959	81,119,057	93,409,448	147,965,686
L17	8,217	20.2%	17.6%	132,538,528	88,035,053	132,402,075	87,934,913
L18	53,990	4.6%	44.2%	141,240,853	1,383,126,502	167,303,814	1,523,231,537
L19	2,996	8.8%	16.8%	32,256,871	31,434,523	31,802,950	31,154,523
L20	18,303	2.5%	12.5%	53,012,602	231,726,397	52,843,295	231,246,117
L21	83,074	6.1%	19.5%	531,521,895	1,728,471,522	529,942,677	1,725,910,552
L22	293	7.3%	44.9%	38,158,852	69,190,132	37,791,698	68,490,132
L23	2,357	1.2%	13.7%	8,326,752	47,705,165	8,265,121	47,565,165
L24	9,287	13.1%	25.2%	116,560,941	153,060,871	114,551,415	151,840,731
L25	47,638	22.4%	64.7%	1,469,074,820	4,334,794,492	1,467,663,468	4,331,452,692
L26	227,075	7.3%	31.8%	2,208,509,203	10,160,216,618	2,206,965,559	10,154,767,168
TDH1	233	10.7%	10.3%	25,011,713	6,620,110	25,011,713	6,620,110
TDH2	1,855	5.1%	5.0%	13,865,503	5,581,380	13,865,503	5,581,380
TDH3	357	49.0%	55.5%	201,326,936	70,588,892	201,326,936	70,588,892
TDH4	220	30.5%	56.8%	177,731,591	102,543,282	177,731,591	102,543,282
TDH5	14	28.6%	64.3%	160,575,832	100,822,140	160,575,832	100,822,140
TDH6	105	1.0%	70.5%	7,154,628	153,780,170	9,547,777	198,207,431
TDH7	61	4.9%	3.3%	11,094,466	1,813,200	11,094,466	1,813,200
TDH8	3,118	56.3%	55.3%	679,226,127	0	679,226,127	0
TDH9	1,217	11.2%	38.7%	184,395,830	381,502,126	184,395,830	381,502,126
TOTAL				**8,458,141,789**	**21,543,498,705**	**8,636,931,144**	**22,507,785,011**

[1]Values of TDH refers to number of records of the different habitats, while extent of landscapes is expressed in Km^2

[2]Scope of the study: Scottish territorial and offshore waters

[3]Scope of the study: English territorial and UK offshore waters

[4]Values expressed in £2011 prices

[5]Values expressed in £2006 prices

Table J 3. Net Present Values (discount rate 3.5%) arising from designation of Scenario I network by landscape and habitat type (compared with NPV arising from the CRO 380 report)

Landscape/ Habitat	Extent of Landscapes/Habitats			Scenario I MCS-MPA		Scenario I HR-MPA	
	Total (whole UK)[1]	% Protected (present study)[2]	% Protected (CRO 380)[3]	NPV (present study)[4]	NPV (CRO 380)[5]	NPV (present study)[4]	NPV (CRO 380)[5]
L1	15,117	21,2%	23,9%	321,394,078	184,957,357	310,339,954	175,754,397
L2	1,559	28,3%	0,0%	73,322,165	0	73,322,165	0
L3	12,876	14,9%	5,8%	73,349,667	19,570,043	73,349,667	19,570,043
L4	26,724	10,3%	6,4%	150,345,861	87,656,754	150,345,861	87,656,754
L5	6,738	13,4%	8,9%	71,157,461	32,829,565	71,157,461	32,829,565
L6	9,090	33,3%	17,4%	195,369,422	63,245,059	195,369,422	63,245,059
L7	20,928	22,3%	5,1%	157,058,089	24,973,964	157,058,089	24,973,964
L8	72,686	10,6%	9,9%	456,070,795	429,402,952	456,070,795	429,402,952
L9	14,714	22,2%	26,2%	165,953,775	140,766,201	165,953,775	140,766,201
L10	3,919	12,8%	13,2%	265,289,807	148,891,966	265,289,807	148,891,966
L11	8,206	3,0%	15,1%	10,886,854	28,500,813	33,000,871	78,052,707
L12	17,429	2,0%	29,2%	18,459,315	229,947,296	47,501,330	551,248,833
L13	35,582	5,3%	28,3%	204,451,786	909,736,198	267,026,067	1,210,688,927
L14	992	6,3%	27,8%	40,151,290	61,477,072	58,133,065	91,881,464
L15	2,121	0,7%	19,0%	4,859,911	50,581,813	7,291,454	83,315,647
L16	4,001	7,5%	22,1%	58,436,959	81,119,057	93,409,448	147,965,686
L17	8,217	20,2%	17,6%	132,538,528	88,035,053	132,402,075	87,934,913
L18	53,990	4,6%	44,2%	141,240,853	1,383,126,502	167,303,814	1,523,231,537
L19	2,996	8,8%	16,8%	32,256,871	31,434,523	31,802,950	31,154,523
L20	18,303	2,5%	12,5%	53,012,602	231,726,397	52,843,295	231,246,117
L21	83,074	6,1%	19,5%	531,521,895	1,728,471,522	529,942,677	1,725,910,552
L22	293	7,3%	44,9%	38,158,852	69,190,132	37,791,698	68,490,132
L23	2,357	1,2%	13,7%	8,326,752	47,705,165	8,265,121	47,565,165
L24	9,287	13,1%	25,2%	116,560,941	153,060,871	114,551,415	151,840,731
L25	47,638	22,4%	64,7%	1,469,074,820	4,334,794,492	1,467,663,468	4,331,452,692
L26	227,075	7,3%	31,8%	2,208,509,203	10,160,216,618	2,206,965,559	10,154,767,168
TDH1	233	10,7%	10,3%	25,011,713	6,620,110	25,011,713	6,620,110
TDH2	1,855	5,1%	5,0%	13,865,503	5,581,380	13,865,503	5,581,380
TDH3	357	49,0%	55,5%	201,326,936	70,588,892	201,326,936	70,588,892
TDH4	220	30,5%	56,8%	177,731,591	102,543,282	177,731,591	102,543,282
TDH5	14	28,6%	64,3%	160,575,832	100,822,140	160,575,832	100,822,140
TDH6	105	1,0%	70,5%	7,154,628	153,780,170	9,547,777	198,207,431
TDH7	61	4,9%	3,3%	11,094,466	1,813,200	11,094,466	1,813,200
TDH8	3,118	56,3%	55,3%	679,226,127	N/A	679,226,127	N/A
TDH9	1,217	11,2%	38,7%	184,395,830	381,502,126	184,395,830	381,502,126
TOTAL				**8,458,141,789**	**21,543,498,705**	**8,636,931,144**	**22,507,785,011**

[1]Values of TDH refers to number of records of the different habitats, while extent of landscapes is expressed in Km^2

[2]Scope of the study: Scottish territorial and offshore waters

[3]Scope of the study: English territorial and UK offshore waters

[4]Values expressed in £2011 prices

[5]Values expressed in £2006 prices